10th CLASS

SCIENCE AND TECHNOLOGY

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Foreword

Education is like a third eye for humans. Education helps to explore himself and understand the society surrounded by him according to situations. Education gives identity and respect to mankind. The society with educationalists develop in all fields and stands in top position. "Education for everyone growth for every one is a universal objective".

The open school society is established to provide education for all those who are not able to educate get only in schools. This society gives an opportunity for those who are away from education with an objective "Education for everyone-education at your doorstep".

The individuals who completed 14 years can study 10th class through open school society and can continue intermediate education after passing 10th class.

The society is decided to provide new textbooks from the year 2021 for students studying 10th class through open school. According to the guidelines of National education policy and its fundamental principles, change in social situations and needs the textbooks are modernised and provide quality education to learners.

The word science originated from Latin word scientia, means knowledge, which means the process of acquiring knowledge. The main objective of teaching science is to develop scientific attitude, understanding the process through skills and apply them to daily life situations, understand to objective of protecting nature in students. This textbook is prepared to meet the objective of teaching science and learning outcomes as expected by National council of educational research and training (NCERT).

Science have very high importance in present world. Science is facing many challenges even through it is progressing day by day. The principles of science help, the students to know about the nature around them and understand to build a strong base to lead scientific life. The present book is prepared keeping in view all the fundamental concepts related to age group of 10th Class.

There are 33 lessons in this textbook. The part - I contains 19 lessons related to physical sciences and the part - II contains 14 lessons related to biological science. In physical science the lesson are formed based on (5) five themes and biology the lessons are formed based on the two important themes. They are relation, changes in surrounding system and various biological processes. Regarding surrounding system, we discuss various surrounding systems around us and regarding biological process we discuss and understand from cell to various human systems. In these lessons we give importance to save water and other contemporary issues and like measurements to understand them. We include diagrams, Activities, experiments at appropriate places in this textbook. This book is written in simple language and it is easy for self study.

We are thankful to teachers designers, editorial board members, DTP operators for their effort to bring this book in short time. We appreciate **Sri Yanala Venkat Reddy, Ed Mudhusudhan Reddy, Sri Survana Vinayak**, Co-ordinator SCERT, who played a key role to bring out this book. We are thankful to **Smt. M. Radha Reddy**, Director, SCERT to give permission to utilize the services of subject experts and subject coordinators to bring out this textbook in time. We are thankful to **Sri S. Venkateswara Sharma**, Director, Govt. Textbook Press for his continuous support in initiating the design of textbook.

Our special thank are to **Smt. Chitra Ramachandran**, IAS, Principal Secretary for motivating us and identifying the need to change textbook and giving guidance. Our special thanks are to **Smt. Sabita Indra Reddy** garu Honourable Minister of Education for her encouragement and guidance. We are also thankful to Sri **Marasani Somireddy,** Joint Director and **Sri Boyinapally Venkateswara Rao**, State Coordinator for coordinating and encouraging authors, editorial board, designers, subject coordinators for successful completion of textbook. I hope this textbook would help the learners to meet their needs and improve their standards in science.

Date : 24-12-2020
Place : Hyderabad

Sri A. Krishna Rao,
Director,
Open School Society, Telangana, Hyderabad.

వందేమాతరం

– బంకించంద్ర ఛటర్జీ

వందేమాతరం, వందేమాతరం
సుజలాం సుఫలాం మలయజ శీతలాం
సస్యశ్యామలాం మాతరం; వందేమాతరం
శుభ్రజ్యోత్స్నా పులకిత యామినీం
పుల్లకుసుమిత ద్రుమదళ శోభినీం
సుహాసినీం సుమధుర భాషిణీం
సుఖదాం వరదాం మాతరం వందేమాతరం.

జాతీయ గీతం

– రవీంద్రనాథ్ ఠాగూర్

జనగణమన అధినాయక జయహే !
భారత భాగ్య విధాతా !
పంజాబ సింధ్ గుజరాత మరాఠా,
ద్రావిడ ఉత్కళ వంగా !
వింధ్య హిమాచల యమునా గంగా,
ఉచ్ఛల జలధి తరంగా !
తవ శుభనామే జాగే !
తవ శుభ ఆశిష మాగే !
గాహే తవ జయ గాథా !
జనగణ మంగళదాయక జయహే !
భారత భాగ్య విధాతా !
జయహే ! జయహే ! జయహే !
జయ జయ జయ జయహే !

ప్రతిజ్ఞ

– పైడిమర్రి వేంకట సుబ్బారావు

భారతదేశం నా మాతృభూమి.
భారతీయులందరూ నా సహోదరులు.
నేను నా దేశాన్ని ప్రేమిస్తున్నాను.
సుసంపన్నమైన, బహువిధమైన నా దేశ వారసత్వ సంపద నాకు గర్వకారణం.
దీనికి అర్హత పొందడానికి సర్వదా నేను కృషి చేస్తాను.
నా తల్లిదండ్రుల్ని, ఉపాధ్యాయుల్ని, పెద్దలందర్ని గౌరవిస్తాను.
ప్రతివారితోను మర్యాదగా నడుచుకొంటాను.
జంతువులపట్ల దయతో ఉంటాను.
నా దేశంపట్ల, నా ప్రజలపట్ల, సేవానిరతి కలిగి ఉంటానని ప్రతిజ్ఞ చేస్తున్నాను.
వారి శ్రేయోభివృద్ధులే నా ఆనందానికి మూలం.

Subject Experts - Exeaction

Sri Yanala Venkat Reddy
Co-ordinator, Physical Science,
ZPHS, Chivemla, Suryapet

Sri E.D. Madhusudhan Reddy
Co-ordinator, Biological Science,
ZPHS, Chivemla, Suryapet

Writers

Sri Dandala Madhusudhana Reddy, S.A.,
ZPHS, Kodada, Suryapet Dt.

Sri A. Nagaraja Sekhar, S.A.,
ZPHS, Kudunuru, Bhadradri Kothagudem Dt.

Sri C.V. Harikrishna, S.A.,
ZPHS, Toopranpet, Yadadri Bhuvanagiri Dt.

Sri Tirumala Srinivasa Chary, S.A.,
ZPHS, Chinnathundla, Ranga Reddy Dt.

Sri T. Ajay Singh, S.A.,
ZPHS, Somangurthi, Vikarabad Dt.

Sri K. Bhaskar Reddy, S.A.,
ZPHS, Kulkacharla, Vikarabad Dt.

Sri Bhaskar Desh, S.A.,
ZPHS, Isnapur, Sanga Reddy Dt.

Sri P. Narayana Varma, S.A.,
ZPHS, Koritikal, Nirmal Dt.

Sri K. Krishna Mohan, PGT.,
T.S. Model School and Jr. College,
Munagala, Suryapet.

Sri V. Madhusudhan Rao, TGT.,
TS Model School and Jr. College, Narayanapur,
Yadadri Bhuvanagiri Dt.

Sri K. Suresh, S.A.,
ZPHS, Kondapur, Janagaon Dt.

Smt. A. Uma Rani, Science supervisor,
Dept. of Mathematics asnd Science SCERT,
Hyderabad, Telangana.

Sri A. Gnaneshwar, S.A.,
ZPHS, Mallakapally, Warangal Urban.

Sri Sanjeev Kumar, S.A.,
ZPHS, Abangapatnam, Navipet, Nizamabad.

Smt. K. Pavani, S.A.,
ZPHS, Darga Hussani Shahvali,
Sherilingampally, Ranga Reddy Dt.

Smt. Bandari Malathi Bai, S.A.,
ZPHS, Kalasiguda, Secunderabad, Hyderabad Dt.

Sri Pesara Prabhakar Reddy, S.A.,
ZPHS, Mucharla Jastipally, Kamepally,
Khammam Dt.

Sri Manikya Reddy, S.A.,
GHS, Sadasivapet, Sangareddy Dt.

Sri M.D. Akabar, S.A.,
ZPHS, Vurella, Chevella (M), Rangareddy Dt.

Sri G. Shyamsunder, S.A.,
ZPHS,Chetlapotharam, Jinnaram(M), Songareddy.

Sri D. Nagaraju, S.A.,
GHS, Kompally, Munugoda, Nalgonda Dt.

Smt. Maram Pavithra, S.A.,
ZPHS, Gaddipally, Garidepally, Suryapet Dt.

Smt. Thummala Govardhna Mani, S.A.,
GGHS, Secunderabad, Hyd.

Smt. J. Prasanna Kumar, P.G.T.,
TS Model School and Jr. College,
Munagala, Suryapet Dt.

Smt. S. Srivani, P.G.T.,
TS Model School and Jr. College, Palamakula,
Shamshabad, Rangareddy Dt.

Cover & Diagrams : **Sri K. Sudhakar Chary**, S.G.T., UPPS Mylaram, Rayaparthi (M), Warangal Rural.

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Gowtham Srimannarayana, G. Rathna Sowjanya.

Suggestions to Learners

- Able to understand scientific concepts through science textbook.
- Understand the lessons by applying them to your everyday life.
- In the beginning of every lesson learning outcomes are given for the level of 10th class to meet the objectives of teaching science.
- The lessons are prepared as per learning out comes. Therefore lesson has to understand accordingly.
- Probing questions are given in the beginning of every lesson. Begin your lesson according to them.
- Concentrate on Internal questions to test your previous knowledge before starting a key concept given in the lesson.
- By drawing the diagrams given in the lesson, you can understand the importance of various parts and their use. You can able to draw ray diagrams, graphs and modal making.
- Perform the experiments on your own with available material at your place with the help of your trainer and compare the results with explanation given in lessons.
- Utilize online learning facilities.
- Analyze the data given in tables and come to a conclusion for the respective concepts.
- Each lesson is divided into concepts and subconcepts. Improve your understanding wth the help of "Check your progress" given at end of each subtopic.
- Interesting questions, concepts given in the explanation of the lesson. Apply them to daily life situations.
- The important concepts in the lesson given in the end of the each lesson as "Key points". Using this you can revise the entire lesson.
- To know how far you reach the expected learning outcomes in a lesson you are provided "Practice for learning outcomes". Practice them thruroughly.
- Try to follow 8th, 9th and 10th class regular textbooks along with this book.
- For better understanding of learning outcomes and lessons you should compulsory attend the classes at training centre. You can discuss clarify your doubts with trainer at your centre.
- For doing exercises and to write answers given in textbook, keep a separate notebook. Write answers on your own and take necessary suggestions from your trainee at the training centre.
- In your public examinations questions are not directly asked from you textbook. The questions resembling the questions given in the exericse so if you prepare answers for exercise questions on your own it can be helpful.
- You have online facility to better understanding of exercise and lessons. You can avail benifit of them.
- Even though you are studying 10th class in open school your textbook is of same level of regular 10th Class. So utilize them in proper way to get good result.

Suggestions to Teachers

- Develop understanding on each lesson in science textbook by reading completely.
- In the textbook, foreword, suggestions to students, expected learning outcomes are given.
- You can learn the main aim and understanding the science textbook by reading "Foreword".
- Make the students to read "Suggestions to readings" to understand them. Along with students teachers are also read them to know "How to react with students responses".
- This textbook is not prepared in the lines of completion of lesson and results in examination rather it is prepared to meet the "Expected learning outcomes" as main objective. You can understand learning objectives of this textbook by reading "Learning outcomes".
- The important concepts of the lesson expressed in small sentences under the title "Key points". In the same way questions are given in convenient under "Practice for learning outcomes" for students.
- Understand the unit structure of the lesson in the textbook, and provide the students in the same order.
- By keeping total number of contact classes at the training centre, divide the lessons as per schedule and discuss with students.
- Make students not only understand concepts but also perform exercises on their own.
- Train students to write answers on their own for check your progress and practice for learning outcomes. Explain them how to write answers on the black board. Make them to explain key concepts clearly.
- Involve every student in drawing diagrams, labelling the parts and their explain the uses.
- Improve analysing skills for information given tabular form.
- At training centre 6th - 10th class regular textbooks are available for student for better understanding.
- Ask the students to write exercises a lesson in a separate note book. Give suggestions after observing them.
- Make the students to use online learning facilities.
- In examinations questions were not directly ask form exercises therefore prepare them to write answers on their own by understanding key concepts.

Learning Outcomes, Academic Standards achieved through 10th Class Science Textbook

1. Conceptual understanding

- Identify various objects, shapes, characteristics of organisms and their functions.
- Compare various objects, characteristics of organisms and their functions.
- Differentiate various objects, shapes of various organisms, structures.
- Classify the organisms according to their properties, functions.
- Explain the different processes, phenomena, principles, theories, laws and key concepts.
- Identify the reasons for relation between process and phenomena.

2. Asking questions and making Hypothesis

- Ask questions to clarify the doubts about the concepts.
- They are able to guess the results of an issue with proper reasoning.

3. Experimentation and Field investigation

- They are able to do activities, experiments to get answers for their doubts.
- They are able to participate in field investigation to prepare reports.

4. Information skills

- Able to collect information related to various concepts.
- Able to analyze the collected information by recording them in a tabulae form.

5. Communication through drawing, model making

- Draw the pictures and labelling the parts.
- Draw flow charts and graphs
- Making models and explain them.

6. Appreciation and aesthetic sense, Values

- Appreciate and discuss the stories of scientific inventory.
- Able to appreciate efforts of human beings, the objectives of matter and scientists whjo involved in development of science.
- They are able to follow constitutional values.

7. Application to daily life; Concern to biodiversity

- Able to apply the concepts they learned to daily life situations.
- Recognises the importance of biodiversity.
- Takes measures to protect the biodiversity.

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Chapter 1

Measurement in Science and Technology

Introduction

In everyday life without measurement our day is not complete. Recall your one day activity and notice the instances of measurements. 2 litre of milk, 1 kg of rice, 50 km of distance, 3 m piece of cloth etc., are some examples of measurement we make. In science and technology accurate measurement is essential. If we measure wrongly, the consequences may be very serious in our daily life. We use a wide variety of measurements in our daily life. Are they measured in the right way or not? Are the right units used to measure or not? To answer these questions in this chapter you will learn what is measurement? and types of measurement. What are the diferences between the measurements used in ancient times and the measurements used presently?

Learning outcomes

After completing this lesson you will be able to:

- *Define measurement and explain the need for accurate measurement.*
- *Define physical quantities and differentiate fundamental and derived quantities.*
- *Differentiate between fundamental (Base) and derived quantities.*
- *Explain different systems of measurement widely used in the world.*
- *Explain the development of SI units and need of SI units.*
- *Describe different type of measuring devices.*
- *Use appropriate instruments for accurate measurement.*

1.1 Measurement

1.1.1 What is Measurement?

Activity-1:

To measure the length of your class room using different methods.

Suppose you are asked to measure the length of your class room. What would you do?

- You would walk from one end to another end of the class room and count the number of steps.
- Ask your friend to measure the same length by using a scale.
- Ask another friend to measure the same length by using his hand span.

What do you observe?

To know the length of the class room (unknown) you and your friends use either footsteps or scale or hand span (known).

Similarly to know the weight of your school bag (unknown) you can use spring balance (known) or pan balance (known). That is *measurement involves a comparison between the unknown measurand and something known that we can refer to.*

1.1.2 Why do we need measurement?

Suppose you go to a textile shop to buy clothes. You need 2 m cloth. Do you feel happy if shop keeper measures the cloth by using his hand? No, because the length of the cloth he gives may be more than 2 m or less than 2 m. If it is less than 2 m it is a loss for your and if it is more than 2 m it is a loss for him. To avoid loss for both of you, an accurate measurement is needed.

How do you buy vegetables? Suppose a vegetable seller comes to your street in the morning and your mother goes out to buy vegetables from him. If he gives vegetables without measuring by any balance, do you accept? And think the reason for not accepting it. Thus need of an accurate specific scale is required to make measurements which is called unit.

Check your Progress

- What is the need for measurement?
- How does measurement helps in trading?

1.2 Physical Quantities

1.2.1 What is a Physical quantity?

In your daily life you observe many things (materials), objects, systems around you in which some of them are visible and some are invisible. Suppose take an object in to your hand. What do you feel when you see that object? You think about its colour, shape, size, weight or the volume. These are called some physical properties of that object in which some are measurable. *A physical quantity is a property of a material or system that can be quantified by measurement.*

A physical quantity can be expressed as the combination of numerical value and a unit. That is, the physical quantity consists two parts, a numerical value and unit.

Example-1: Distance between your home and post office is 2 km.

In the above statement "2" denotes numerical value and "km" represents Unit. If you write only as "2" it is meaningless.

Example-2: The time taken to reach your friend's house is 15 minute.

In the above statement "15" is numerical value and "minute" is unit.

1.2.2 Types of Physical quantities

1.2.2a. Fundamental or Base physical quantities:

The Set of physical quantities, for fundamental importance from which all other possible quantities to be derived are called fundamental quantities or base quantities.

Initially Length, Mass and Time is known as fundamental quantities, the remaining quantities are derived from these quantities. But, from 1931 to 1971 CGPM(**English:** General Conference on weights and measurements, **French:** *Conférence Générale des Poids et Mesures*) added some more physical quantities to fundamental or base quantities. Finally there are total 7 fundamental or base quantities. Besides these seven base quantities, CGPM defined two more supplementary quantities.

Table -1 : Fundamental or Base quantities.

S.No	Name of the quantity	Typical Symbol.
1	Length	$l, x, r,$ *etc.*
2	Mass	m
3	Time	t
4	Electric current	I, i
5	Thermo dynamic temperature	T
6	Amount of substance	n
7	Luminous Intensity	I_V

Table -2 : Supplementary quantities.

S.No	Name of the quantity	Typical Symbol.
1	Plane angle	$\alpha, \beta, \psi, \phi$ *etc.*
2	Solid angle	Ω (omega)

1.2.2b. Derived quantities:

All the physical quantities may be expressed in terms of the fundamental quantities. That is they are derived from one or more fundamental quantities. Those are called derived quantities.

Examples: Area of rectangular surface = length × breadth (Since breadth is also kind of length)

Speed = distance/time (Since distance is also kind of length)

Check your Progress

- What are the two parts of physical quantity?
- How do you differentiate base and derived quantities?

1.3 Unit

1.3.1. What is unit?

Activity-2

To understand the concept of unit.

- Take 4 cylindrical shape rulers of different length and same thickness.
- Name them as A, B, C and D as follows.

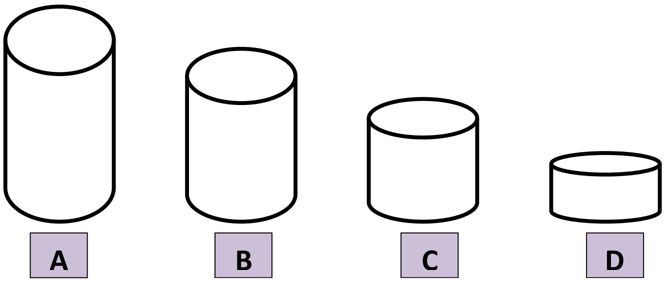


Fig - 1 : Cylindrical Shape rulers

- Now measure the length of ruler A using D.
- Similarly Measure the lengths of rulers B and C using D.
- Note the values in the following table.

Table - 3

S.No	Name of the ruler	Length of ruler in terms of "D"
1	A	
2	B	
3	C	

Now measure the lengths of rulers A, B and D by using ruler "C", note down the value in the table.

Table- 4

S.No	Name of the ruler	Length of ruler in terms of "C"
1	A	
2	B	
3	D	

- What do you observe from above two tables?
- Are the readings same in above two tables for ruler A?
- According to you, which readings are correct?
- If your friend used ruler B as standard, will he / she get same readings for ruler A like in table-4?

Let us discuss, if you take ruler "D" as a standard, table-3 is correct, if you take ruler "C" as standard table-4 is correct. That is, the readings of ruler "A" depend on standard unit.

Physics describes the laws of nature. This description is quantitative and involves measurement and comparison of physical quantities. To measure a physical quantity, need a standard unit of that quantity. Like above example, readings are varied when a person changes a standard unit. When people using their own standardise units would not get accurate values of measurements. So, measurements of physical quantities are expressed in terms of units which are standardized values and globally accepted.

1.3.2. How did our ancestors make measurement?

Activity - 3 :

To measure length of black board using Hand span and digits.

Description:

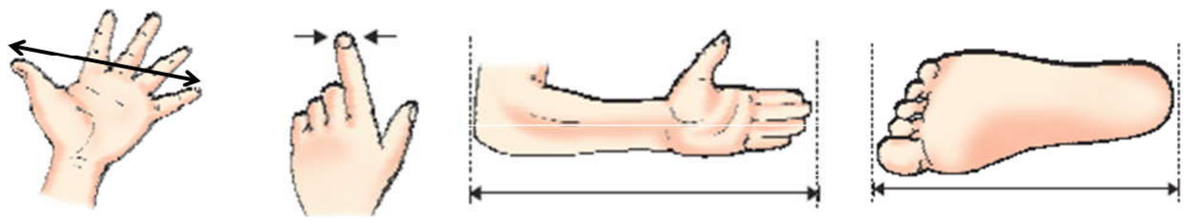
- Go to black board (in case of not available use desk or wall or bench) with a group of 4 to 5 students.
- First measure the length of the black board using hand span and digits as the units of measurement and record your observations in the table.

Table - 5

S.No	Name of the student	Length of the board in hand span and digits.
1		
2		

- What do you observe from the above table?
- Why do the readings of length in the table vary from student to student?

By observing above data we can conclude that hand span and digits that depend on parts of human body are arbitrary and inaccurate. Our ancestors mainly used their body parts while making measurements like Digit; the width of single finger, Foot span; the length of a foot, Cubit; Length of an arm, Hand span; the distance between the tip of the thumb and tip of the little finger when the hand is freely stretched out. It is interesting that these are still used some times in our surroundings.



Hand Span **Digit** **Cubit** **Foot Span**

Fig - 2 : Lengths of body parts

But the results may vary from person to person because size of the unit is different from person to person. This created many problems in trade between persons and between countries. In order to overcome the limitations of body parts as units and bring out uniformity in the measurement system the need for exact measurement is felt. For this a standard measurements had to be developed which are acceptable by everybody.

1.3.3 The Modern Measurement system

After French revolution (1790) the French scientists took lead in establishing a new system of weights and measures. This led to the birth of Metric system which is like a Hindu-Arabic counting system based on the multiples of subdivisions of ten. After detailed considerations the basic unit of length and mass were defined and their working standards were prepared. The working standard for meter was prepared on platinum-iridium bar by making two lines a metre apart. Similarly platinum-iridium cylinder was made equal to the mass of 1 cubic decimetre of water, as the working standard for mass. These two standards were preserved at the International Bureau of weights and Measures at Serves near Paris. The copies of these two were prepared and sent to different countries.

In the meanwhile number of systems were developed. But two systems which were widely used were CGS and MKS systems. The units for length, mass and time are centimetre, gram and second in the CGS system. Similarly metre, kilogram and second are the units for length, mass and time respectively in MKS system.

Table - 6

Measurement System → Base quantities ↓	CGS	MKS
Length	centimetre	metre
Mass	gram	kilogram
Time	second	second

Check your Progress

- How our body parts help to take measurement of length in olden days?
- What are the units for mass in CGS and MKS system?

1.4 SI Units

In 1958, it was realised that the units defined as standard to be redefined. Since 1960, the new exercise of redefining the system of units led to the birth of SI (English : The International system of units, French : *Système international d'unités*) system of units which is currently in use. It was adopted in 11^{th} general conference on weights and measures (CGPM). In 1983 the SI units are redefined.

In 1960 the 11^{th} CGPM formally defined and established the SI and has subsequently revised it from time to time in response to the requirement of users and advances in science and technology. The most recent revision of SI was made by CGPM in its 26^{th} general conference held in Nov-2018 and released a document in 9^{th} edition of SI brochure.

The SI consist system of units for use in all aspects of life including international trade, manufacturing, health and safety, protection of environment in the basic science.

1.4.1 Fundamental Units (Base Units)

The definition of the SI units established in terms of a set of even defining constants. The complete system of units can be derived from the fixed values of these defining constants, expressed in the units of the SI.

Table-7

Name of the Base quantity	Typical Symbol	Base unit name	Symbol
Length	l, x, r etc	metre	m
Mass	m	kilogram	kg
Time	t	second	s
Electric current	I , i	ampere	A
Thermo dynamic temperature	T	kelvin	K
Amount of substance	n	mole	mol
Luminous intensity	I_v	candela	cd

1.4.2 Derived Units

Base units like length, mass and time are independent. Other physical quantities like area, volume, speed, acceleration, force etc., are derived from these basic quantities. The units of the derived quantities are called derived units. Initially find out the relationship between derived and fundamental quantities, and then substitute the units of the base physical quantities to find derived units. Let us discuss an example.

Example - 1 : Derive the SI unit for volume of a solid cuboid.

In order to derive the unit for volume, find the relation between volume and base physical quantity. As you know the volume of a solid cuboid is the product of length, breadth and height. So as the first step we write volume as

$$\text{Volume} = \text{length} \times \text{breadth} \times \text{height}$$

Breadth and height are also kind of length. So we came to write as

$$\text{Volume} = \text{length} \times \text{length} \times \text{length}$$

To find the derived unit of volume, we substitute the units of length as

$$\begin{aligned}\text{Units of volume} &= \text{metre} \times \text{metre} \times \text{metre}\\ &= (\text{metre})^3\\ &= m^3\end{aligned}$$

The SI unit of volume is m^3 and pronounced as cubic metre.

Example - 2 : Find the units for Density.

We know that density is defined as mass per unit volume.

Density = Mass/volume

Since volume = $(\text{length})^3$

Therefore density = mass / $(\text{length})^3$

SI Units for Density = kg/m^3 = kg m^{-3}

Table - 8 : Some examples of derived units.

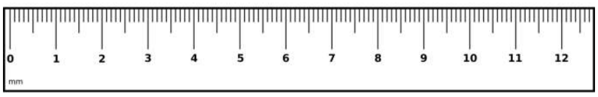
Derived Quantity	**Relation between base and derived quantity**	**Name of unit**	**Symbol of unit**
Area	length × length	square metre	m^2
Volume	length × length × length	cubic metre	m^3
Speed , velocity	Length/time	metre per second	m/s
density	$\text{Mass}/(\text{length})^3$	kilogram per cubic metre	Kg/m^3

Check your Progress

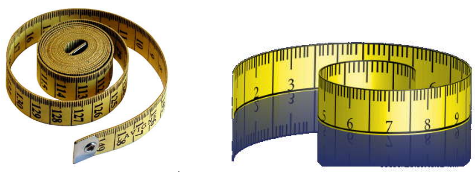
- What is the importance of SI units?
- Derive units for velocity and acceleration.

1.5 Measurement of length

In your day to day situations we observe many measurements of lengths, in general, breadth, distance, displacement, height all are same kind of length. To measure length we have many devices like centimetre scale, metre scale, plane tape, rolled tape, verniar scale, screw gauge etc. In these some of the devices are used to measure short distances like length of table, breadth of class room etc., some devices like vernier scale , screw are gauge used to measure very small distances like thickness of copper wire, inner and outer diameters of hallow pipe etc.



Centimetre Scale



Rolling Tape

Fig - 3 : Measurement Scale and Tapes

SI unit for length is metre. But sometimes we use other units to measure length like centimetre, kilometre, millimetre and etc. What is the relation between these units? Let us see.

1 m = 100 cm

1 cm = 10 mm

1 m = 1000 mm

1 km = 1000 m

1 m	=	10^{-3} km
1cm	=	10^{-2} m

Least count of a device

When we are using a device we must know about its working principle and its least count, the smallest value that can be measured by the measuring instrument is called its least count. Measured values are good only up to this value.

Least count of a centimetre scale commonly using in your compass box is 1 mm. similarly least count of vernier scale is 0.1 mm, and screw gauge is 0.01 mm. That is, the minimum possible value taken by a centimetre scale is 1 mm.

1.5.1 Measurement of length by using a scale or tape

One metre is divided into 100 equal parts and each part is called a centimetre. Each centimetre is equally divided into 10 parts, each part is called a millimetre. Generally scale has centimetres marked on one edge and inches on another edge. Centimetres have decimal divisions while inches have fractional divisions. Scale may have bevelled edge to avoid errors due to parallax error. The least count of scale is 1 mm or 0.1 cm. list count in vernier scale is 0.1 m or 0.01 cm, screw gauge lowest count 0.01 mm or 0.001 cm.

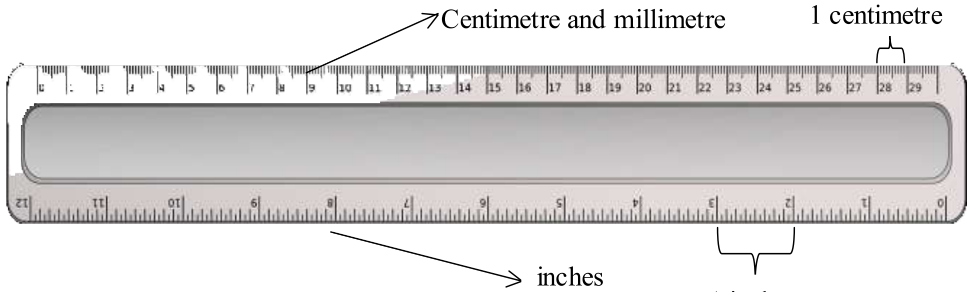


Fig - 4 : Measurement Scale

- Suppose we are asked to measure the length of a table. We take a metre scale and mark zero on the scale is made to coincide with one end of the table and the reading at the point which is coinciding with the other end of the table is taken. Since a metre scale has some thickness, we may make an error if the eye is not correctly positioned. The correct position of the eye is "B" which is vertically above the end where the reading is to be taken. So that the corresponding graduation can be read clearly. If eye is not kept exactly vertically above the end of the object, it leads to an error called parallax error.

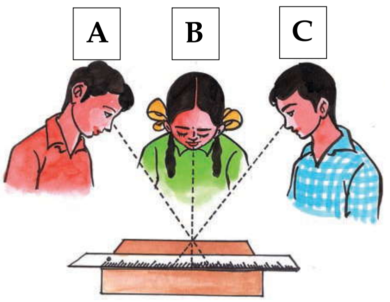


Fig - 5 : Parallax error

- Do we get proper measurement by viewing from **A** and **C** places? Why?

1.5.2 Precautions while using metre scale

We must take the following precautions while using a metre scale for measuring length.

(i) The scale should be placed exactly along the length to be measured.

(ii) Zero point on the scale should coincide with the starting point of the length to be measured.

(iii) Our eye must be vertically above the point of coincidence of scale where the measurement is to be taken.

(iv) Ensure that the ends of the scale are not worn out.

(v) Measure the length of an object more than two times and then take the average of these measurements for accuracy.

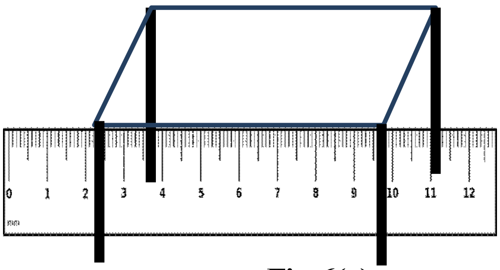


Fig-6(a)

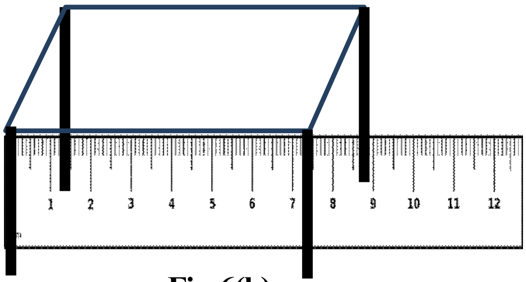


Fig-6(b)

- In above 2 figures in which case scale is placed correctly? Why?

Activity-4:

To find the length and breadth of the table using metre scale.

- Place the metre scale along the length of the table so that the "0" mark on the metre scale coincides with one end of the table edge and reading at the other end of the scale indicates the length of the object.(fig-7(a))
- To avoid wear and tear off the end of the scale, sometimes the scale is placed along the table and reading at the ends of the table is taken. The length of the table is obtained by subtracting lower reading from higher reading.(fig-7(b))
- Take readings without parallax error.
- Repeat the process to measure breadth of the table.(fig-7(c))
- You and your friends take 5 to 6 readings and record in the table.

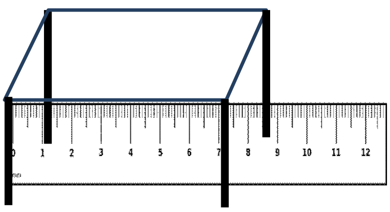


Fig-7(a)

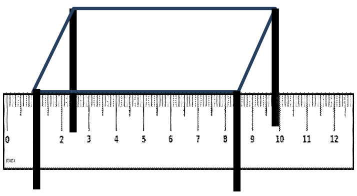


Fig-7(b)

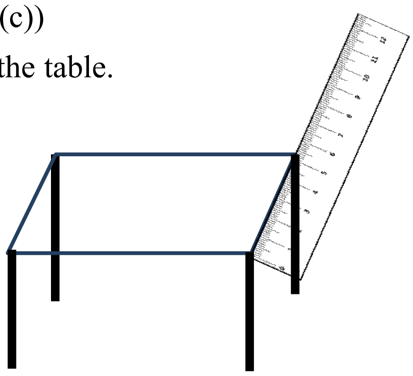


Fig - 7(c)

Table - 13 Observations:

S.No	Name of the student	Length of the table	Breadth of the table

- What do you observe from above table?
- Are the readings of length measured by you and your friends the same?

Activity-5:

Measuring the length of a curved path

- Fix pins at the ends of the curved line to be measured as shown in the Fig. 8.
- Now tie a knot with cotton thread at the first point of the pin A and move the cotton thread along points B, C, D, E etc.
- Care should be taken that the thread is neither too tight nor too loose and see that the thread coincides with the curve at each point while moving along the path.
- When the thread reaches the extreme end of the curved path, cut it at that point.
- Remove the thread from A and then place it straight along the length of a meter scale, and measure its length. The length of the thread is the measure of the length of the curved path.

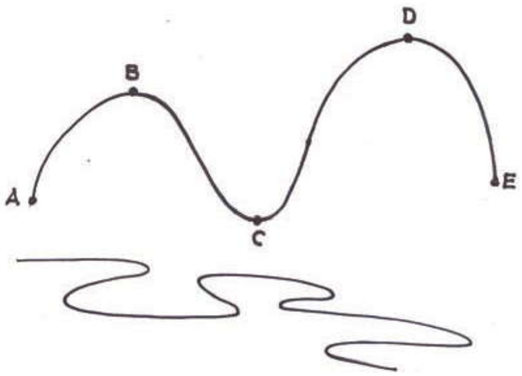


Fig - 8 : Measuring the length of a curved path

Check your Progress

- What are the precautions you have to take while measuring the length of a table?
- Can a metre scale is used to measure distance between two villages? Why?

1.6 Measurement of Mass and weight

What is mass? Let us discuss, mass is a measure of the amount of matter contained in an object. In general mass is measured in terms of kilogram, gram, milligram, quintal, tonne etc. To measure the mass we have different type of balances like pan balance, physical balance and table balance, analytical Balance.

1 kg	=	1000 gram		
1 gram	=	1000 milligram		
1 quintal	=	100 kg		
1 tonne	=	1000 kg	=	10 quintal
1 gram	=	10^{-3} kg		
1 milligram	=	10^{-3} gram		

Pan Balance **Table Balance**

Fig - 9 : Types of Balance

Weight is gravitational force acting on a body. It is denoted by "W". It is the product of mass and acceleration due to gravity at that place. The SI units of weight are Kgwt or newton (N). CGS units are gm wt. Generally it is measured by using spring balance, platform balance, electronic balance etc.

$$\text{Weight (W)} = \text{mass (m)} \times \text{acceleration due to gravity (g)}$$

Mass is constant at anywhere in the universe, but weight of the body varies as per acceleration due to gravity. You will learn in detail about weight in Gravitation chapter.

Compression Balance **Electronic Balance** **Spring Balance** **Platform Balance**

Fig - 10 : Types of Balance

Check your Progress

- Write any two differences between mass and weight?
- Why spring balnce is used to measure weight?

1.7 Measurement of time

Time is the interval between two events. The study and science of time measurement is called chronometry. SI unit of the time is second. In our day to day life we are using many other units of time like minute, hour, day, week, month, year etc.

In everyday practice, we use 12-hour clock system. Airlines and railways use 24-hour clock system.

1 minute	=	60 second		
1 hour	=	60 minute	=	3600 second
1 day	=	24 hour	=	86,400 second
1 week	=	7 days		

Time can be measured using a simple pendulam clcok, stopwatch, atomic clock, mechanic clock, quartz clock, sun dial, water clock, sand clock etc.

Measurement of time is very important because the time can be considered as a common language between people and due to which everybody proceeds in an orderly manner in this fast-paced world. The time is important for keeping social interactions.

The oldest and most used method of mesuring time is based on the earth rotating about its axis due to which the day and night occur. Rising and setting of the sun considered as a periodic motion and is considered as the reference for measuring time.

Pendulum clock

Digital clock

Sand dial

Sun dial

Fig - 11 : Measurement of time

1.7.1 Stop watch

A stopwatch is used to measure the time interval of an event. It is a kind of watch that stands out for the accuracy and precision with which it can measure the time of an event. It works by pressing a start button and then stopping it. It is also known as a chronometer and is used to measure fractions of time, usually short and accurately. Basically there are two types of stopwatches, Digital stopwatch and Analog stopwatch.

How to read Digital stop watch?

It is commonly used in laboratories; it can measure a time interval upto 0.01 second. It starts to indicate the time lapsed as the start/stop button is pressed. As soon as the start/stop button is pressed again, it stops and indicates the time interval recorded by it between the start and stop of an event. A reset button restores its initial zero settings.

Fig - 12 : Digital stop watch

How to read analog or Mechanical stopwatch?

A mechanical stopwatch can measure a time interval of upto 0.1 second. It has a knob that is used to wind the spring that powers the watch. It can also be used as a start-stop and reset button. The watch starts when the knob is pressed once. When pressed the second time, it stops the watch while the third press brings the needle back to zero.

Fig - 13 : Analog stopwatch

Check your Progress

- What are the different units for time?
- Name different type of devices used to measure time.

1.8. Measurement of volume

In your daily life you observe many situations of measuring volume like measuring volume of milk, petrol, diesel etc. What is volume? Volume is the measure of extent of space occupied by an object. May the object is solid or liquid or gas, SI unit of volume is cubic metre. In general volume is measured in different terms like litre, cubic centimetre, millilitre etc. To find the volume of regular solid bodies has some formulae (like volume of cube is equal to its third power of side). But to measure the volume of liquids or irregular solid bodies we can use many devices like measuring jar, measuring flask, pipette, burette etc.

1 litre = 1000 millilitre

$1\ m^3 = 10^6\ cm^3$

1000 cubic centimetre = 1 litre

1.8.1 Measuring Jar

It is cylindrical in shape, with graduations marked on its body. Measuring cylinders are available in different sizes. They are used in laboratories to measure a certain volume of a liquid and to measure milk, oils etc. by shop keepers. We can fill it with the liquid to be measured and then read the marking at the lowest point of the concave surface of liquid. We must bring our eyes in line with this level of liquid and then read it.

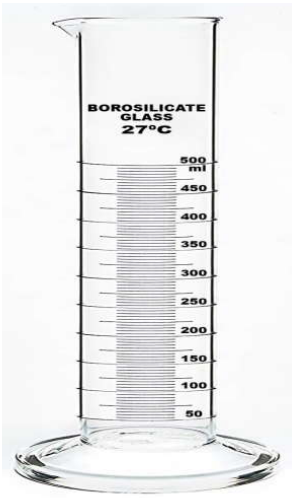


Fig - 14 : Measuring Jar

Activity - 6

Measurement of volume of irregular solids using a measuring cylinder

- Take a measuring cylinder and fill almost half of it with water. Record the volume of water Let us assume it is “a” cm^3 (or “a” ml).
- Now tie a small irregular solid (stone) with a fine cotton thread. Put the solid gently into the water in the cylinder so that it is completely immersed in water.
- What changes do you notice in the water level of the cylinder?
- You may notice that the level of water in the measuring cylinder rises as the stone displaces water equal to its own volume.
- Record the new volume of water.Let us assume that it is “b” ml.
- Now the volume of stone will be the difference between the second volume and the first volume i.e volume of the stone = (b - a) cm^3

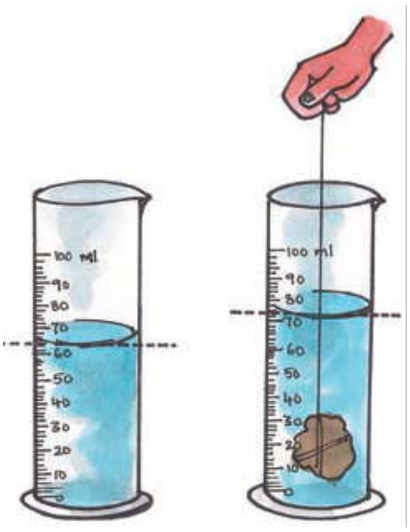


Fig - 15 : Finding volume of stone

Check your Progress

- How do you find the volume of petrol by using measuring jar?
- What are the different units for volume?

Key Points

- Measurement is a basic skill which forms an essential part of our day to day life.
- It is a process of comparison and involves counting of the number of times a chosen scale is used to make the measurement.
- A property of a substance or system which is measurable is physical quantity.
- Physical quantity which is independent is fundamental quantity.
- Globally accepted system to measure physical quantities is SI system.
- Mass is constant in universe. Weight is gravition attraction force on a body. It changes from place to place.
- To measure the mass we have different types of balances like pan balance, physical balance, table balance.
- Generally weight is measured by using spring balance, platform balance, electronic balance etc.
- Time can be measured using a simple pendulam clcok, stopwatch, atomic clock, mechanic clock, quartz clock, sun dial, water clock, sand clock etc.
- To measure the volume of liquids or irregular solid bodies we can use many devices like measuring jar, measuring flask, pipette, burette etc.

Practice for Learning Outcomes

1. What is the importance of measurement in our day to day life?
2. How Unit plays important role in trading? Give examples.
3. Write precautions while using a meter scale.
4. Explain parallax error, how do you minimize parallax error while taking readings?
5. How do you find length and breadth of table by using a metre scale?
6. Explain the working principle of a digital stop watch.
7. Assume and write, what will happen if there is no system of measurement?
8. Explain the procedure in the experiment to find the volume of irregular body.

Multiple choice questions

1. 1 hour is equal to ( )
   A) 60 second B) 3600 second C) 3600 minute D) 30 minute
2. Number of base quantities ( )
   A) 3 B) 9 C) 7 D) 12
3. Choose derived quantity from the following ( )
   A) Length B) Mass C) Time D) Speed
4. Which of the following device is used to measure weight ( )
   A) Pan balance B) Table balance C) Analytical balance D) Spring balance

Chapter 2

Motion and Its Description

Introduction

We observe birds flying in the sky, fluttering butterflies, fish in a pond, dogs, cows, ants wandering in our surroundings, buses, autos, cars, bullock carts moving on the road, trains on railway tracks, an aeroplane in the air, rotating blades of the electric fan, a swing and many other objects around us are in motion. Certain other objects appear to be at the rest. For example houses, tables, trees, bridges, mountains do not move. But when we are moving in a car, trees and other objects on the sides of the roads look like they are in motion.

Which of them are moving?

Which are at rest?

How do you decide whether an object is in motion or at rest?

Let us learn about the position of moving and stationary objects and various types of motion, distance, displacement, speed, velocity, acceleration, uniform motion, and nonuniform motion, and the time period in this lesson.

Learning Outcomes

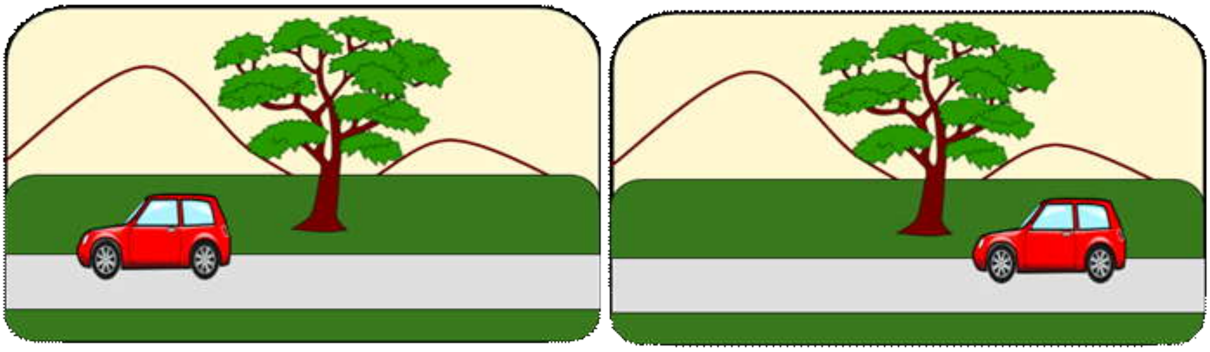
After completing this lesson you will be able to:

- Explains the concept of motion and rest
- Classifies types of motion
- Defines the distance, displacement, speed, velocity and acceleration
- Distinguishes between speed and velocity
- Explains the difference between scalar and vector
- Distinguishes between uniform motion and non-uniform motion
- Solves simple numerical problems to understand average speed, velocity and acceleration

2.1 Motion and Rest

You might have seen that the butterfly is not in the same place after some time, while the house is at the same place in our surroundings. But when you are in a moving car you feel that the house is also moving. Now let us understand with an activity.

Activity: 1 : Observing the position of an object, relation to its surroundings.



- ***What difference do you notice in the position of the car?***
- ***What difference do you notice in the position of the tree?***
- ***Why has this difference occurred?***
- ***Is it because the tree moved to the right of the car or the car moved to the left of the tree?***

We can observe the position of the car has changed concerning the tree in a while. But there is no change in the position of the tree concerning its surroundings. Thus we can say that the *tree is at rest* and the *car is in motion*, we observe them over a while.

If an object changes its position with respect to its surroundings with time, then it is said to be in motion.

If an object does not change its position with respect to its surroundings with time, then it is said tobe at rest.

To describe the position of an object, we specify its position with respect to a fixed position known as Origin (Point of Observation). An object may be at rest with respect to one set of surroundings and at the same time be in motion with respect to another set of surroundings. Thus motion is relative to the observer with surroundings. Hence ***motion is relative***.

Check your Progress

- Explain with an example how motion is relative.
- How do you say an object is at rest?

2.2 Types of Motion

- ***Are the movements of a stone thrown into the air at an angle and a stone thrown from the top of a building the same?***
- ***Are the earth rotating around itself and the earth revolving around the sun the same motions or different?***

The motion of all objects is not the same. Different objects show different types of motion. Some of the important types of motion are:

- ***Translatory***
  - ***Linear motion***
  - ***Curvilinear motion***
- ***Rotational motion***
- ***oscillatory motion (Periodic motion)***
- ***Random motion***

2.2.1 Translatory Motion

When an object moves from one place to another over a period of time, the position of the object changes, its motion is called translatory motion.

A vehicle moving on the road in a straight path but sometimes in a curved path also. So, we can say that ***rectilinear and curvilinear or circular motions*** of an object are ***translatory.***

(a) Rectilinear motion:

Motion in a straight line is called rectilinear motion. When an object moves along the straight-line path, it is called rectilinear motion. For example,

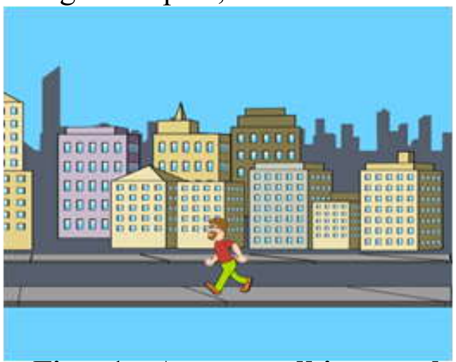


Fig - 1 : A man walking on the road

Fig - 2 : March-past of Soldiers

Fig -3 : Vehicles on the road

(b) Curvilinear Motion or Circular motion

The motion of an object moving in a curved path is called curvilinear motion. The curvilinear motion describes the motion of a moving object that confirms to a known or fixed curve. It can be uniform, with a constant angular rate of rotation and constant speed. For example; Motion of a paper aeroplanes thrown into air, the motion of a snake, a stone thrown into air with an angle, the motion of a ball thrown into basket, the motion of a bicycle tyre, circulation of blood in our body etc.

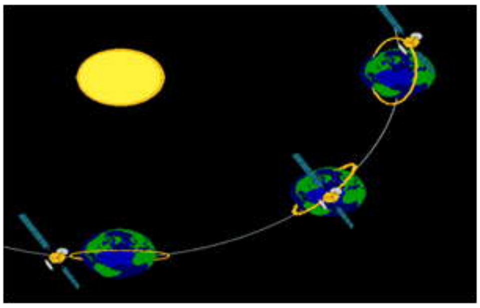


Fig - 4 : The motion of the earth around the sun

Fig - 5 : An Athlete running around the circular path

2.2.2 Rotational Motion

If a body moves about a fixed axis, it is called rotational motion. Rotational motion is non-uniform with a changing rate of rotation. In rotatory motion, the body rotates on its axis.

For example, rotation of hands of a clock.

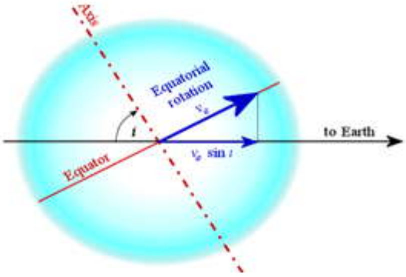


Fig - 6 : Rotation of the earth on its axis

Fig -7 : Rotation of the fan

Fig - 8 : Spinning top on the ground

2.2.3 Oscillatory Motion

A motion that repeats itself at regular intervals of time is called oscillatory motion. *It is also known as* ***periodic*** *motion.* For example a swing in motion, a water wave, pendulum bob in a clock.

Fig - 9: Vibrating tuning fork

Fig -10 : A rocking chair

Fig -11 : A bouncing ball

2.2.4 Random Motion

If the motion of moving objects is not in a definite path it is known as random motion. For example, the motion of fish in the water.

Fig - 12 The motion of dust particles in the air

Fig -13 : Fluttering butterflies

Activity 2 :

Finding the motion of objects

Observe the following objects in motion, state whether they are moving along the straight line (rectilinear) or curvilinear or rotational or periodic or random.

Sl. No.	Objects in motion	Rectilinear/ Circular/ Rotational/ periodic /random
1.	A man walking on the straight path	Ex: rectilinear
2.	The motion of the earth around the sun	
3.	The motion of the earth around its axis	
4.	Birds flying in the air	
5.	Blood flowing inside our body	
6.	Hands of a Clock	
7.	Bus tyres moving on the road	
8.	Sewing machine	
9	A vehicle moving on the road	
10.	The motion of a ball on the ground	

- ***If you are walking on a straight path, What type of motion it is?***
- ***What kind of motions does a vehicle have?***
- ***What motion does the earth have?***
- ***In the case of a moving bus, what kind of motion do the tyres have?***
- ***Did you say an object can have more than one motion?***

Now, we can conclude that a vehicle moves on the road in a straight path but sometimes in a curved path also. Our earth moves around the sun in a circular path as well it rotates around its axis. Bus tyres moving on the road have both circular and rotational motions. A sewing machine also has more than two motions like circular, rotational and oscillatory motions. Some of the objects move in rectilinear, curvilinear, rotational and in periodic motion but some of them are a combination of two or more.

Check your Progress

- Explain the types of motions with examples.
- Can an object posses translatory and rotatory motion at the same time?

2.3 Distance and Displacement

Gayatri goes to school every day. The school is 1 km away from her home. Departing from home it took at least 10 minutes to reach the school on the road.

How far is the school from Gayatri's house?

What is the starting point of Gayatri? What is the endpoint?

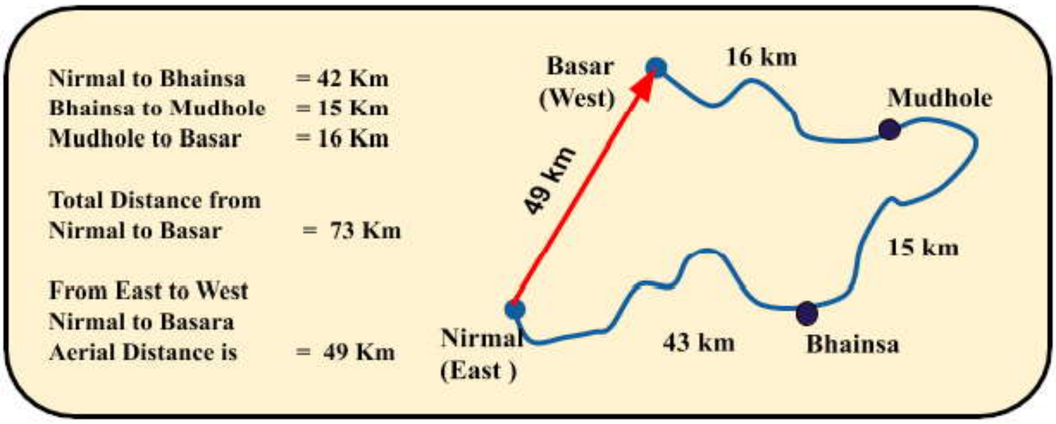
The length of the path is travelled distance. Distance is path-dependent without any direction. It can not be zero or negative during the motion of an object.

Distance is defined as the length of the actual path from the initial position to the final position of an object.

SI Units: meter (m)

CGS units: Centimeter (cm)

Check out the routes from Nirmal to Basara on the below given map.



How many routes are there to travel from Nirmal to Basara?

Which route has the minimum distance?

There are two ways to travel from Nirmal to Basara, curved path shows the distance travelled from Nirmal to Basara and it is the maximum distance consisting 73 km. Minimum distance travelled is shown in the figure as the shortest path which is the aerial distance consisting 49 km from East to West. When two points are joined with a straight line it represents ***the shortest-path or shortest distance between two points is called 'Displacement'***

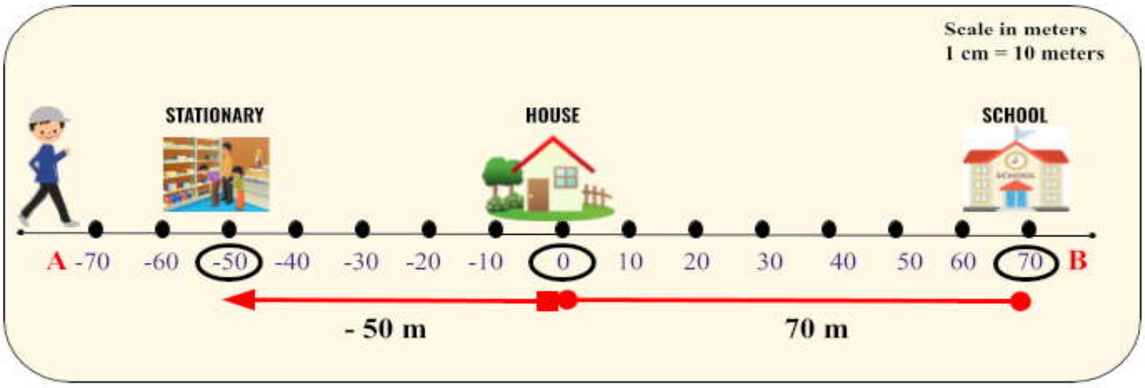
Distance and Displacement are the two quantities that seem to be the same but they are distinct in meaning. For a moving object, two points are significant. One is the **starting point** or **initial point** where the object starts its motion and the other is the endpoint where it reaches after a certain interval of time.

Activity 3

Finding the distance and displacement of objects in the same path

Suppose you are going to school which is 70 m away from your house in a straight path. The length of the path is 70 m in a particular direction. If you return from school to home then the distance travelled by you is = 70 m + 70 m = 140 m.

But the displacement is zero. Because you have travelled from your home and returned on the same path to the same point there is no change in position.



Now you go to a stationery shop to buy a notebook from your home which is located left side 50m to your house, later you have reached to the school. (Your initial position is home and the final position is school). In this case, the length covered by you is:

Length from home to stationary = 50 meters
Length from stationery to home = 50 meters
Length from home to school = 70 meters
The total length you covered = 170 meters.

In this case, you changed your direction of motion and the magnitude of length is 170m. We say, this is the distance covered by you.

Now let us try to understand displacement in the same path.

You started at home and moved 50 meters towards the left to buy a notebook in a stationary shop and reached home in the same way. Mathematically if the direction of motion changes towards the left, we indicate it with a negative sign.

Length from home to stationary = -50 meters
Length from stationery to home = 50 meters
Length from home to school = 70 meters
Total Displacement = - 50 m + 50 m + 70 m
= 70 meters

We consider the magnitude of length and direction. When we consider direction, resultant length may increase, decrease or become zero. To say it in another way, qualitative (effective) length covered by the object is called displacement whereas quantitative length covered by an object is distance.

Distance is a non zero and positive value. Displacement value can be positive, negative or zero. Distance is the measure of ***"how much length covered in the ground by an object during its motion"*** while displacement refers to the measure of ***"how far out an object is placed in a particular direction"*** **Distance is the scalar quantity, Displacement is the vector quantity.**

Check your Progress

- Explain distance and displacement with examples.
- How do you calculate distance and displacement?

Scalar and Vectors

Sometimes we discuss the physical quantities of objects with their mass only. But some other quantities can be described with their direction also.

- ***2 litre of milk.***
- ***A needle of 5 cm.***
- ***The Sun sets today at 6 pm.***
- ***A bus moves 60 km/hr speed, in the south direction.***
- ***A person who weighs 55 kg.***

Based on the above examples, the measurement of milk does not need direction. The movement of the bus is related to the direction.

Mass, time, distance, volume, speed and temperature are the scalar quantities that have a size or magnitude, whereas weight, force, velocity, displacement, acceleration and momentum are Vector quantities having magnitude and direction. Vector quantities are important in the study of motion.

A Physical quantity which has only magnitude is a Scalar.

A Physical quantity which has both magnitude and direction is a Vector

Difference between vector and scalar quantities

Quantity	Scalar	Vector
Definition	*A physical quantity which has only magnitude.*	*A Physical quantity which has both magnitude and direction*
Examples	*Mass, time, distance, volume, speed, and temperature*	*Weight, velocity, displacement acceleration and momentum*
Quantity	*yes*	*yes*
Direction	*No direction*	*It has direction and denoted by* $\rightarrow$

Check your Progress

- Why is mass not a vector?
- Distance and displacement are different quantities. Why?

2.4 What is speed?

It is a common experience that the motion of some objects is slow. The motion of some other objects is faster. Examine the following sentences carefully. Fo exampleAnurag runs faster than Rishi, the tortoise was slower than the hare,a bus moves faster than a bicycle, a hi-speed train is faster than other trains. Is a cheetah faster than a deer? How would you decide which object is faster than the other?

Can we expect the same object may move slow at one time and fast at other times?

For example, the bus will move slowly when the traffic is more and moves fast when the road is free. *We can conclude that a faster object can move with greater speed than a slower object.*

Speed can be defined as the distance covered by an object in one second.

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

For convenience, we write "Distance travelled" as Distance and "Time is taken" as time.

While travelling in a car, it is difficult to travel with constant speed, because we apply brakes at many places like curved roads, hills, in the traffic area and stop the car at various places and during this time it is difficult to find the speed of the car. But the car does not move with this speed at all times. **We consider only the time taken for the entire distance in average speed.**

When the **speed** of an object is constantly changing, the **instantaneous speed** is the **speed** of an object at a particular moment (instant) in time. **Instantaneous speed is the maximum speed may be achieved over a small time.**

Units of Speed: The unit of speed depends upon the unit of distance and unit of time used. In SI units of distance is expressed in meter, and time expressed in seconds,

The units of speed are metre/second or m/s

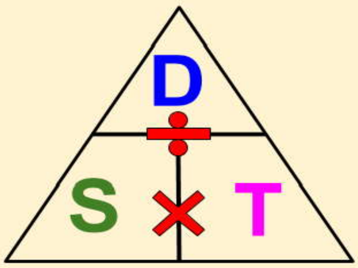
The other commonly used unit is kilometre/hour or km/h

The small units of speed centimetre/second or cm/s

$$1 \text{ km/h} = \frac{1000 \text{ m}}{60 \times 60 \text{ s}}$$

$$= \frac{5}{18} \text{ m/s}$$

Magic Triangle for Speed, Distance and Time



Distance = Speed x Time

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

Problem 1 : Find the average speed of a car travelling a distance of 200 km in 5 hours.

Solution : Car travelled distance = 200 km, Time taken = 5 hours

$$\text{Average Speed} = \frac{\text{Total Distance travelled}}{\text{Total Time is taken}}$$

$$\text{Average Speed} = \frac{200}{5} = 40 \text{ km per hour.}$$

Problem 2 : A train moving with a uniform speed covers a distance of 120 meters in 2 seconds.

(i) Calculate the speed of the train

(ii) Time is taken to cover a distance of 240 meters.

Solution :

(i) A train is in uniform motion.

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time is taken}}$$

$$\text{Speed} = \frac{120}{2} = 60 \text{ m/s}$$

(ii) time taken to cover 240 m/s

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time is taken}}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{240}{60} = 4 \text{ Seconds}$$

Check your Progress

- What do you mean by speed? Write its units?
- A car moves 50 m in 10 sec then what is its speed?

You might have heard announcements of train or bus departure and arrival timings.

"The train from Secunderabad Junction to Bombay via Nizamabad will arrive at platform number one shortly".

How can the railway staff predict the arrival time at the railway station?

How do they estimate train arrival or departure time?

Similarly, When you book a taxi or auto cab online, the message sent to our mobile saying "Your Vehicle from Varma is arriving in 7 minutes", how do they know in advance the arrival time? How can they predict auto cab times? Can time be estimated based on the speed of the train or autocabs? With the Google Maps app, you can track the time taken by different modes of transportation, for different travelling routes. The average speed is calculated based on the distance and time taken by the object. This information is sent in the form of a message to our GPS connected mobile. The Global Positioning System (GPS) is used to track the location and time of objects. In our day-to-day lives, we can observe the use of GPS in mobile phones, vehicles, security, mining, aviation, surveying, agriculture, maritime, military and entertainment sectors. It is possible to estimate the speed, time and exact location of objects based on the signals given by the GPS. It is possible to send navigational information from a GPS satellite, from anywhere in the world at no cost. On iOS and Android phones, you can use any mapping app to track your location without the need for an internet connection.

2.5 Uniform and Non-uniform Motion

Observe the motion of Anuraag and Rishi who are in a race, both of them start moving at the same time from rest and both of them travel the same distance. But there is a difference in the rate of change in position.

Time in seconds	0 s	10 s	20 s	30 s	40 s	50 s
Position of Anuraag (m)	0 m	4 m	8 m	12 m	16 m	20 m
Position of Rishi (m)	0 m	4 m	12 m	12 m	12 m	20 m

Do you find any difference between the motion of Anuraag and Rishi?

Is the rate of change in position is equal for both persons?

Who is in uniform motion?

Who is in non-uniform motion?

Anuraag covered the distance in equal intervals of time. But Rishi covered the same distance in different intervals of time. The rate of change in position of Anuraag is equal at all intervals of time. But Rishi suddenly increased his speed. Finally, both of them reached at the same time.

If an object covers a distance in equal time intervals, it is said to be in uniform motion. Speed remains constant in uniform motion. For example, the motion of an object in a straight line and the motion of Earth.

If an object is in motion and the speed keeps on changing it is called non-uniform motion. Speed changes time to time in non-uniform motion. For example, Motion of the train coming to the railway station, vehicles stopping in front of the traffic signal.

Check your Progress

- Explain uniform and non-uniform motion with examples.
- Write the differences between uniform and non-uniform motion.

Speedometer and Odometer

How do you measure the speed of a vehicle?

How is the distance travelled by the vehicle measured?

When you are driving a vehicle, you have to check your vehicle speed. ***An instrument which indicates the speed of the vehicle when it is running is called a speedometer.*** This instrument is fixed on the vehicle dashboard. The wheels of the vehicle have sensors that count the number of rotations completed by the wheels per second. This number, together with the diameter of the wheel is used to estimate the distance covered by the vehicle in a second. It shows the speed in km/h.

Odometer is an instrument for measuring the distance travelled by a vehicle. It is fixed inside the speedometer in a small rectangular window of the vehicle. It shows the reading for the distance covered by the vehicles in kilometres.

2.6 What is Velocity?

Observe the situations given below

Case-1: On the highway, two cars are moving in the same direction with different speed,
Case-2: On the same highway, if both cars are moving in the opposite direction.

Can we determine which car is moving fast?

Yes, We can determine the speed easily when the two cars are in the same direction. If the two cars are in the opposite direction we have to find the instantaneous speed along with instantaneous direction at a point is known as velocity. Speed gives an idea of how fast or slow an object is moving without direction. Velocity describes the motion of objects in a direction

Velocity can be defined as the rate of change of displacement of an object.

$$\text{Velocity} = \frac{\text{Displacement of an object}}{\text{Time is taken}}$$

The units of velocity : meter/second (m/s)

The other commonly used unit : kilometre/ hour (km/h)

The small units of velocity : centimetre/second (cm/s)

Average Velocity

The displacement obtained by an object during the standard period is called the average velocity. It is the ratio of total displacement to the total time taken.

$$\text{Average Velocity} = \frac{\text{Total displacement}}{\text{Total Time}}$$

If final Velocity 'v' and Initial velocity 'u' are known, then

$$\text{Average velocity} = \frac{\text{Final velocity} + \text{initial velocity}}{2} = \frac{v+u}{2}$$

Problem 3

A person travels 2 km in the north direction from his home to school in half an hour and travels to his home from school in another half an hour?

1. Total distance covered by a person is?
2. What is the time taken to cover the distance?
3. What is the total displacement?
4. Calculate the speed of a person?
5. Calculate the velocity?

Solution:

1. Total Distance = **2 km + 2 km = 4 km**
2. Time taken to cover the distance = **1 hour**
3. There is no Displacement or Displacement is zero

   Because he started from home and travelled some distance and again reached home.
4. Speed $= \frac{\text{Distance}}{\text{Time}} = \frac{4}{1} = 4$ km/h
5. Velocity $= \frac{\text{Displacement}}{\text{Time}} = \frac{0}{1} = 0$

What is a speed detector?

A speed gun is a device used to measure the **speed of moving objects.** It is also called a Radar gun. A radar detector is an electronic device used by motorists to detect if their speed is being monitored by police or law enforcement using a radar gun. The word "radar" is an acronym for "Radio Detection and Ranging." Radar uses radio waves reflected on to the a moving object to determine its speed when they bounce back off your car, they are picked up and amplified by a receiver so they can be analyzed. Most radar detectors are used so the driver can reduce the car's speed before being ticketed for speeding. Current speed camera technology allows detailed video and images of drivers to be taken from upto one kilometre away. Most cameras, however, use markings on the road to measure the distance over time and determine your speed.

Check your Progress

- Write the units for velocity?
- Distinguish between uniform and non-uniform motion.

2.7 Acceleration

- ❖ A car moves slowly on an inclined road by applying brakes.
- ❖ A car changes its speed suddenly from 30 kmph to 50 kmph when the driver accelerates the car.

When the car is moving on the inclined road acceleration decreases, by applying the brakes the speed changes. When the speed increases suddenly, then we can say that the car is accelerating.

For example, a train starting from the station, a ball bouncing on the road, a boy whirling a stone tied with thread, a freely falling body from a building, an apple falling from a tree and a car turning at the corner. In the above situations, acceleration is also a change in speed and direction with respect to time.

Acceleration is the rate of change of velocity. It is a vector quantity.

Acceleration is a quantity that allows us to compare the high or low velocities with time. ***For example****, A bus moves very fast compared with a bike, the bus has more* acceleration than a bike. ***If the body changes its velocity by the equal interval of time, the body is said to be uniform acceleration.*** **For example,** the earth rotates around the sun with uniform acceleration.

In uniform motion, velocity remains constant, therefore acceleration is zero. Whereas in non-uniform motion velocity of an object changes with time.

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Time taken for change}}$$

$$= \frac{\text{Final velocity - initial velocity}}{\text{Time}} = \frac{v - u}{t}$$

Unit of acceleration is metre/ second^2 or m/s^2.

Check your Progress

- Explain acceleration with suitable example.
- Write the unit for acceleration.

Key Points

- Motion is relative. The motion of an object depends on the observer.
- When an object moves from one point to another along a straight path or curved path, its motion is called translatory.
- Motion in a straight line is called rectilinear motion.
- The motion of an object moving in a curved path is called curvilinear motion.
- If a body moves in a circular path it is said to be in a circular motion.
- A motion that repeats itself at regular intervals of time is called oscillatory motion.
- If a body moves about a fixed axis, it is called rotational motion.
- The motion of particles are not in a definite path is known as random motion.
- Distance is defined as the length of the actual path from the initial position to the final position of an object. SI Units: meter (m), CGS: Centimeter (cm).
- The shortest-path or distance between two points is called 'Displacement'.
- A Physical quantity with only magnitude is a Scalar.
- A Physical quantity which has both magnitude and direction is a Vector.
- Speed can be defined as the distance covered by an object in one second (or in one unit

$$\text{Speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

❖ Velocity can be defined as the rate of change of displacement of an object.

$$\text{Velocity} = \frac{\text{Displacement of an object}}{\text{Time taken}}$$

❖ Acceleration is the rate of change of velocity. It is a vector quantity.

$$\text{Acceleration} = \frac{\text{Change in Velocity}}{\text{Time taken for the change}}$$

Practice for Learning Outcomes

1. Distinguish between Speed and Velocity?
2. How do you measure the instantaneous speed?
3. Distance between your home and school is 5 Km. You are starting from your home and reaching school. Find the distance and displacement?
4. Gayatri covers a certain distance in one hour and Vihan covers the same distance in two hours, Who travels at a higher speed?
5. The displacement of a moving object in a given interval of time is zero. Would the distance travelled by the object also be zero? Justify your answer?
6. While travelling in a bus, it appears that the trees near the road are moving whereas co-passengers appear to be stationary. Explain the reason?
7. An object moves from A to B with a velocity of 20 m/s and comes back from B to A with the velocity of 30 m/s. Find the average velocity of the body during the whole journey?

Multiple-choice Questions

1. The motion of a stone is thrown into the air at an angle. ( )
   A) Rectilinear B) Circular C) Periodic D) Random
2. The basic units to measure speed is ( )
   A) m/s B) m/s^2 C) m/s^{-1} D) m/h
3. A bus travels 60 km in one hour. The speed of the bus is ( )
   A) 0.6 m/s B) 0.5 m/s C) 0.4 m/s D) 1.5 m/s
4. If we denote speed by S, the distance by D and time by T, the relationship between these quantities is ( )
   A) S = D X T B) T = S / D C) S = D / T D) S = T / D
5. The correct symbol to represent the speed of an object is ( )
   A) 5 m/s B) 5 mp C) $5\ m/s^1$ D) $5\ m/s^2$
6. If the acceleration of a moving object is constant then the motion is said to be ( )
   A) Motion with constant speed B) Motion with uniform acceleration
   C) Motion with uniform velocity D) Motion with non-uniform acceleration

Chapter 3

Force - Motion

Introduction

We know that some moving objects may stop, and objects at rest may move. What makes these objects to move or to stop? When do the objects change the state of motion or rest? What changes the speed and direction of moving objects? What changes the shape of the object? Why does a ball thrown up falls down? Why do cutting tools always have sharp edges?

In this lesson we shall try to find answers for all such questions.

Learning Outcomes

After completing this lesson you will be able to:

- Define the term force and different types of forces
- Differentiate different types of forces
- Cite examples from everyday situations for different types of forces
- Give reasons for motion of a object
- Derive relationship between force, mass and acceleration
- Explain the three Newton's laws of motion and their significance in daily life
- Explain terms inertia, momentum, thrust and pressure citing suitable examples

3.1 Force

Activity - 1

Place a marble on a flat and smooth surface. The marble is at rest. Now push it gently. It starts moving. Pull it to stop. Pull or push on the marble brings change in its state of motion or rest. ***Push or pull acting on an object is called as a force.*** Force is a measurable quantity. The S.I. unit force is Newton. It is denoted by 'N'.

Fig - 1 : Marble moving on floor

Force can act on an object with or without coming into contact with it. They are: 1. Contact forces, 2. Field forces.

3.2 Contact Forces

To move the marble on flat smooth surface you apply force (push or pull) on it by physical contact with the marble. “Force which results when there is direct physical contact between two interacting objects is called contact force”.

The different types of contact forces are :

Muscular force:

The force which is exerted by body muscles is called muscular force.

Ex: Human beings and animals use muscular force to carry out regular activities.

Fig - 2 : Boy pushes tyre

Normal force:

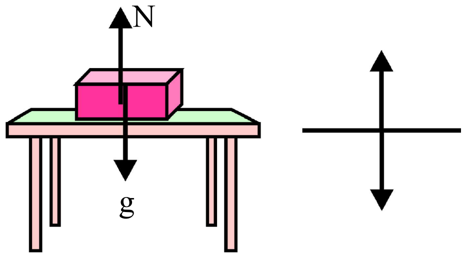


Fig - 3 : Normal force and gravitation acting on a body

The force that a solid surface exerts on any object in normal (perpendicular to surface) direction is called normal force.

Ex: The force that acts on the body placed on a table perpendicular to its surface against the attraction force (gravitation) to balance it.

Tension:

The force exerted by a string in opposite direction to the force acted on it within its elastic limit is called tension.

Ex: The rope of a bucket exerts tension.

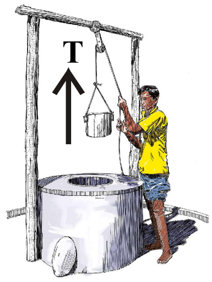


Fig - 4 : Drawing water from well

Friction force:

The force that opposes relative motion of surfaces in contact is called force of friction. Friction exists between the contacting surfaces of all materials. The direction of friction is always in a direction opposite to the motion.

Ex: When you try to push a heavy rock, it will not move. Rolling ball stops after some time.

We know that unbalanced force is required to change the state of the object. Not only vehicles but also any object, moving over the surface of another object slows down when no external force is applied on it. The force that acts on a moving body that slows down is called friction. Friction opposes the relative motion between two surfaces in contact. It acts on both the surfaces.

Activity - 2

Take a book. Place it on horizontal plane. Push the book gently. Initially, the book moves and stops after some time covering some distance. The force that stopped the book is friction. In this activity, the force of friction acts between the surface of the book and the surface of horizontal plane. Friction acts in opposite direction to that of applied force at contact surface. It acts on both the bodies.

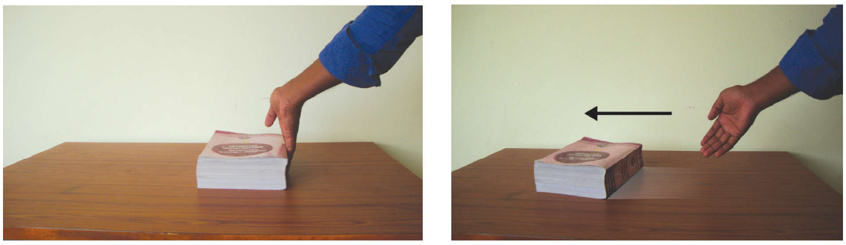


Fig - 5 : Pushing a book on a plane

- The force of friction is greater if a rough surface is involved.
- "Friction depends on how hard the two surfaces are pressed together."
- Increase of normal force increases the friction.

Advantages and disadvantages of friction:

The friction plays a very important role in our day to day life. It has several advantages as well as disadvantages.

(a) Advantages of friction:

(i) The force of friction developed between the soles of your shoes and the ground helps us to move.

(ii) You can write with a pen on page or with a chalk on the blackboard due to friction.

(iii) Without friction, you cannot hold anything in your hand. Buildings may be constructed only due to force of friction between different building materials.

(b) Disadvantages of friction

(i) Due to friction, a lot of energy is wasted in the form of heat that causes wear and tear of the moving parts of a machine.

(ii) Friction reduces efficiency of the machines as considerable amount of energy is wasted in overcoming friction.

(ii) Friction wears out the soles of shoes or tires of vehicles.

How to manage friction?

Wherever necessary we can reduce (minimize) or increase (maximize) friction, but we cannot make friction less.

- **Reduce (minimize) friction:**
  - ❑ Lubricants such as grease, oils and powders are used in moving parts of machines
  - ❑ Ball bearings are used to avoid wear and tear of the moving parts of a machine.
- **Increase (maximize) friction:**
  - ❑ Friction can be increased by making a surface rough.
  - ❑ The sole of the shoes and the tires of the vehicles are treaded to increase friction.

Check your Progress

- Discus the advantages of friction.
- Suggest some ways to reduce friction.

3.3 Field Force (Force Acting At A Distance)

Activity - 3

Take a ball and drop it. What do you observe? Ball falls down. What pulled the ball down? Did the earth pulled it by direct contact? No. The earth pulled it even though it is not in contact with the ball. The earth exerted force on the ball and pulled it down. This force is called gravitational force. Force which results when there is no direct physical contact between two interacting objects is called field force. The different types of field forces are:

Magnetic force

The force of attraction or repulsion that arises due to magnets is called magnetic force.

Ex: Magnetic force attracts iron nail when it is brought near a magnet.

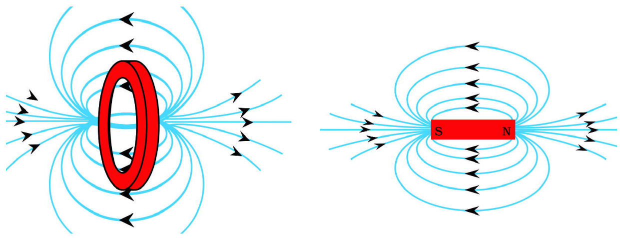


Fig - 6 : Magnetic force lines

Gravitational force

The attractive force between any two objects at a distance is called gravitational force.

Ex: The force which acts on vertically thrown up ball, the force which acts on a body which is away from earth, the force that acts between planets and sun and between the celestial bodies.

Electrostatic force

The force exerted by a charged body on another charged body is called as electrostatic force.

Ex : A straw rubbed with paper attracts another straw, the combed comb attracts piece of papers, thermocol balls attracted by polythene covers etc.

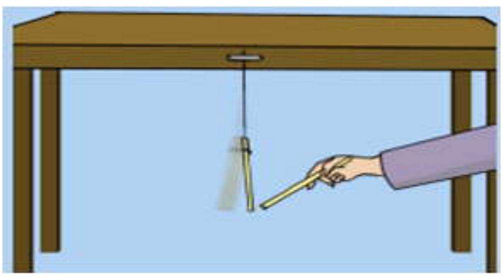


Fig - 7 : A straw rubbed with paper attracts another straw

❖ You know that force can move or stop an object. W[illegible]?

Activity - 4

Fig - 8 : Cuboidal sponge

Take a cuboidal sponge and place it on a smooth plane surface. Place your palm on its upper surface. Press it gently. What do you observe? The shape of the sponge changed. So force can change the shape of an object.

In a cricket match, bowler bowls the ball to the wickets. But batsman changes the direction of it towards boundary line. Here, force changes the direction of moving object.

Bicycle moves slowly if you apply less force on its pedal. Now apply more force on it. What do you observe? Force changes the speed (velocity) of bicycle.

The force applied on an object can

- Make the object move from rest or rest from motion.
- Change the speed of a moving object.
- Change the direction of motion of the object
- Change the shape of the object.

Check your Progress

- Give an example from your daily life in which velocity (speed) of an object changes by applying force.
- Write some applications of 'force'.

3.4 Pressure

- Why is it needed to fill air in tubes of tires?
- Why do shoulder bags are provided with broad straps and not thin strap?
- Why do Lorries carrying heavy loads have a large number of broader tyres?

Let us try to know answers to these questions.

Activity - 5

Try to push a nail into a wooden plank by its head. Did you succeed? Now, try to push the nail by the pointed end. Could you do it this time? Yes, you could succeed in this time. When you try to fix nail in wooden plank by its head you applied force on its pointed end. The force applied area is less. Second time you applied force on its head whose area is more. Do you get the feeling that the area over which the force is applied plays a role is making these tasks easier?

Fig - 9 : Pushing a nail into a wooden plank

Yes, force applied on large area shows more effects on pointed end.

The force acting on a unit area of a surface is called pressure.

Pressure = Force / Area on which it acts

The unit of pressure in S.I. system is Newton/meter^2 or N/m^2. This unit is named as "pascal' in honour of the scientist named Blaise Pascal.

Pressure is measured using barometer. Pressure of air in vehicle tyres is measured using aneroid barometer.

For a given force, if surface area is smaller, the pressure is greater and vice versa

Fig - 10 : Aneroid Borometer

Try to cut vegetables with a blunt and a sharp knife. Which is easier? Why do the tools meant for cutting and piercing always have sharp edges ?

To decrease pressure, Lorries have broader tyres and bags have broad stapes. Sharp edge object like knife exert more pressure. Gases and liquids also exert pressure. The pressure exerted by air around us is known as atmospheric pressure. Weuse air pressure to dig borewells, tubes of vehicles etc.

Check your Progress

- Why does potter carrying water pot, place a round piece of cloth on his head?
- Explain 'pressure' and give its units in SI system.

3.5 Balanced and Unbalanced Forces

Have you ever seen a game of tug-of-war? In this game when the two teams pull with equal force they apply balanced forces on the rope. The rope thus remains stationary. When one of the teams applies greater force, it is able to pull the other team and the rope towards their side. In this case forces are unbalanced.

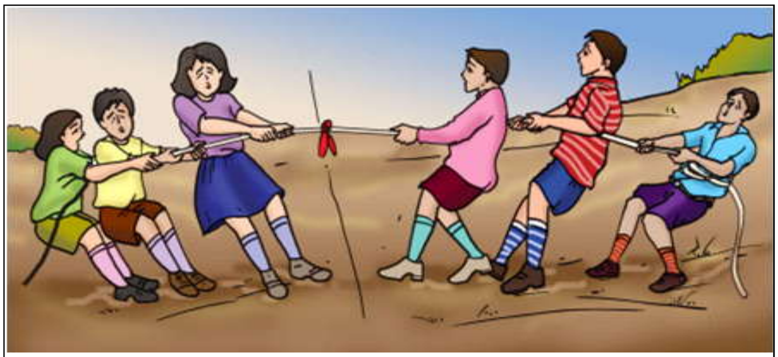


Fig - 11 : The rope may not move if the two teams pull with equal force

To understand the concepts of balanced and unbalanced forces, let us perform the following activity.

Activity - 6

Place a book on a table. Push the book towards left with your right hand. What do you observe? The book begins to move to the left direction. Now push the book towards right with your left hand. In which direction the book moved?

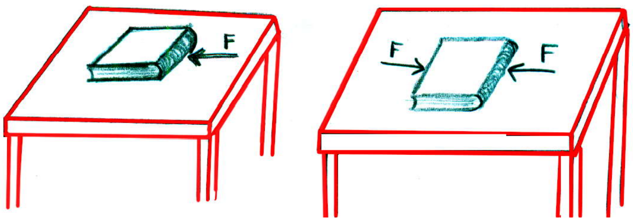


Fig - 12 : Pushing a book on the table

Now push the book from both the sides by applying equal forces. What do you observe? You will observe that book did not move in any direction. In this case the two forces balance each other. Such forces are called balanced forces.

What type of changes can be produced by balanced forces?

The balanced forces do not change the state of rest or motion of the object on which they are applied. Now, recall the activity done above with sponge. Balanced force acted on it. The result is it changed its shape.

As in the case one of above activity when unbalanced forces act on a book, the book would begin to move in the direction of greater force. Unbalanced forces acting on an object may change its state of rest or motion.

Try to find out some more examples of balanced and unbalanced forces.

Check your Progress

- Write the differences between balanced force and unbalanced force.
- Which force changes the shape of the object?

You learnt that unbalanced external force is cause for the motion of object. Sir Isaac Newton proposed three fundamental laws. These laws give relationship between force and change in motion.

3.6 Newton's Laws of Motion

Inertia: Why does a standing person in a moving bus falls forward when it stops suddenly? Why do water drops fall instantly when you shake a tree after rain? Hit the bottom of the stack of carom coins with a striker. What do you observe? You might have noticed that bottom coin moved without disturbing the stack of coins. Why?

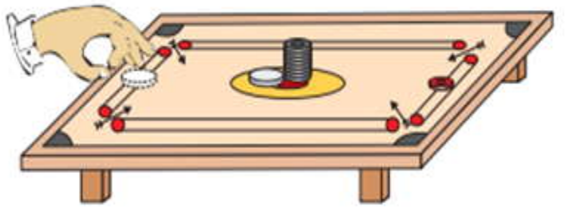


Fig - 13 : Only the carom coin at the bottom of a pile is removed when a fast moving carom coin (or striker) hits it.

Let us try to find answers to these questions.

Activity - 7

Take a thick paper. Keep it on a glass. Keep a coin on the paper. Pull the paper as fast as you can. What do you observe? Does the coin fall in the glass? Though the paper moved rapidly, coin did not change its place with paper. This is due to inertia of the coin. It fell in the glass. *"Inertia is the tendency of objects to stay at rest or keep moving with same velocity".* With this knowledge you can answer questions above this activity.

Fig - 14 : Fast pulling of paper

Inertia and Mass: In this session let us try to understand the relationship between mass and inertia.

Activity - 8

Keep an empty water bottle on flat smooth surface. Push it. Now fill same bottle with water. Do the same as did with the empty bottle. In which case you could push easily? Mass of an empty bottle is less so it exerts less inertia. So you could push empty bottle easily.

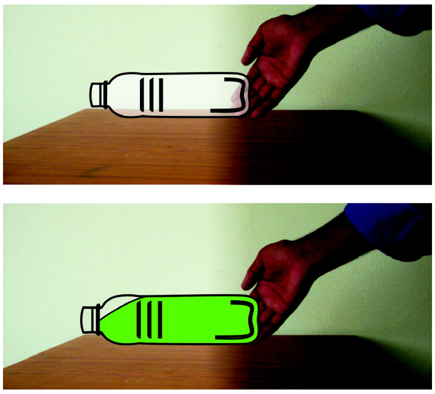


Fig - 15 : Pushing an empty and full water bottles

Massive objects resist more to change the state than the lighter ones. We can say that mass is a measure of inertia.

3.6.1 Newton's First Law of Motion

Newton's first law of motion states that, ***"Every body continues in its state of rest or of uniform motion until and unless it is compelled by an external force to change its state."***

Newton's first law of motion tells us that all bodies resist a change in their state of motion or at rest or direction of movement. That is why, Newton's first law of motion is also known as the law of inertia from above activity.

First law of motion has many applications in our daily life.

The passengers standing in a bus fall in backward direction when the stationary bus begins to move suddenly. This observation can be explained on the basis of first law of motion. The feet of passengers are in contact with the bus. When the bus starts suddenly, the feet start moving with the bus. But the upper part of the passengers tries to remain at rest due to inertia and tends to fall in the backward direction.

Some more applications of Newton's first law of motion:

1. A bowler runs a while before delivering the ball to get inertia of motion to ball.
2. Washed clothes are jerked before drying them to remove water from them.
3. When branches of trees bearing fruits are shaken, the fruits fall
4. An athlete runs some distance before taking a long jump to get velocity due to inertia addition the velocity of the athlete to jump long distance.
5. If you throw a water bottle upward in a bus moving with uniform velocity, it reaches you.

Check your Progress

- Give two examples for Newton's first law of motion in daily life.
- Why do dust particles get detached from a carpet when you hit it with a stick?

3.6.2 Momentum

Activity - 9 Does velocity affect the force?

Take two balls of same mass and size. Throw one ball with less force (this ball moves with less velocity), another ball with greater force (this ball moves with greater velocity) from same height into a sand pile. Which ball goes more deep into sand pile? Certainly the ball with high velocity goes deep into the pile. *"Velocity of the object influences effect of force"*.

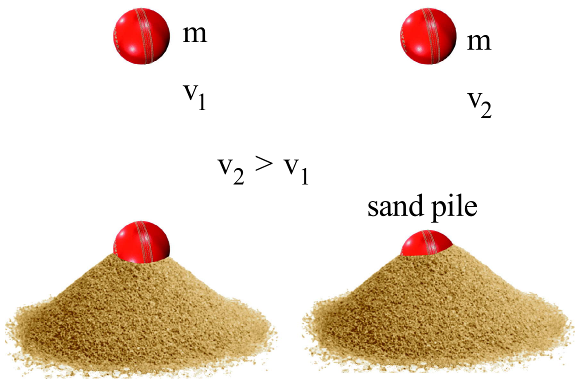


Fig - 16 : Balls of same mass were thrown in to sand file with different velocities.

Activity - 10 Does mass affect the force?

Now you take a two bottles of same size and shape. Fill one bottle with water (more mass) and keep another empty (less mass). Now mass of two bottles is different. Empty bottle has less mass. Drop these two bottles from same height into sand pile. What do you notice? Which bottle sinks deeper in the sand? Your answer will be the bottle filled with water. Bottle with more mass has more effect of force. *Mass of the object influences effect of force.*

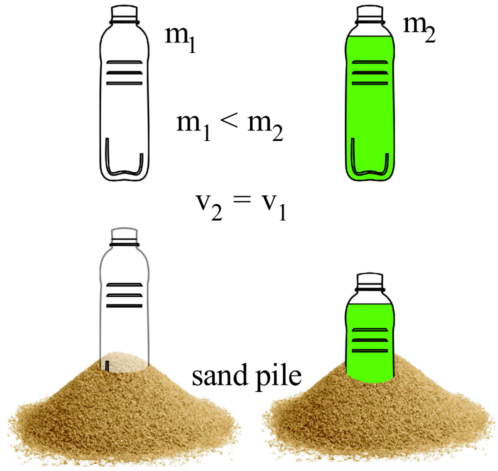


Fig - 17 : Bottles of different masses droped into sand pile

Newton introduced the concept of 'momentum' to measure the quantitative effect of force. The quantitative effect of force is dependent on mass and velocity of the object. Momentum is defined as the product of mass (m) and velocity (v) of the object. It is denoted by 'p'. Thus momentum 'p' of a body of mass 'm' and velocity 'v' is given by p = mv units.

SI unit of momentum is kg m/s (kg m s^{-1}). Momentum has both magnitude and direction. Direction of momentum is as same as that of velocity.

3.6.3 Newton's Second Law of Motion

Newton's second law of motion establishes relationship between force and change in the momentum.

Newton's second law of motion states that, *'the rate of change of momentum with respect to time of an object is proportional to the force applied on it and change in momentum is in the direction of force.'*

$$\text{Hence, Force} = \frac{\text{change in momentum}}{\text{time}}$$

$$F \propto \frac{\Delta p}{\Delta t}$$

Here Δp is the change in momentum of the body. Δt is time interval.

We can write the above relation as $F = k\frac{\Delta p}{\Delta t}$, 'k' is constant. It's value depends on the unit chosen for measuring.

$$F = \frac{k\Delta(mv)}{\Delta t} \quad \text{(We know that } p = mv\text{)}$$

If the mass of the body is constant during it's motion then, $\Delta p = m\Delta v$.

Now we have $F = km\frac{\Delta v}{\Delta t}$

We know that $\frac{\Delta v}{\Delta t}$ is uniform acceleration, denoted by 'a',

$F = k\,ma$ (when mass remains constant throughout the motion).

We choose the unit of force in such a manner that the value of k becomes one. For this we can define one unit of force as that amount which produces an acceleration of 1 m ^{2}/s in an object of 1kg mass. So that:

1 unit of force = k (1 kg) × (1 ms^{-2})

So, the value of 'k' becomes 1.

Then, $F = ma$ (when mass remains constant throughout the motion).

The above formula says that force produces acceleration in a body in the direction of force. SI unit of force is 'newton' and denoted by 'N' or kg m/s^2 or kg m s^{-2}.

Some Examples of Second Law of Motion from Daily Life:

We know that $F = \frac{\Delta p}{\Delta t}$ (if k =1), in order to minimize F, we have to maximize the stopping time. We get impulse $\Delta p = F\,\Delta t$ from above equation. This can be used in our everyday life. In many situations we try to decrease or increase the rate of change of momentum by changing the time in which the change of momentum takes place. Let us consider some examples.

(a) Eggs dropped on cushioned pillow don't break as smaller force acts on it for long time.

(b) An athlete doesn't get hurt when jumps into sand pit as less force acts on him in long time.

(c) To break a coconut you hit it to hard rock rapidly. Here, you are decreasing the time of motion of it. So more force acts on it to break it.

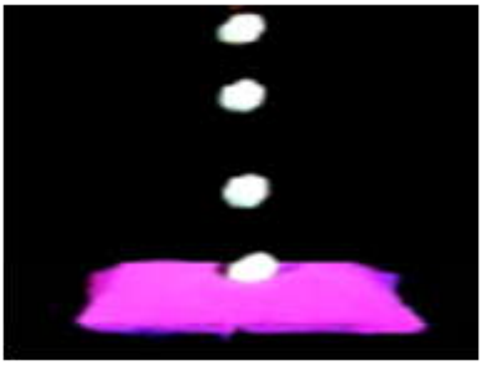


Fig - 18 : Fall of an egg on a cushioned pillow.

(d) While catching a fast moving cricket ball, the fielder lowers is hands to avoid getting hurt. By lowering his hands he increases time interval in catching the ball. So, lesser force acts on the hands. The fielder escapes the hurt.

Same thing happens during cutting tree with an axe, hitting hot iron bar with hammer to mould it.

Fig - 19 : Fielder lowers is hands to avoid getting hurt.

Check your Progress

- Why does a person get hurt when he fall on a cemented floor?
- How does a karate player break a pile of tiles or a slab of ice with a single blow?

3.6.3 Newton's Third Law of Motion

Activity - 11

Inflate a balloon. Tie a thread to its neck. Fix a straw to it with a tape. Pass a tread through the straw. Tie this thread to two nails which are apart one below another on wall. Bring the balloon to one end of the thread. Make sure that the neck of the balloon faces down. Now release the thread of the neck of the balloon. What do you observe? Why does the balloon move upward?

Fig - 20 : Balloon inflated to straw moves up while air goes down

The air within the balloon exerts force on walls of the balloon equally in all directions. When you release the neck of the balloon, the balloon moves in opposite direction to that of motion of escaping air. The algebraic sum of momentum of the balloon and air is zero. So when the air escapes from balloon, it moves in opposite direction to balance the momentum of escaping air.

From this activity we can conclude that 'when an object exerts a force on another object, the second object also exerts force on the first object with equal magnitude but in opposite direction. If the force exerted by the first object is action, the force exerted by the second object is reaction vise.

Newton's third law of motion states that 'to every action, there is an equal and opposite reaction.'

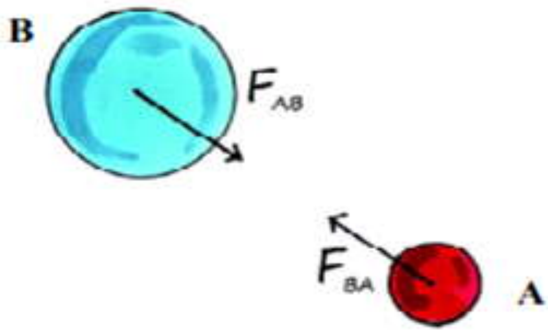


Fig - 21 : Action and reaction forces

Let us test whether action and reaction forces are equal and in opposite direction.

Activity - 12

Let us take two spring balances connected together along the hocks. The fixed end of balance 'B' is attached with a rigid support, like a wall. When a force is applied through the free end of spring balance 'A', it is observed that both the spring balances show the same readings on their scales. It means that the force exerted by spring balance 'A' on balance 'B' is equal but opposite in direction to the force exerted by the balance 'B' on balance 'A'. Any of these two forces can be called as action and the other as reaction.

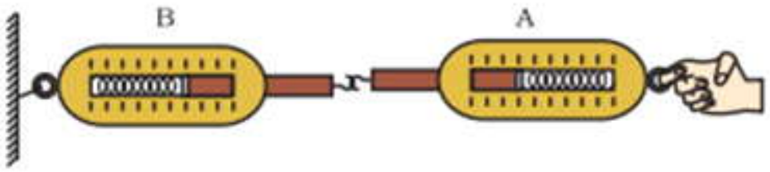


Fig - 22 : Action and reaction forces are equal and opposite

Action = – reaction.

here '–' indicates the direction of action or reaction

There are three significant features of third law of motion:

(a) We cannot say which force out of the two forces is the force of action and which one is the force of reaction. They are interchangeable.

(b) Action and reaction always act on two different bodies.

(c) The force of reaction appears so long as the force of action acts. Therefore, these two forces are simultaneous.

Some example for Newton's third law of motion:

1. While swimming, the swimmer pushes water backwards. For this action water pushes him forward as reaction.

Fig - 23 : A swimmer pushes the water backwards with hands to move in forward direction.

2. In order to fly upwards, the bird pushes the air downwards with its wings. In turn the air gives equal and opposite reaction on it wings to fly upwards.
3. In order to walk, we press the ground on backward with our feet. To this action, ground exerts an equal and opposite reaction which enable us to walk.

4. It may be interesting for you to know that rockets and jet-planes also work on the principle of action and reaction. In each of these, the fuel burn and hot burning gases are ejected from its tail. The hot gases come out in the backward direction and the rocket or the jet plane moves in the forward direction.

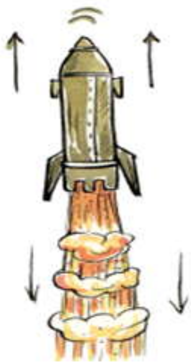


Fig - 24 : Motion of rocket

Check your Progress

- What are the significant features of Newton's third law of motion?

3.7 Conservation of Momentum

Activity - 13

Take two one inch PVC water pipes about 50 cm each. Plaster them side by side. Place this arrangement on a horizontal plane. Put 4 to 5 marbles of the same size in the middle of the channel. Now hit the marbles by a marble (same size as placed in the channel) from one end. What do you observe? Only one marble leaves the series of marbles in the channel with velocity of the striker marble. Now do the same with two marbles. This time two marbles leave. Increase the marbles to hit. You will find that number of marbles left is equal to the number of marbles you used to hit.

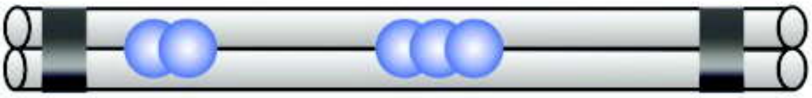


Fig - 25 : Hitting Morbles

From this activity we can conclude that total momentum of marbles before collision is as same as after collision. This is called 'law of conservation of momentum'

Law of conservation of momentum states that, if no external force acts on a system, the momentum of the system remains constant.

Check your Progress

- Explain law of conservation of momentum.

Key Points

- ❖ Force could be a push or a pull.
- ❖ A force arises due to the interaction between two objects.
- ❖ Force has magnitude as well as direction.
- ❖ A change in the speed of an object or the direction of its motion or both implies a change in its state of motion.

- Force acting on an object may cause a change in its state of motion or a change in its shape.
- A force can act on an object with or without being in contact with it.
- Force per unit area is called pressure.
- Liquids and gases exert pressure on the walls of their containers.
- The pressure exerted by air around us is known as atmospheric pressure.
- First law of motion: An object continues to be in a state of rest or of uniform motion along a straight line unless acted upon by an unbalanced force.
- The natural tendency of objects to resist a change in their state of rest or of uniform motion is called inertia.
- The mass of an object is a measure of its inertia. Its SI unit is kilogram (kg).
- Force of friction always opposes motion of objects.
- Second law of motion: The rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.
- The SI unit of force is kg ms^{-2}. This is also known as newton and represented by the symbol N. A force of one newton produces an acceleration of 1 m s^{-2} on an object of mass 1 kg.
- The momentum of an object is the product of its mass and velocity and has the same direction as that of the velocity. Its SI unit is kg m s^{-1}
- Third law of motion: To every action, there is an equal and opposite reaction and they act on two different bodies.
- In an isolated system (where there is no external force), the total momentum remains conserved.

Practice for Learning Outcomes

1. What is force? Name some kinds of forces.
2. Why is it advised to tie the luggage with a rope on the roof of buses?
3. What is the force of friction? Suggest two methods to reduce friction.
4. What is pressure? State the SI units of pressure.
5. Explain Newton's third law of motion with a suitable example.
6. Give two examples for Newton's second law of motion.

Multiple Choice Questions

7. What is the momentum of an object of mass m, moving with a velocity v?
   (a) $(mv)^2$ (b) mv^2 (c) ½ mv^2 (d) mv
8. What are the factors that affect inertia?
   (a) Shape (b) Volume (c) Mass (d) Area
9. Example for field force
   (a) friction (b) tension (c) muscular (d) gravitation

Chapter 4

Gravitation

Introduction

Why does an object dropped from certain height always fall towards the earth? Why do planets revolve around the sun continuously? When a small stone and a big rock are dropped from a certain height, which one will reach the ground first? Is mass and weight same? Does your weight change on the moon?

In this lesson, let us try to answer these types of questions

Learning Outcomes

After completing this lesson you will be able to:

- Illustrate the existence of gravitational force
- State Newton's law of gravitation
- Explain the term acceleration due to gravity
- Modify equations of motion of an object falling due to gravity
- Distinguish between mass and weight
- Find the relation between mass and weight
- Define free fall motion and explain weightlessness

4.1 Gravitation

An object when thrown upwards reaches a certain height and then falls downwards. This must be due to some force acting on it. Sir Issac Newton tried to explain the force acting between the object and the earth. There is an interesting story about Newton. Once Netwon sat under an apple tree. An apple fell down. The fall of apple set Newton to think. Why did the apple fall down? If some force is acting on the apple, the same force must accelerate the motion of the apple. The same type of force also should act on the moon to pull it towards the earth or vice versa. Let us try to understand this with help of an activity.

Issac Newton (1647-1727)

Activitv - 1:

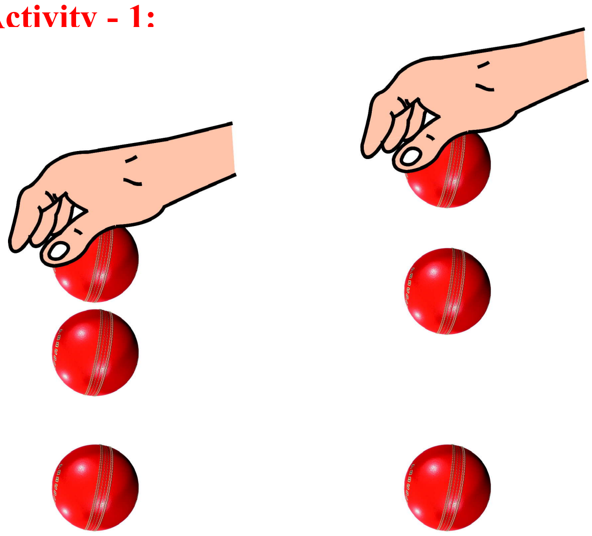


Fig - 1 : Motion of ball when dropped form different heights

Sit on a floor. Release a ball from your hand. Observe its speed just before it hits the ground. Now you stand and release the same ball. Again observe its speed just before it hits the ground. Do not throw the ball in both the cases. Did the ball possess the same speed just before it hit the ground in both the cases? We can observe that, in second case the ball strikes the ground faster. Which force accelerated the ball?

In this activity, the force of attraction due to earth accelerated the ball. Newton knew that bodies fall towards the earth due to force of gravity. He further thought, if the earth can attract an apple or a stone or a ball, it can also attract the moon. He was also curious to know whether the same force was responsible for keeping the planets go around the sun in their orbits.

All bodies irrespective of their masses in the universe attract each other. The force between two masses is called gravitional force.

Newton expressed a law of gravitation on the basis of his observations.

4.2 Newton's Law Of Gravitation:

Newton stated that, ***"every object in the universe attracts other objects. The force of attraction between the objects is directly proportional to the product of their masses and inversely proportional to the square of the distance between them".***

If two objects having masses m_1 and m_2 respectively are at 'r' distance the force along the line joining the objects is

$$F \propto \frac{m_1.m_2}{r^2}.$$

This can be expressed as $F = \dfrac{Gm_1.m_2}{r^2}.$

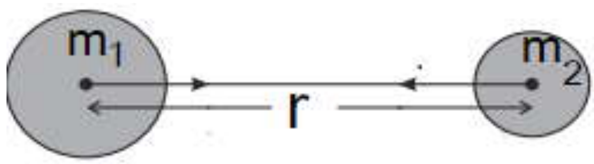


Fig - 2 : Force between two objects at 'r' units away

G is universal gravitational constant. It's value is $6.67\times 10^{-11} N\,m^2 kg^{-2}$. The value of G is equal to the magnitude of force between a pair of one kg masses that are one meter apart. This value is very small.

The solar system

The sun and other celestial bodies which revolve around it form solar system. Solar system consists, a large number of celestial bodies such as planets, satellites, asteroids, comets and meteors. The gravitational attraction between the sun and celestial objects keep them revolving around it. The Moon and the man made satellites sent into space, revolve around the earth due to gravitational force between the earth and them.

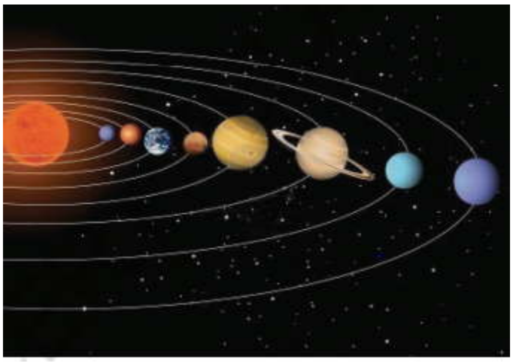


Fig - 3 : The solar system

Importance of the Universal Law of Gravitation

The universal law of gravitation successfully explained several phenomena which were believed to be unconnected:

(i) The force that binds us to the earth.

(ii) The motion of the moon around the earth.

(iii) The motion of planets around the Sun.

(iv) The tides due to the moon and the Sun.

Problem 1 :

Try to calculate the gravitation force between two objects which are 1 m away from each other with masses $m_1 = 50$ kg and $m_2 = 70$ kg.

Solution: We know that $F = \frac{Gm_1.m_2}{r^2}$; and

$G = 6.67 \times 10^{-11} N\,m^2\,kg^{-2}$;

$m_1 = 50$ kg and $m_2 = 70$ kg; $r = 1$m

Substitute these values in $F = \frac{Gm_1.m_2}{r^2}$

$F = 6.67 \times 10^{-11} \times 50 \times 70/ 1 \times 1$ N

$F = 23345 \times 10^{-11} / 1$N

$F = 2.3345 \times 10^{-7}$N; this force is very small.

Here masses of bodies are very small. Hence force of attraction is also very less.

Problem - 2:

Now let us try to calculate force of attraction between the earth and the moon.

Solution: The mass of the earth, $m_1 = 6 \times 10^{24}$ kg

The mass of the moon, $m_2 = 7.4 \times 10^{22}$ kg

The distance between the earth and the moon,

$r = 3.84 \times 10^5$ km $= 3.84 \times 10^5 \times 1000$m

$= 3.84 \times 10^8$ m

$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}

$$F = \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 7.4 \times 10^{22}}{3.84 \times 10^8 \times 3.84 \times 10^8} N$$

$$F = \frac{296.148 \times 10^{35}}{14.7456 \times 10^{16}} N$$

$F = 20.0838 \times 10^{19}$

$F = 2.0084 \times 10^{20}$ N.

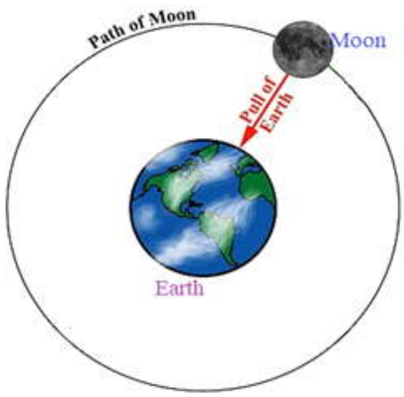


Fig - 4 : The Earth and Moon

Thus, the force exerted by the earth on the moon is 2.0084×10^{20} N. This force is very huge. The force of gravitation becomes appreciably strong if the masses of objects are increased. Hence when we are dealing with large masses like the earth, the sun etc. the gravitational force between such objects is considerably very large.

The gravitational force due to the earth is called gravity.

Check your Progress

- What is the SI unit of universal gravitational constant 'G'?
- What is the magnitude of the gravitational force between the earth and a 1 kg object on its surface? (Mass of the earth is 6×10^{24} kg and radius of the earth is 6.4×10^6 m).

Acceleration due to Gravity:

Activity - 2:

Fig - 5 : A ball vertically thrown up

Take a ball. Throw it vertically upward. Observe the motion of the ball. Due to gravity it reaches certain height and starts falling down. Whenever objects fall towards the earth under gravitation force alone, we say that the objects are in free fall. While falling there is no change in direction of motion but its velocity changes. Rate change in velocity is acceleration. When the ball moves downwards its velocity increases with respect to time. Here the ball is accelerated due to gravity. ***"The acceleration produced in the motion of a body under the effect of gravitation force of the earth is called acceleration due to gravity."*** It is denoted by 'g'. SI unit of 'g' is m s^{-2} (units of acceleration).

Near the surface of the earth 'g'= 9.8 m s^{-2}

Is 'g' (acceleration due to gravity) is same everywhere on the earth?

The acceleration due to gravity (g) changes when there is change in height, depth, equator and poles of the earth. When height increases 'g' decreases as 'r' increases. At poles 'g' value is little high and at equator it is little less. So, weight of an object is little high at poles and less at the equator.

Activity - 3

Take two water bottles of same kind. Fill one of them with water. Close the bottles. Now drop the two bottles at a time from same height. What do you observe? Both the bottles seem to reach the ground in same time. Do this again and again increasing dropping height. The result is same.

From this activity we can say that though the masses of the bottles are different acceleration due to gravity in motion of the bottles is same. A small stone a nd a big rock when dropped from same height reach the ground in same time. Mass of the object does not influence the acceleration due to gravity in air free medium.

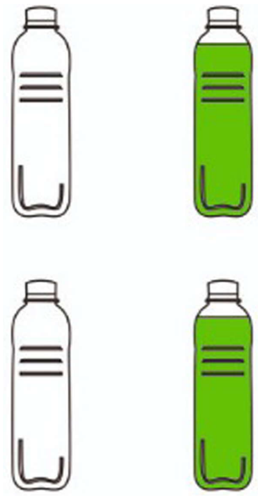


Fig - 6 : Two bottles dropped from same height to reach the ground at the same time

- It is known that Galileo dropped different objects from the leaning tower of Pisa in Italy to prove that objects of different masses fall at the same rate.
- Robert Boyle placed a coin and feather in vacuum a glass tube. When the tube was inverted both the coin and the feather hit the bottom at the same time.

So acceleration due to gravity of the earth is given by $g = \frac{GM}{r^2}$; M- mass of the earth, r – radius of the earth.

Note: Mass of the moon is less than that of the earth therefore, 'g' of the moon (1.625 m s^{-2}) is less than that of the earth. So weight of a body on moon is less than that of on the earth.

Table - 1

'g' value of some of the celestial bodies.

Celestial body	Mass (kg)	Radius (m)	Value of 'g' (m s^{-2})
Earth	5.97×10^{24}	6.37×10^{6}	9.80
Moon	7.35×10^{22}	1.73×10^{6}	1.62
Jupiter	1.90×10^{27}	6.99×10^{7}	24.79
Uranus	8.81×10^{25}	2.54×10^{7}	8.87
Mercury	3.28×10^{23}	2.45×10^{6}	3.7
Sun	1.99×10^{30}	6.96×10^{8}	274.0

Equations of motion

Since free fall acceleration is constant near the earth, the equations of uniform accelerated motion can be written as

$$v = u + gt$$

$$s = ut + \frac{1}{2}gt^2$$

$$v^2 = u^2 + 2gs$$

where 'u' is initial velocity; 'v' is final velocity; 's' is distance covered in time 't'; 'g' is acceleration due to gravity.

Check your Progress

- Write the factors that affect 'g'.
- Name a planet on which 'g' is greater than that of the earth.

4.3 Mass and Weight

Mass: The quantity of matter contained in a body is called mass. It is same everywhere in the universe. Its SI units are kg.

Weight: In general we use mass and weight in same context. But scientifically both are different quantities. The weight of an object is the force with which it is attracted towards the earth.

Force = mass x acceleration

F = mg; g is acceleration due to gravity. If weight of an object is denoted by 'W', then W = mg.

As weight is a force, SI unit of weight is newton (N) or Kg m s^{-2}. The weight of an object is generally measured using spring balance.

Problem - 3 : If your mass is 54 kg, find your weight on the earth. Consider g = 9.8m/s^2

Mass (m) = 54 kg; g = 9.8 m/s^2

Solution: We know (weight) W = mg

$W = 54 \times 9.8$

$W = 529.2$ kg m s^{-2} or 529 N

Weight of an object depends on its mass and value of g. As the value of g is constant at a given place, therefore, the weight of the object at a given place is directly proportional to its mass. However, the weight of an object will be different on different parts of the earth as the value of g is different on different parts of the earth.

Will your weight be same on the moon as it is on the earth?

On the moon, 'g' is less so even your mass is same as it is on the earth, variation in 'g' reduces your weight on moon. What is your weight on Jupiter?

Table - 2 : Differences between mass and weight

Mass	Weight
It is the quantity of matter contained in a body	It is the force which attracts the object towards the earth
It is a fundamental quantity	It is a derived quantity. It depends on mass and acceleration due to gravity W = mg
It measured using common balance or simple balance	It is measured using spring balance, platform balance, and electronic balance.
It does not change across the universe	It changes from place to place
SI units : kg	SI unit : kg m s^{-2} or N

Note : Commonly used spring balances are calibrated to measure mass in terms of kg.

Weightlessness

You may have noticed increase in weight while moving in Lift/Elevator upward and decrease in weight when moving downward. You experience weightlessness, when you jump in to water to swim from certain height. The same type of experience you get when you are swinging in a swing. Also you have heard that an astronaut experiences weightlessness in space.

What does the term weightlessness mean?

"*The apparent loss in weight of an object, when it is in free fall is called weightlessness.*"

Activity - 4

Lifting up a school bag

Lift your school bag. What do you feel? It will be heavy. Now hold it in that spot for some time. What changes do you observe? Now move your bag quickly in downward direction. Can you feel the weight? Now you will feel that weight of the bag is decreased. Why did it happen so?

Consider three cases (i) lifting up the bag (ii) holding it still (iii) bringing it down

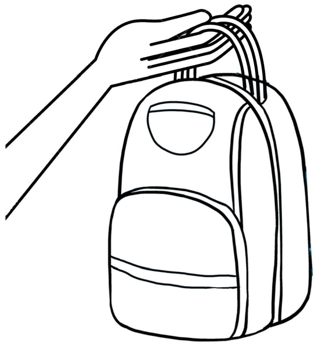


Fig - 7 : Lifting a school bag

Case (i) : While lifting up the bag, you feel heavier than usual. As the motion of the bag (object), is opposite to that of the direction of gravity. Therefore, gravity is added with acceleration of the bag. So, we have to exert more force ($F = m(g + a)$). Force itself is weight. Hence we feel more weight.

Case (ii) : The bag is not in motion, so acceleration due to gravity of the bag is zero. Then weight (force) remains constant. $F = mg$

Case (iii) : In this case, motion of bag is same as that of the direction of gravity. Therefore, gravity is in favor of the motion of the object ($F = m(g-a)$). Hence we feel that it's easier to bring it down than lifting it up. So we feel less weight.

When a person moving up and down in a lift. What type of experience does he/she gbet?

Check your Progress

- Write the differences between mass and weight.
- Does your weight change at poles? Support your answer.

Key Points

- ❖ The law of gravitation states that the force of attraction between any two objects is proportional to the product of their masses and inversely proportional to the square of the distance between them. The law applies to objects anywhere in the universe. Such a law is said to be universal.
- ❖ Gravitation is a weak force unless large masses are involved.
- ❖ The force of gravity decreases with altitude. It also varies on the surface of the earth, decreasing from poles to the equator.
- ❖ The weight of a body is the force with which the earth attracts it.
- ❖ The weight is equal to the product of mass and acceleration due to gravity.
- ❖ The weight may vary from place to place but the mass stays constant
- ❖ A body falling freely under gravity is weightless

Practice for Learning Outcomes

1. What are the differences between mass of the object and weight of the object?
2. Write the equations of motion of an object moving or falling only under gravity.
3. Why will a sheet of paper fall slower than one that is crumpled into a ball?
4. What is the importance of universal law of gravitation?
5. If the moon attracts the earth, why does the earth not move towards the moon?
6. What happens to your weight, if you land on moon? (Mass of the earth is 6 times greater than moon.)

Multiple Choice Questions

7. The state of a freely falling body is ( )

   A) increase in weight B) decrease in weight

   C) zero weight D) does not change

8. Mass of a body ( )

   A) changes on moon B) changes at poles

   C) changes at equator D) constant every where

9. The force of attraction between celestial bodies ( )

   A) magnetic force B) mascular force

   C) gravitational force D) friction force

Chapter 5

Sources of Energy

Introduction

Every living thing on earth will take food for living and its growth. Every motorized instrument, vehicles, airplanes and everything requires fuel as food.

Almost all forms of energy on this earth come from the energy of the sun, known as solar energy. The energy that we absorb from sun in the forms of heat and light, which is responsible for most of the natural phenomena on earth.

- Can we survive without sun?

Fig - Sun

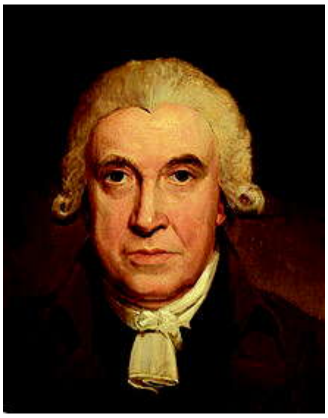
- How do you feel if you don't take food in regular time?
- What did you observe while boiling milk at your home?
- why the lid of the vessel is jumped while boiling?

The answer is boiling water pushed the lid. So the vapour has enough energy to move the lid.

Steam Engine

A steam engine is a machine that burns coal to release the heat energy it contains. So it's an example of what we call a heat engine. It's a bit like a giant kettle sitting on top of a coal fire. The heat from the fire boils the water in the kettle and turns it into steam. Instead of blowing off uselessly into the air, like the steam from a kettle, the steam is captured and used to power a machine. This lead to an industrial revolution on earth.

Imagine living only with coal and water and still having enough energy to run machines at over 100 mph. That's exactly what a steam locomotive can do. Although these giant mechanical machines are now extinct from most of the world's railroads, steam technology lives on in people's hearts and locomotives like this still run as tourist attractions on many heritage railways. Steam locomotives were powered by **steam engines**, and deserve to be remembered because they swept the world through the Industrial Revolution of the 18th and 19th centuries.



James Watt

In 1765 James Watt greatly improved the engine by adding a separate condenser to avoid heating and cooling the cylinder with each stroke. Watt then developed a new engine that rotated a shaft instead of providing the simple up-and-down motion of the pump, and he added many other improvements to produce a practical power plant.

When we wake up in the morning we feel hungry and will take food. That food will give us Energy. Energy plays a vital role in our day to day life. In every aspect of life we use energy for comfort and everything. To do all types of activities we rely on energy sources. Our body will utilize energy to do respiratory, circulatory, or digestive functions.

- What we use to cook our food?
- How we are able to do work?

Let us know about energy and its sources

Learning Outcomes

After completing this lesson you will be able to:

- Can explain energy
- Can explain different forms of energy
- Can distinguish between Conventional and Non-Conventional energy sources.
- Can explain various types of energy sources.
- Can explain advantages and disadvantages of energy sources.
- Can explain the reason for energy crisis.
- Can explain the need of conservation of energy in our daily life

5.1 Energy

What is energy?

Do we require energy?

Fig - 1 : Person playing pole vault

Energy is defined as the ability to do work. We require energy for all types of activities including the activities within our body. If our body has energy means we are capable to do work.

An engine of the vehicle uses energy of its fuel to move. Battery stores the energy and releases it whenever requires. The tidal flow of water can move the ship as it has energy. Similarly the wind also carries enough energy to shake trees and move objects.

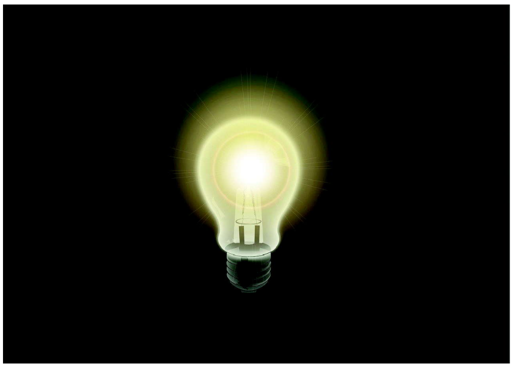


Fig - 2 : Electric energy

Almost all the machines used for the production and manufacture of different types of items would be unable to operate without the use of a source of electrical energy. Nowadays, the electrical energy has become so important that almost in all activities of life electricity is required. For example all electrical appliances in our homes and workplaces requires electricity. All the industries and factories run on electricity.

5.2 Forms of Energy

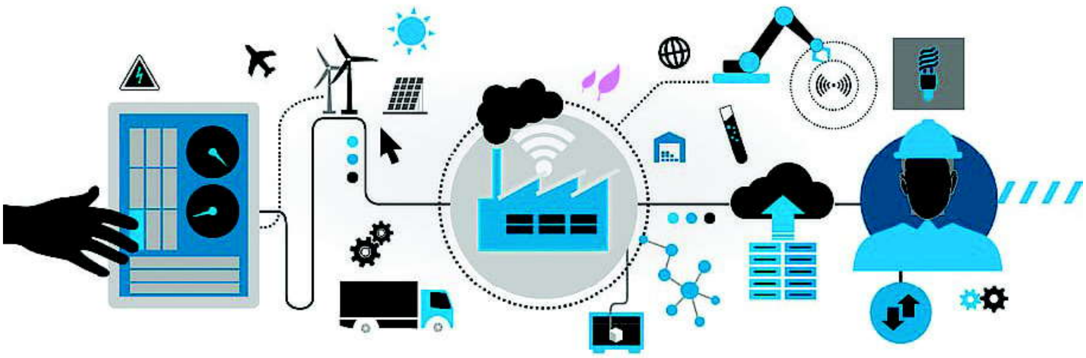


Fig - 3 : Forms of Energy

We use different forms of energy such as heat energy, light energy, mechanical energy, electrical energy, chemical energy and sound energy in our daily life. Common forms of energy are Thermal, light and electricity. We use all these forms of energies for different types of work.

In order to use all these forms of energies efficiently we need to change one form of energy to another. We call this as Transformation of Energy.

5.3 Sources of Energy

A source from which the usable energy can be extracted or recovered either directly or by means of a conversion or transformation process. There are different sources of energy e.g. Coal, Petrol, Natural Gas, solar power etc…

A fuel that is formed over the millions of years from the remains of living things i.e. Plants and Animals is known as Fossil fuel. Fossil fuels include coal, petroleum and Natural Gas which we use in our daily life.

All the sources of energy can be divided into two categories: renewable sources and non-renewable sources of energy e.g. coal, petrol, diesel kerosene and natural gas etc... Renewable sources are ones which can be recycled or reused. E.g. hydroelectric power, wind mills, solar power, biomass etc. Non-renewable sources cannot be reused and so there is a limited amount available and when that runs out there will be none left.

Check your Progress

- Write any four activities that we use different forms of energy in our daily life.
- Is it possible to convert light energy to electrical energy?

5.4 Non-Renewable Energy Sources

We commonly use petrol or diesel to run different kinds of vehicles, Similarly, kerosene and natural gas are used as fuels in lamps and stoves. You should also know that crude oil coal and natural gas occur in limited and exhaustible quantities. They cannot be regenerated in a short period of time or used again and again. Hence, they are called non-renewable sources of energy. These energy sources are also known as conventional sources of energy.

Oil and natural gas reserves may last for another 30-35 years. Similarly the coal reserves may last no longer than another 100 years. So we must use these non-renewable energy sources judicially and avoid all wastages.

Do you know?

The fuels Petrol and diesel which we are using in vehicles are obtained from mineral called petroleum. Petroleum has been known almost since 4000 years ago. Asphalt (Petroleum Product) was used in the construction of walls and towers of Babylon. There are also records from ancient China about shallow wells being dug to get petroleum.

· But what did our Ancestors do with this Petroleum?

They used as a fuel for lamps also used for making their wooden boats waterproof, and in some other traditional remedies.

We realized the importance of petroleum only after science and technology progressed to give us petrochemicals and petrol to run industries.

- What will happen if fossil fuel like coal and petroleum are completely exhausted?
- What would be our future energy resources?
- Why these resources exhausted? Is it happening Because of humans?

5.5 Fossil Fuels

Fossil fuels are formed From the remains of the living things which are buried in the earth for millions of years. When any plant or animal dies, its body gradually gets buried under the layers of the sand and with extreme high temperature and pressure inside the earth which slowly converts dead remains of the living things into fossil fuels.

Fossil fuels, such as coal, oil and natural gas, are important non-renewable sources of energy. Since the beginning of mankind, we have been using fossil fuels to generate heat, light and electricity for various purposes. These are the primary sources for generating electrical energy in the world today. Over 85% of our energy demands are met by the combustion of fossil fuels. Carbon is the main constituent of these fossil fuels. Fossil fuels are excellent sources of energy for our transportation needs. You may be surprised to know that approximately 1.9 billion tons of coal is burnt in a year to generate electricity in the world.

A large amount of chemical energy is stored in the fossil fuels. This stored chemical energy is converted into various other forms of energy such as heat, light and mechanical energy.

- Where we use Coal in our daily life?
- Which fuel is used to cook in the areas of Coal belt?
- Where we find coal?

(a) COAL

Coal is made of decomposed plant matter in conditions of high temperature and pressure inside the earth, though it takes a relatively shorter time to form than petrol. Coal is not a uniform substance either; its composition varies from deposit to deposit. Factors that cause this deviation are the types of original plant matter, and the extent to which the plant matter decomposed.

Fig - 4 : Coal

There are different types of coal such as peat, lignite, sub-bituminous and bituminous. The first kind of coal is **peat** which is merely a mass of dead and decomposing plant matter. Peat has been used as fuel in the past, as an alternative to wood. Next, the peat becomes **lignite**, a brownish rock that contains recognizable plant matter and has a relatively low calorific value. Lignite is basically the halfway point from peat to coal. The next phase is **sub-bituminous** which is a shade of dull black with very little visible plant matter. This type of coal has a less than ideal calorific value. **Bituminous** coal is the best quality of coal. It. is jet black, very dense and brittle. This type of coal has high calorific value.

When coal is heated in air, it burns and produces mainly carbon dioxide gas. Coal is processed in industry to get some useful products such as coke, coal tar and coal gas. **Coke** is a tough porous and black substance. It is an almost pure form of carbon. Coke is used in the manufacture of steel and in the extraction of many metals.

Coal tar is a black colored thick liquid with an unpleasant smell. It is a mixture of about 200 substances. Products obtained from the coal tar are used as starting material for manufacture of various substances like Synthetic dyes, drugs, explosives, perfumes, plastics, paints, and roofing materials etc. Interestingly naphthalene balls used to repel moths and other insects are also obtained from coal tar.

Coal gas is obtained during the processing of coal to get coke. It is used as a fuel in many industries situated near the coal processing unit.

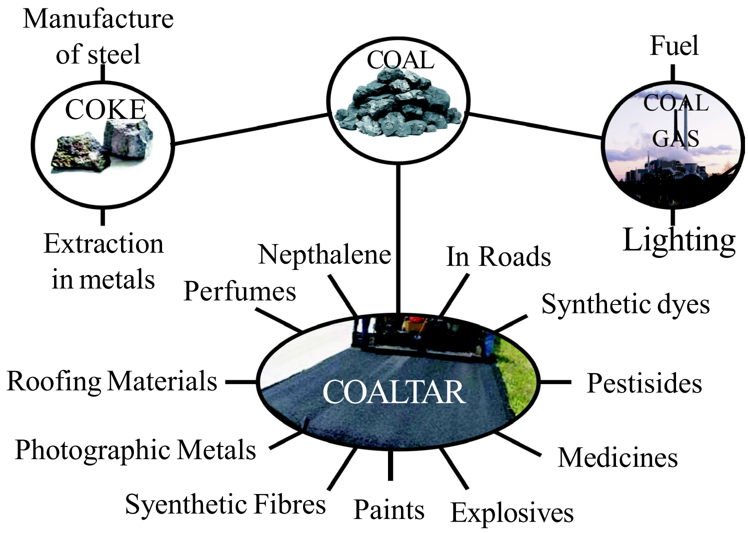


Fig - 5 : Uses of coal and its products

- Do you know where we use the coal?
- Which coal is known as best quality coal?

(B) Petroleum

Petroleum was formed from the remains of tiny organisms called **plankton** that were found in the bottom of seas and oceans. Plankton have tiny droplets of oil inside their bodies. As these organisms died, their bodies settled at the bottom of the sea or ocean and covered with layers of sand and clay.

Over millions of years, due to absence of air, high temperature and high pressure these dead organisms transformed into petroleum and natural gas. Like coal, petroleum and natural gas were also formed from the dead remains (fossils) of living organisms. Hence they are also known as fossil fuels.

Most of us think petroleum is a source of fuel. But an advance in our understanding of various chemical processes has led to the use of both coal and petroleum as the starting materials for a wide variety of products.

Petroleum is a complex mixture. It is separated into various components by a separation technique called Fractional Distillation.

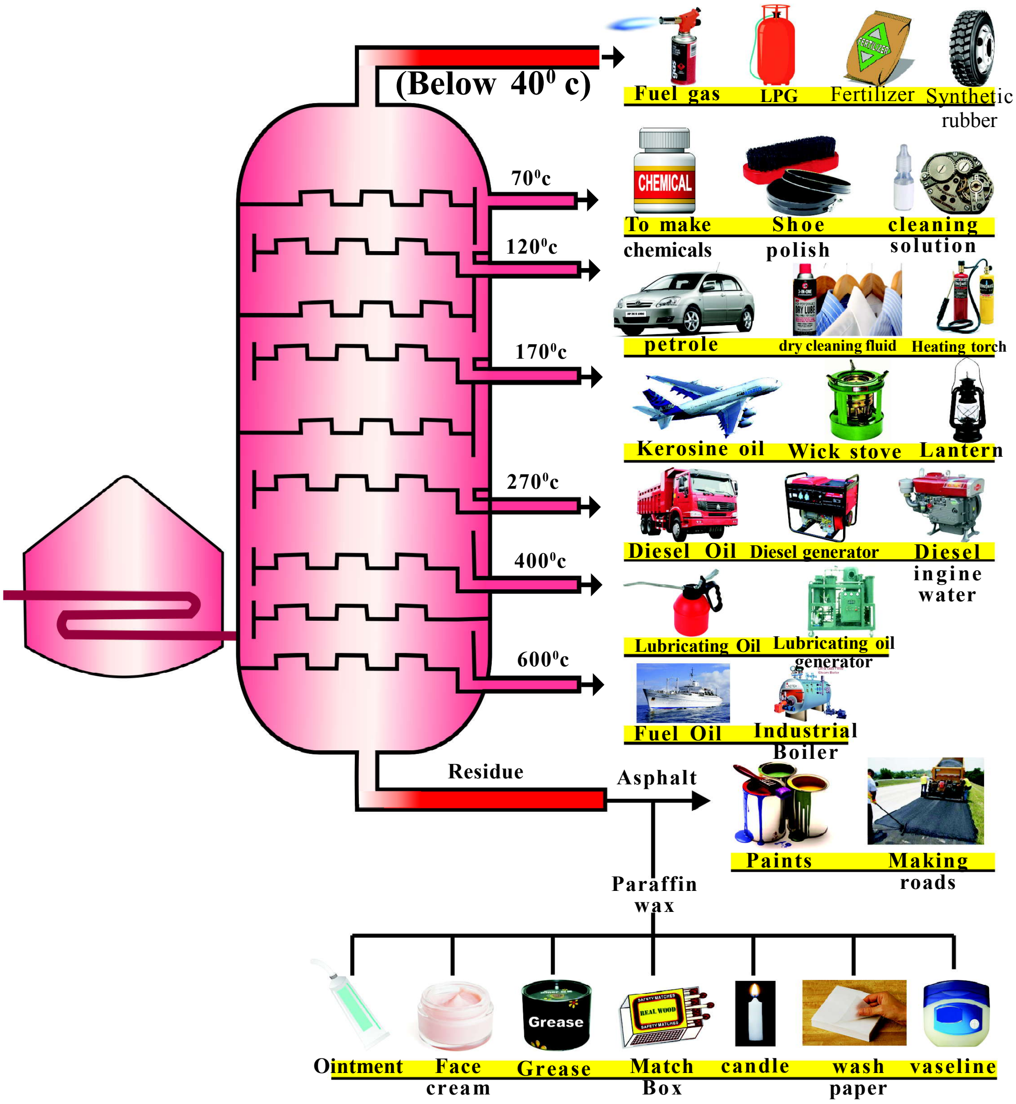


Fig - 6 : Uses of petroleum

We can see the various products which are now being obtained from petroleum. Initially, the separation techniques available were not advanced and could separate only a few components from the petroleum mixture.

(c) Natural Gas

Natural gas is **formed** deep within the Earth from decomposed organic matter. Over Millions of years, this matter is compressed as more and more layers form over it. When this organic material is exposed to high pressure, it is broken down into hydrocarbons and becomes **natural gas.**

In its pure form, natural gas is a colorless, odorless gas composed primarily of methane. Methane, the simplest and lightest hydrocarbon, is a highly flammable compound.

Fig - 7 : Liquid petrolium gas (LPG)

- Why we get different pungent smell from LPG cylinder?
- Is there any other alternative source for Natural gas?

Do you know?

Alternatives To Natural Gas

Methane hydrate is an "ice" that only occurs **naturally** in subsurface deposits where temperature and pressure conditions are favorable for its formation.Several other names are commonly used for **methane hydrate** are **methane clathrate**, hydromethane, **methane** ice, fire ice,

5.5.1 Uses of Petroleum products

One of the first fractions to be separated from petroleum is kerosene which is the better fuel than the petroleum.

Agriculture Sector

Petroleum is used in the production of ammonia, which is used as a source of nitrogen in agricultural fertilizers. To achieve high crop yields, pesticides are widely in agricultural sector. Most of the pesticides are produced from petroleum. Besides, machinery for agricultural tasks also consume petroleum. In this way, agriculture is one of the major users of petroleum. In Agricultural sector Plastic tubes, baskets, storing box, cultivation implements are made of petroleum products.

Fig - 8 : Tractor

Fig - 9 : Spraying pesticides

Industrial Sector

We use petroleum products In industrial sector. Cars, vehicles, motor boats, communication devices, construction material, paper industry and so many. Petroleum by-products are used by many chemical companies as raw materials. They are used in the manufacture of chemical fertiliser, synthetic fiber, synthetic rubber, nylon, plastics, pesti-cides and insecticides, perfumes, and dyes, paints, among others.

Refining of crude oil results in the production of several by-products, which are used in making different products for household and industrial purposes. Major by-products of petroleum include plastic, detergents, neptha, grease, vaseline, wax, and butadine, among others.

We are using petroleum products in Medical equipments, apparels like clothes.

Bedding, socks, furniture, paints, washing liquids, fiber, cosmetics, medicines, polishing liquids etc.

Fig - 10 : Paints

Domestic Sector

Many household products such as detergents, vaseline, wax, and others are derived from petroleum. Kerosene, a byproduct of petroleum, still used in many countries for cooking, lighting and other domestic purposes.

Advantages of Energy from Fossil Fuels

1. It is easy to generate energy from fossil fuels and relatively cost effective.
2. They have a very high calorific value
3. They can generate huge amounts of electricity in just a single location.
4. Transportation of these fossil fuels like oil and gas to the power stations can be made through the use of pipe-lines, shows how easy to transport.

Disadvantages of Energy from Fossil Fuels

1. Fossil fuels emit carbon dioxide when burnt which is a major greenhouse gas and the primary source of pollution. This has contributed to global warming.
2. They are a non-renewable resource, i.e., once used they cannot be replaced.
3. Combustion of fossil fuels makes the environment more acidic.
4. Harvesting of fossil fuels also causes fatal diseases among the people. For eg., the coal miners often suffer from Black Lung Disease.

Check your Progress

- Write the names of Non Renewable energy sources available.
- Explain how coal is formed in the layers of the earth.
- Write the daily life applications of petroleum products.

5.6 Renewable Energy Sources

Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished. A renewable resource, essentially, has an endless supply such as solar energy, wind energy, and geothermal energy.

5.6.1 Solar Energy-the Ultimate Energy

The sun provides us heat and light since billions of years and it is expected that it will continue for billions of years to come. Plants get their energy from the sun and all animals get their energy mainly from the plants. Therefore, it may be concluded that sun is a source of energy for the earth.

Fig - 11 : Solar panels

Fig. - 12 : Solar Cooker

The sun in fact is the ultimate source of energy for all living beings. Apart from nuclear energy, all other forms of energy result from solar energy.

Sun is one of the most powerful renewable sources of energy for the future. As long as the sun exists, we will continue to get its energy. About 30% of the incoming solar radiation is absorbed by the upper atmospheres, the rest is absorbed by the land, sea and clouds.

Solar energy is used commonly for heating, cooking, and mainly production of electricity, and even in the desalination of seawater. With the help of solar cells, solar energy is converted into electricity. The sun's energy is also used to provide power to the vehicles, generate electricity, lighting streets, cooking etc. On a small scale, solar energy is being used as water heaters for daily use in our homes.

Fig - 13 : Solar street lights

Fig - 14 : Solar water heater

Fig - 15: Photovoltaic cell

Solar photovoltaic cell is a device that is used to convert solar energy into electrical energy. A solar cell is made of silicon and is used in calculators, watches etc.. To produce more electrical energy we need to connect more number of cells together as a solar panel.

Advantages of Solar Energy

Solar energy is a pollution free energy, Nothing emits in this process.

Sun is a free source of energy and available for everlasting.

Can be transformed into electrical energy

Limitations

We can not produce this solar energy In the absence of Sun.

Establishment is very expensive

Storage and maintenance is also expensive

The solar panels need to be regularly maintained and cleaned to continue generating electricity.

5.6.2 Geo Thermal Energy

Geothermal energy is another renewable source of energy. Geothermal energy is obtained from the internal heat of the earth. The Word **geothermal** comes from the Greek words geo (earth) and therme (heat). **Geothermal energy** is a renewable **energy** source because heat is continuously produced inside the earth. People use **geothermal** heat for bathing, to generate electricity.etc..

Do you heard about volcanoes? Volcanoes when they are in active mode, contains lots of heat. These volcanic features are called geothermal hotspots. Basically a hotspot is an area of reduced thickness in the mantle which expects excess internal heat from the interior of the earth to the outer crust. The steam from these hotspots will be used to run turbines that can generate electricity.

The geo thermal energy can be produced 24 hours and it occupies very small area. Sometimes this type of drilling will produce some hazardous minerals and gases. In India many geo thermal power plants are established in the state of Himachal Pradesh.

Fig - 16 Geo Thermal Energy power plant

5.6.3 Wind Energy

Wind refers to be moving Air. Moving air will have kinetic energy, this kinetic energy of wind called wind energy or wind power. Over the years all over the world people are using wind energy to convert grains to flour. People used these wind energy in boats and for irrigation. Wind mills are still using to pump water in many countries.

The modern windmills use the energy of winds to generate electricity. In areas or places where wind blows strongly, and steady the windmills are set up to run turbines which leads to generate electricity. In some areas of india small windmills known as phirki are established to utilize the electricity and as water pump. In Telangana wind mills are established in Parigi Division of Vikarabad District.

Fig - 17 : Wind mill

Fig - 18 : Phirki

Fig - 19 : Blades

Wind energy is free of cost and reliable, Wind power is clean and produces no environmental Pollution In wind power generation no harmful by-products are left over as in case of burning of fossil fuels, Since wind is a renewable source of energy, we never run out of it.

Working of Windmill

Wind mill has blades. The blades of the windmill rotate in a vertical plane, which is kept perpendicular to the wind. As wind flow crosses the blades of the windmill, the blades start rotating. The rotation of blades makes the turbine rotate. The turbine is attached with an electrical generator which converts wind energy into electrical energy. The blades are angled into the wind, so as to rotate in a way which maximize the generation of electricity.

Check your Progress

- What do you mean by renewable energy sources?
- Is it possible to extract energy from the internal heat of earth? Explain.

5.6.4 Nuclear Energy

Nuclear energy is energy in the nucleus (core) of an atom. Atoms are tiny particles that make up every object in the universe. There is enormous energy in the bonds that hold atoms together. The energy released during nuclear fission or fusion reaction is known as nuclear energy.

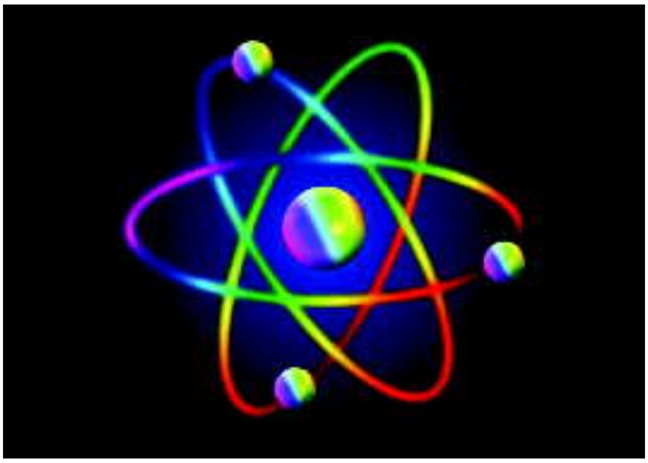


Fig - 20 : Nuclear Energy

These energies are of two types.

1. Nuclear Fission
2. Nuclear Fusion

The energy stored in the nuclei of atoms can be released by bombarding the a heavy nucleus such as uranium with low energy neutrons. The splitting of the nucleus of an atom into fragments that are roughly equal in mass with the release of enormous amount of energy is called **nuclear fission**. Here Nuclear binding energy is responsible for releasing huge amount of energy. Nuclear binding energy is the minimum energy that would be required to disassemble the nucleus of an atom into its component parts.

In nuclear fission reaction a large amount of energy is released by vanishing the little mass. The energy released in this reaction can be expressed as $E=mC^2$ where m is the mass which is lost and C is the velocity of Light. When a free neutron strikes a Uranium (235) nucleus at a correct speed, it gets absorbed. A Uranium (235) nucleus on absorbing a neutron becomes highly unstable and splits into nuclei of smaller atoms releasing huge amount of energy in the process. During this process, a few neutrons are also released. These neutrons split other nuclei of the Uranium (235). The reaction continues rapidly and is known as the **chain reaction**. In India, the nuclear power plants are situated at Tarapur (Maharashtra), Rana pratap sagar (Rajasthan), Kalpakkam (Tamilnadu), Narora (Uttar Pradesh), Kaprapur (Gujarat), and Kaiga (Karnataka).

In this process a large amount of energy is released. This energy is used to vaporize the water and that water vapor will run the turbines to produce electricity.

Energy is also produced when two light nuclei such as deuterium (heavy hydrogen) combine together to form a heavy nucleus. A process in which the nuclei of light atoms are combined to form a nucleus of a heavier atom with the release of energy is called **nuclear fusion.** Nuclear fission reaction occurs in Sun and stars where Helium splits into Hydrogen atoms by releasing enormous amount of energy.

Fig - 21 : Nuclear power plant

Uses of Nuclear Energy

1. Small amount of matter produces large amount of energy
2. No gases or waste material is produced in the plant.

- Why do people oppose the proposal of excavation of Uranium in Nallamala?
- Why do people oppose the establishment of Nuclear power plant at Nagarjuna Sagar?

Hazards of Nuclear Energy

1. Harmful nuclear radiations may get accidentally leaked/released in this process, which can penetrate human bodies and cause irreparable damage to cells. For preventing this from happening, nuclear reactors are covered with a thick shell of radiation absorbent material such as lead. However, accidental releases of these extremely harmful radiations into the environment pose a constant threat to those inhabiting the surrounding areas. Eg. In Chernobil nuclear plant Russia radiation leaked years ago and till date the radiation is existing.
2. Another problem is disposal of harmful radiant wastes mainly spent fuels produced in the fission process. During nuclear reactions, a number of harmful substances capable of emitting nuclear radiations are generated. These substances are called nuclear wastes. Presently, most of the nuclear waste generated in nuclear power plants is simply being stored underground in strong lead containers.

5.6.5 Biomass Energy

Biomass is an organic material made from plants and animals. It includes garbage, industrial waste, crop residue, manure, wood, sewage and dead parts of living objects. In a direct combustion system, biomass is burned in a combustor or furnace to generate hot gas, which is fed into a boiler to generate steam, which is expanded through a steam turbine or steam engine to produce mechanical or electrical energy.

Bio mass contains stored energy from the Sun. Plants absorb the Sun’s energy in a process called photosynthesis. When bio mass is burned, the chemical energy in bio mass is released as heat. Biomass can be burned directly. It can also be converted into Coal, Petroleum, Cow dung Cakes, Bio gass etc. Fuels like Coal, Petroleum are called as fossil fuels. Biomass is the only renewable energy source that can be converted into liquid biofuels such as ethanol and biodiesel. Biofuel is used to power vehicles, and is being produced by gasification in countries such as Sweden, Austria, and the United States. In india some states are adding biodiesel in the diesel. i.e in diesel around 20% of the biodiesel is added.

Biogas

‘Biogas’ is a renewable source of energy. It is produced mainly from cow dung, sewage, crop residues, vegetable wastes etc. It contains about 65% of methane and widely used as fuel for cooking. The slurry obtained as a byproduct, left in the biogas plant after the biogas is used up can be used as a manure, which is rich in nitrogen and phosphorous.

Fig - 23 : Biogas

5.6.6 Ocean Energy

The energy from the sea can be obtained mainly in two forms. (a) Tidal energy, (b) Ocean Thermal Energy.

Tidal Energy

During the high tide, the water from sea can be sent into a reservoir of the barrage and turns turbines. The turbines then turn the generators to produce electricity. Presently, the power of the tides is being harnessed to produce electricity in Canada and France

Fig - 24 : Tidal Energy

Ocean Thermal Energy

Heat from the sun is absorbed by the water on the surface of ocean, but at deeper levels of ocean, the temperature is very less. So, there is temperature difference between the water 'at the surface of ocean' and 'at deeper levels'. This difference in temperature is called Ocean Thermal Energy (OTE). The OTE can be converted into electrical energy by using Ocean Thermal Energy Conversion (OTEC) plants.

5.6.7 Hydro Electrical Energy

Hydroelectric Energy, also called **hydropower**, electricity produced from generators driven by turbines convert the energy of falling or fast-flowing water. In the early 21st century, hydroelectric power was the most widely utilized form of renewable energy. Hydroelectric is produced by the natural flow or fall of water. By channelling water that is flowing downhill, the force of the water can be transformed into electricity.

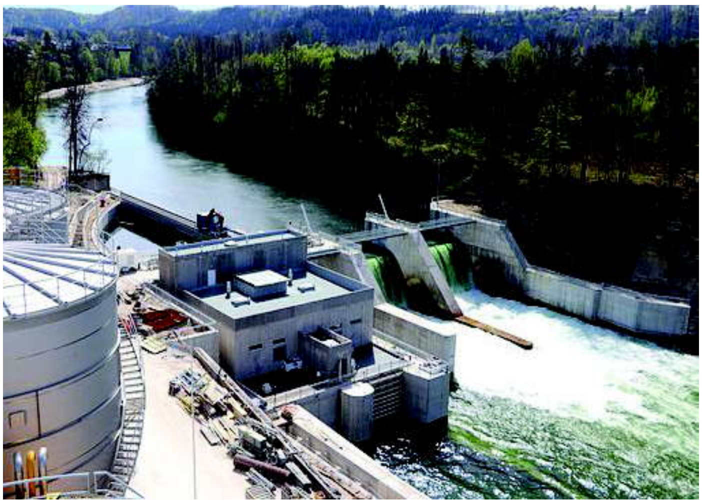


Fig - 25 : Hydro Electrical Energy plant

The output energy is calculated by the height of the Dam or source greater the height of the source higher the energy output.

Hydal Power Generation

In the generation of hydroelectric power, water is collected or stored at a higher elevation and led downward through large pipes or tunnels (penstocks) to a lower elevation; the difference in these two elevations is known as the head. At the end of its passage down the pipes, the falling water causes turbines to rotate. The turbines in turn drive generators to produce electricity. Transformers are used to convert the alternating voltage suitable for the generators to a higher voltage suitable for long-distance transmission.

This hydro electricity is cost effective and productive than other energies. In India half of the power is generated in this process. The main drawback of this energy is dependency over monsoon rains. If monsoon is improper then we cant produce this energy.

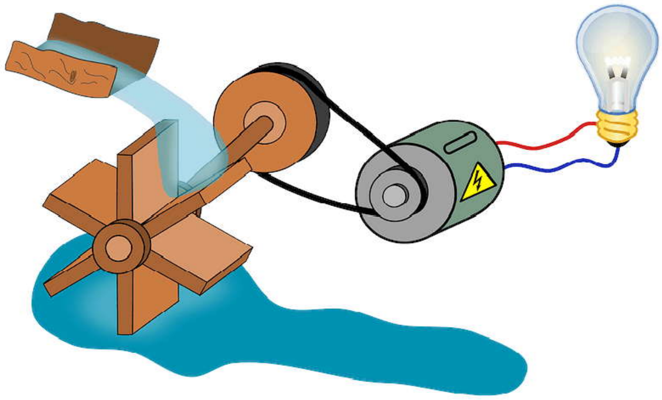


Fig - 26 : Hydal Power Generation

Check your Progress

- Explain why fission reaction will exert enormous amount of energy?
- Explain how bio mass is converted into energy

5.7 Transformation of Energy

Energy transformations are processes that convert energy from one type (e.g., kinetic, gravitational potential, chemical energy) into another. Energy cannot be created or destroyed (which is called the conservation of energy); however, it can be transformed from one type into another. In fact, every useful process transforms energy from one form to another. There are many different forms or types of energy.

Some examples of everyday energy transformations are:

Situation	Energy Transformation
Rubbing the hands together to get warm	Kinetic energy to thermal energy
Using flash light of the charged light	Electrical energy to light energy
Switching on the fan	Electrical energy to mechanical energy
Using battery	Chemical energy to electrical energy

Food that we eat has chemical energy. When we eat the food it will be converted into mechanical energy to do all forms of work.

In a thermal power station, the chemical energy of coal is transformed into heat energy of the hot steam, and then into mechanical energy of turbine. This mechanical energy is transformed by a generator into electrical energy, which passes through the power lines to various places – cities, towns, houses, factories etc., where it is transformed back to heat, light, sound or mechanical energy.

5.8 Energy Crisis

The large and increasing gaps between availability and demand of energy, may be termed as the energy crisis. Energy crisis is being faced by all developing nations including India. Human population is increasing but our energy sources are not increasing as rapid as population

Reasons for energy crisis in India.

1. Less availability and limited sources of energy in India.
2. Huge gap between demand and supply
3. Increasing the fuel price quite frequently.
4. Reluctance in promoting renewable energy sources.
5. Over use and misuse of resources.

How to overcome energy crisis in India?

Tackling the Energy Crisis in India

1. Making efforts to discover and develop the sources of oil in the country.
2. Improve the fuel efficiency in the transport and in other industrial sectors for the conservation of the energy.
3. A variety of new technologies such as improved chullahs, bio-gas plants, solar voltaic system, wind mills, and small hydro- plants have been developed.
4. Government should encourage private sector investment in power generating schemes.

5.9 Conservation of Energy

The law of conservation of energy states that energy can neither be created nor destroyed - only converted from one form of energy to another. This means that a system always has the same amount of energy, unless it's added from the outside. The wise and economic use of energy is called conservation of energy.

Steps to be taken to conserve energy are

1. Switching off all electrical appliances when not required.

2. Encourage the usage of CNG instead of other fossil fuels.
3. Using the devices like solar cooker, solar heater and utilize the renewable energy sources.
4. Use more of tube lights and CFL bulbs in place of normal bulbs.
5. Gas pipelines, oil pipes and water pipes should be maintained properly.

Check your Progress

- Explain how energy transformation take place in our daily life?
- Explain how to overcome the energy crisis.
- Why we need to conserve energy?
- What happens if energy is not transformed? Guess.
- Write the steps to be taken to conserve energy in our daily life

Key Points

- ❖ Almost all forms of energy on this earth come from the energy of the sun.
- ❖ Energy means capability to do work.
- ❖ Common forms of energy are Thermal, light and electricity
- ❖ The energy that cannot be regenerated in a short period of time or used again and again. Hence, they are called non-renewable sources of energy. These energy sources are also known as conventional sources of energy.
- ❖ Fossil fuels are formed millions of years from the remains of the living things.
- ❖ Coal is made of decomposed plant matter in conditions of high temperature and pressure inside the earth.
- ❖ Petroleum was formed from the remains of tiny organisms called **plankton** that were found in the bottom of seas and oceans.
- ❖ **Natural gas** is **formed** deep within the Earth from decomposed organic matter. Over Millions of years,
- ❖ Petroleum is used in the production of ammonia, which is used as a source of nitrogen in agricultural fertilizers.
- ❖ Petroleum by-products are used by many chemical companies as raw materials. They are used in the manufacture of chemical fertiliser, synthetic fiber, synthetic rubber, nylon, plastics, pesticides and insecticides, perfumes, and dyes, paints, among others.

- ❖ Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished.
- ❖ Sun is one of the most powerful renewable sources of energy for the future.
- ❖ Solar photovoltaic cell is a device that is used to convert solar energy into electrical energy.
- ❖ Solar energy is a pollution free energy, Nothing emits in this process.
- ❖ Geothermal energy is obtained from the internal heat of the earth.
- ❖ Moving air will have kinetic energy, this kinetic energy of wind called wind energy or wind power.
- ❖ Nuclear energy is energy in the nucleus (core) of an atom. Atoms are tiny particles that make up every object in the universe. There is enormous energy in the bonds that hold atoms together. The energy released during nuclear fission or fusion reaction is known as nuclear energy.
- ❖ Harmful nuclear radiations may get accidentally leaked/released in this process, which can penetrate human bodies and cause irreparable damage to cells.
- ❖ Bio mass contains stored energy from the Sun. Plants absorb the Sun's energy in a process called photosynthesis. When bio mass is burned, the chemical energy in bio mass is released as heat.
- ❖ Biogas is produced mainly from cow dung, sewage, crop residues, vegetable wastes etc.
- ❖ In Tidal Energy During the high tide, the water from sea can be made to sent into a reservoir of the barrage and turns turbines. The turbines then turn the generators to produce electricity.
- ❖ Hydroelectric Energy, also called hydropower, electricity produced from generators driven by turbines that convert the potential energy of falling or fast-flowing water into mechanical energy.
- ❖ The large and increasing gaps between availability and demand of energy, accompanied by rapidly increasing energy prices that threaten economic and social development of the nation may be termed as the energy crisis.
- ❖ The law of conservation of energy states that energy can neither be created nor destroyed - only converted from one form of energy to another.

Practice for Learning Outcomes

1. Write any four activities that we use energy in our daily life.
2. Expalin how coal and Petroleum was formed?

3. Write the uses of Petroleum in different sectors.
4. Why we call coal and petroleum as fossil fuels?
5. Sun is the Ultimate source of energy on earth. Why?
6. Is it possible to get energy from atoms? Explain
7. Explain the hazards of Nuclear Energy.
8. What are the steps required to overcome energy crisis?

Multiple choice Questions

1. This converts solar energy into electrical energy. ( )
   A) Battery B) Turbine
   C) Photo voltaic cell D) Sun rays
2. Which of the following is not a Fossil Fuel ( )
   A) Coal B) Petroleum
   C) Bio gas D) Natural Gas

Chapter 6

Work and Energy

Introduction

People carry out various tasks in daily life. For example, lifting of weights, carrying of weights, sweeping / cleaning of house, cooking of food and watering of plants in the garden etc are some of the day-to-day activities. Similarly you might have also observed that people employ machines in their homes to carry out different tasks like blowing of air by fan, pumping of water by electric motor, heating of water by electric heater, etc. Washing machines and vacuum cleaners are used for cleaning of clothes and cleaning the house respectively.

- How these works are being done?
- What we need to perform these works?

Learning Outcomes

After completing this lesson you will be able to:

- Can define the terms work and energy and units
- Can compute work done by a constant force
- List various forms of energy-like mechanical, thermal, light, sound, electrical, chemical, and nuclear energy with examples.
- Can explain potential and kinetic energy with suitable examples
- Can give examples of transformation of energy;
- Can explain the term power and define its SI unit.

6.1 Work

In general 'work' is a common term we use in our day to day conversation. Generally we include all the activities like standing, reading, lying etc., in the category of work. But in sciences physical work has a very specific meaning, that is, work is said to be done when force is applied on a body and the body moves through some distance in the direction of force.

If there is no motion produced in the body even when a force acts on it, the work done is said to be zero. Work is said to be done when the force is applied on a body makes it to move. i.e displacement of the body is necessary. For example if a person is pushing a auto, a horse is pulling the cart, a person pulling the cart, cyclist pedaling the cycle , a railway porter lifting weight, all do work.

Fig - 1 : Pulling a trolley

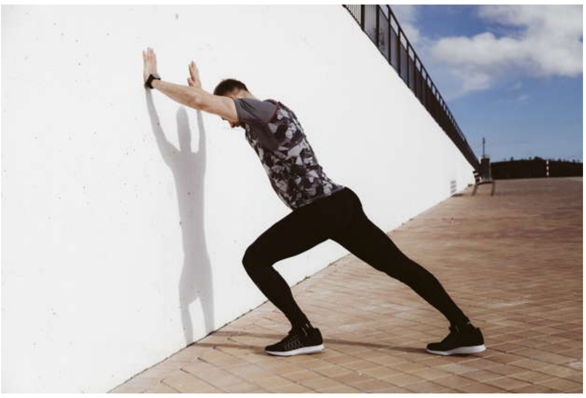


Fig - 2 : Pushing a wall

If a person pushing the wall, a person trying to move big stone as they don't push the wall and move the stone, scientifically no work is being done by them.

Let us see some more situations

1. Lahari is in examination preparation. She spends lot of time in studies. She reads books, draws diagrams, organizes her thoughts, collects question papers, discusses problems with her friends etc. In our common view 'she is working hard'. But if we go by scientific definition of work, the above mentioned activities are not considered as work. So Lahari does no work.
2. Sriharsha is trying to push a rock with his all efforts. He gets completely exhausted and tired. According to our common view he worked hard but as per science he has not done any work on the rock.

After observing all the above examples we can understand work.

To understand better let us do a activity

6.2 Activity

Two similar objects are placed on a table. Suppose that a constant force (F) acts on an object and object is moved through a distance (s) along the direction of the force (F) as shown in the figure. In science, we define work to be equal to the product of the force (F) and the displacement (s) moved along the direction of the force.

Work done = Force x Displacement.

$W = FS$

Note : This formula for work is used for the objects in translatory motion.

Work has only magnitude but no direction. So work is a scalar. We measure force (F) in newtons (N) and distance (S) in meters (m). In equation W=FS, if F=1 and S=1 then the work done by the force will be '1 N-m'.

Hence the unit of work is 'newton-meter' (N-m) or 'joule' (J)

Thus 1 joule (J) is the amount of work done on an object when a force of 1 newton (1N) displaces it by 1m along the line of action of the force.

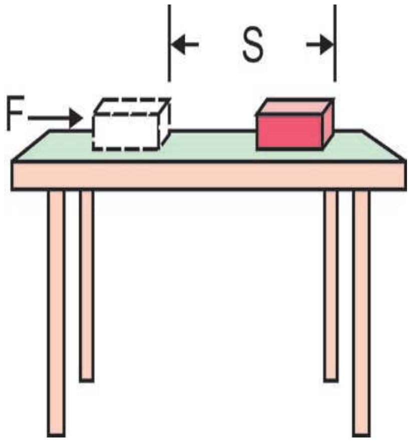


Fig - 3 : Pushing two objects

- What would be the work done when the displacement of the object is zero?

For example if a ball is thrown up as shown in Figure, the motion is in upward direction, where as the force due to earth's gravity is in downward direction. If a ball is moving on plain ground shown in the figure will get stopped after some time due to frictional force acting on it in opposite direction.

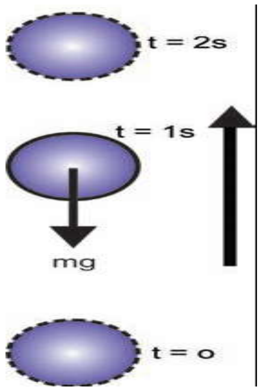


Fig. - 4 : Ball thrown upward

Fig. - 5 : Displacement and force are in opposite directions

If the force acting on an object and displacement are in opposite directions then the work done by the force is taken as negative.

$$W = -FS$$

If work has positive value, the body on which the work has been done would gain energy. If work has negative value, the body on which the work has been done loses energy.

6.3 Relation between work, Force and Displacement

As we know that work = force × displacement in the direction of the force.

If force and displacement are in the same direction you can easily find work done by finding their product. But if force and displacement are in different directions the work done is obtained by finding the product of force and the projection of displacement in the direction of the force.

Here work done is W = F × (PR) and but not F × PQ

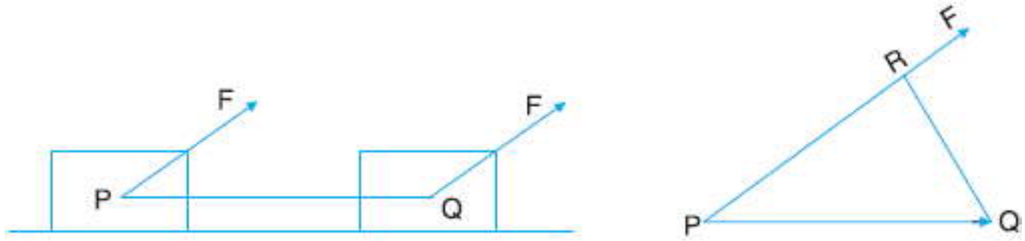


Fig - 6 : Work done when force and displacement are in different directions

Check your Progress

- Explain the relation between work, force and displacement
- A person is standing at railway station with luggage on his head. How much work done in this case? Why?
- Name the SI units of Work.

6.4 Energy and its relation with Work

When you play for a long time or do a lot of physical work at your home or outside you get **tired**, i.e., your body shows unwillingness towards further play or work. At this time you may also feel hungry. After taking rest for some time or eating some thing you may again be ready for work. How does one explain these experiences? In fact, when you do work, you spend energy and more energy is required to do more work. The capacity of a body to do work is determined by the energy.

Fig - 7 : Energy and Force

We often says "I lost so much of energy today", "you are looking so energetic today" so

- What is energy and how do we say that an object gains or looses energy?

Take a metal ball and throw it on a fibre plate from low height and repeat the same with increasing the height then observe the result. In the first case there is no effect of energy on plate and in the second case the plate was broken because of the energy acting on the plate.

Raju will lift 50 kgs of weight and ravi can lift only 20kg why?

- Why the capacity to do work changes person to person?

The energy of a body is its capacity to do work.

Like work, energy is also scalar. The units are same as that of work.

The SI unit of Energy is Joule (J) and the CGS unit is erg where 1J = 10^7 erg

6.5 Different forms of Energy

We all do work by spending muscular energy which you gain from the chemical energy of the food you eat. Fan runs on electrical energy. While playing with magnets you might have seen that a magnet can move a piece of iron so it has magnetic energy. Thus energy is available to us in many different forms like mechanical, thermal, light, electrical, magnetic, sound and nuclear. Let us discuss the different forms of energy.

1. **Mechanical Energy :** The capacity of doing work that a body possesses by virtue of its position i.e. potential energy or by virtue of its motion i.e. kinetic energy. The sum of the kinetic energy and the potential energy of an object is called its mechanical energy. Consider the following example.

   The kinetic energy of an aeroplane at rest is zero. Its potential energy when it is on ground is also considered as zero. Thus its mechanical energy is zero while it rests on the ground. When the same aero plane flies it has kinetic energy as well as potential energy, the sum of these energies gives the total mechanical energy of the aero plane in flight.

(a) Potential Energy

A body (say hammer) raised to a certain height above the ground when left to itself, falls down. If it is allowed to fall on a fiber plate it may break it into pieces. A body raised above the ground has thus ability to do work i.e. it has energy. This energy possessed by a body raised above the ground is called its **potential energy.**

Fig. - 8 : Potential Energy

When two sharp edged stones, one lighter and another heavier are dropped from the same height on a pit of sand it will be found that the heavier stone penetrates more in sand than the lighter. Hence a heavier stone possesses more potential energy. If same size stones are dropped from different heights, we find that the stone dropped from a greater height penetrates more, hence it has more potential energy. Potential energy of a body, thus depends on

1. Weight of the body ($W = mg$)
2. Height of the body (h) above the ground

It is found that the relation between Potential energy PE (Ep), weight (W), and height (h) is $Ep = W \times h = mgh$

(b) Kinetic Energy

Kinetic energy is the capacity of doing work that a body has by virtue of its motion.

Examples for kinetic energy are

- Hydropower Plants. Hydropower plants are places where the generation of electricity takes place with the help of water.
- Wind Mills. Windmills form one of the good examples of applications of kinetic energy.
- Moving Car.
- Bullet From a Gun.
- Flying Airplane.
- Walking & Running.
- Cycling.
- Rollercoaster.

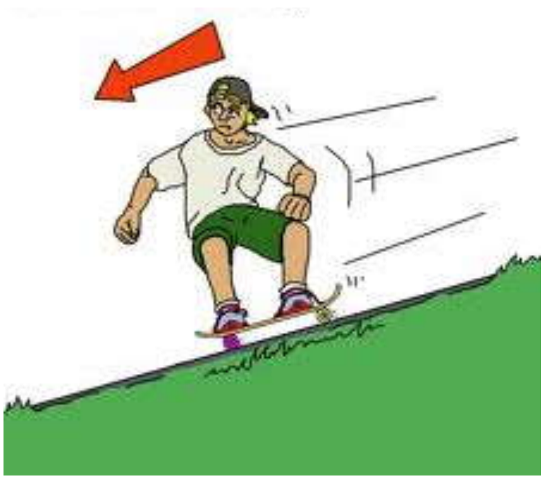


Fig. - 9 : Kinetic Energy

To understand better let us do an activity

Activity

Take a table and make it to form a sloping plane. Place a match box near the plane with its length parallel to the horizontal edge of the incline. Let a pencil cell roll down the incline and hit the match box. Does the match box move? Yes. The rolling cell had some kinetic energy due to which it made the match box move through a distance.

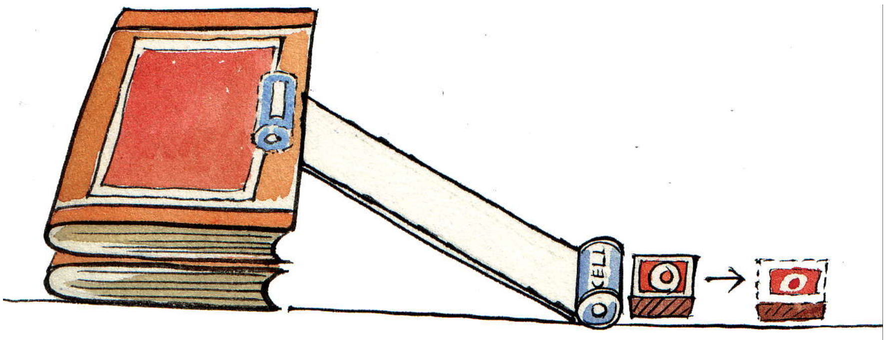


Fig - 10 : Conversion of potential energy into kinetic energy

Thus a moving object has ability to do work. Now placing the match box at the same position let a torch cell roll from the same height and strike the match box. Does it move again? Does it move through a longer distance? Why does it do so? The torch cell has more mass than pencil cell so it has more kinetic energy and does more work.

Now repeat the experiment by making the cell roll from a greater height. Does it move the match box through still more distance? From these observations we may conclude that

- When a body comes down from a height its potential energy decreases where as its kinetic energy increases.

The kinetic energy (KE) of a moving body depends on :

- its mass (*m*) – more the mass (for same velocity) more is its kinetic energy.
- its velocity (*v*) – more the velocity (for same mass) more is its kinetic energy.

It is found that the kinetic energy of a moving body, K.E.= $\frac{1}{2} m v^2$

2. **Thermal Energy :** Thermal energy refers to the energy contained within a system that is responsible for its temperature. Heat is the flow of thermal energy. This is a form of energy which flows into our body to give us sensation of hotness and out of our body to give us sensation of coldness. You shall learn the detailed thermal energy in the next chapter.

3. **Light Energy :** Light energy is a kind of kinetic energy with the ability to make types of light visible to human eyes. Light is defined as a form of electromagnetic radiation emitted by hot objects like lasers, bulbs, and the sun. Light contains photons which are minute packets of energy. You shall learn the light energy in the next chapter.

4. **Electrical Energy :** The electrical energy is generated due to movement of charged particles. You may be familiar with the energy that lights our bulbs, runs our fans, operates our pumps, heats our rooms, turns on our TV and radio and runs the refrigerator in our homes. You will learn more about this form of energy in upcoming lessons.

5. **Magnetic Energy :** The energy involved in the functioning of a magnet is called magnetic energy. You know that a magnet can attract a piece of iron. Thus magnets have an ability to do work. You will study more about this form of energy in upcoming lessons.

6. **Sound Energy :** The form of energy which enables us to hear is called sound. Sound originates when a body vibrates giving out waves which travel to our ear through a material medium. You will study more about sound in upcoming lessons.

7. **Nuclear Energy :** The nuclear energy is energy which is released in nuclear reactions by conversion of mass into energy. You must have read in lesson sources of energy that India is trying to generate electrical power through nuclear energy.

Check your Progress

- Write any 4 forms of energy
- Explain kinetic energy with suitable example
- Explain potential energy with suitable example.
- What happens to its KE and PE, if a body comes down from height?

6.6 Energy Transformation

- What does flowing water have to do with the electricity?
- What does solar heat have to do with electricity?
- What does tidal force have to do with current?

The conclusion is transformation of energy.

The energy from one form of energy to another form is known as energy transformation.

Some energy changes involve single transformations, while others involve many transformations.

- A cell phone transforms electrical energy to electromagnetic energy that travels to other phones.

Fig - 11 : Cell phone converting waves

- Your body transforms the chemical energy in your food to mechanical energy you need to move your muscles.

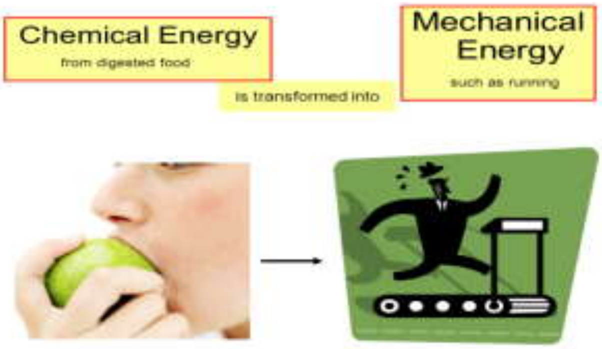


Fig - 12 : Chemical energy converted to mechanical energy

- Chemical energy in food is also transformed to the thermal energy your body uses to regulate its temperature.
- The mechanical energy used to strike a matchstick is transformed first to thermal energy. The thermal energy causes the particles in the matchstick to release stored chemical energy, which is transformed to thermal energy and the electromagnetic energy you see as light.

Fig - 13 : Matchstick converting chemical energy to thermal and light energy

- In a car engine, another series of energy conversions occurs. Electrical energy produces a spark. The thermal energy of the spark releases chemical energy in the fuel. The fuel's chemical energy in turn becomes thermal energy. Thermal energy is converted to mechanical energy used to move the car, and to electrical energy to produce more sparks.

Fig - 14 : Spark in engine

- Potential energy of water stored ina dam changes into kinetic energy as water falls from a height. The kinetic energy of flowing water changes into rotational kinetic energy of a turbine. The coil attached with the shaft of the turbine rotates in a magnetic field to convert rotational kinetic energy of the turbine into electrical energy.
- In our homes an electric bulb (or tube light) converts electrical energy into light energy, electric oven (or heater or iron or soldering iron) convert electrical energy into heat energy and electric pump (or motor) converts electrical energy into mechanical energy.
- An electric cell converts chemical energy into electrical energy; solar cell converts light energy into electrical energy and a thermocouple changes heat energy into electric energy.
- A microphone converts sound energy into electrical energy and a loudspeaker changes electrical energy into sound energy.
- Heat engine converts heat energy into work (mechanical energy) and work done against friction is converted into heat.

6.7 Energy Conservation

The law of Conservation of Energy states that energy cannot be created or destroyed - it can only be transferred from one type to another. Let us see some examples

- Water can produce electricity. Water falls from the sky, converting potential energy to kinetic energy. This energy is then used to rotate the turbine of a generator to produce electricity. In this process, the potential energy of water in a dam can be turned into kinetic energy which is now converts into electric energy.
- When you push a book across the table, the energy from your moving arm is transferred from your body to the book, causing the book to move.

- When kicking a football that is sitting on the ground, energy is transferred from the kicker's body to the ball, setting it in motion.
- Thus energy may be converted from one form to another. The principle of conservation of energy states that the total amount of energy remains the same in such conversions, i.e., energy cannot be created or destroyed.

6.8 Power

In our day to day life we observe many situtation where same activity is being completed in different time intervals. Forexample a hefty rickshaw puller is able to reach the destination in less time when compared other thinner rickshaw puller. Sometimes we notice that a grinder in our home takes more time to grind 1kg of ' dal' when compared to the grinder in the neighbours house.

- Do all of us do work at the same rate?
- Is the energy spent by the force doing work the same every time?
- Do machines consume or transfer energy at the same rate every time while doing a particular work?

A stronger person , may do certain work in relatively less time compared to another person, similarly a powerful machine can do a work assigned to it in relatively short time compared with another machine. We talk about the power of machines like motorbikes, motorcar, water pumping motors etc., the speed at which these machines do work is the basis for their classification. Power is a measure of the rate of doing work, that is how fast or how slow work is done.

Power is defined as the rate of doing work or rate of transfer of energy.

Power = *Work/Time*

P = W/t

The unit of power is 'watt' and denoted by symbol 'W'

1Kilowatt (KW) = 1000 Watts

1Kilowatt (KW) = 1000 J s^{-1}

Check your Progress

- Explain the transformation of energy with suitable examples.
- An aeroplane is moving in the sky. Explain what types of energy it will have?
- Explain law of conservation of energy
- Write the examples of energy conservation.
- Explain power with suitable examples
- Write the units of Power.

Key Points

- ❖ Work is said to be done when the force is applied on a body makes it to move. i.e displacement of the body is necessary.
- ❖ If there is no motion produced in the body even when a force acts on it, the work is done to be zero.
- ❖ Work done is equal to the product of the force (F) and the displacement (s) moved along the direction of the force.
- ❖ Work has only magnitude but no direction. So work is a scalar.
- ❖ 1 joule (J) is the amount of work done on an object when a force of 1 newton (1N) displaces it by 1m along the line of action of the force.
- ❖ The capacity of a body to do work is determined by the energy.
- ❖ The energy is available to us in many different forms like mechanical, thermal, light, electrical, magnetic, sound and nuclear.
- ❖ The sum of the kinetic energy and the potential energy of an object is called its mechanical energy.
- ❖ The energy possessed by a body raised above the ground is called its potential energy.
- ❖ Kinetic energy is the energy possessed by the body by virtue of its motion.
- ❖ A change from one form of energy to another form is known as energy transformation.
- ❖ The law of Conservation of Energy states that energy cannot be created or destroyed.
- ❖ Power is defined as the rate of doing work or rate of transfer of energy.
- ❖ The unit of power is watt and denoted by symbol "W".

Practice for Learning Outcomes

1. Explain the relation between work, force and displacement
2. A person is standing with luggage on his head. How much work he did ?
3. Explain different forms of energy.
4. Explain potential energy with suitable example.
5. Explain kinetic energy with suitable example.
6. What happens to its KE and PE, if an aero plane comes down from height?

7. What happens if energy transformation is not possible?

8. Explain the term conservation of energy.

9. Write the units of power.

Multiple choice questions

1. Find the kinetic energy of a ball of 250 g mass, moving at a velocity of 40 cm /s. ( )

   A) 0.01J B) 0.02J C) 0.03J D) 0.04 J

2. In which of the following case the work is done. ( )

   A) A person is standing on a wall.
   B) A bus moving from one place to another.
   C) A person pushing the wall.
   D) A person standing with luggage on his head.

3. In which of the following case the work is not done. ( )

   A) A person is walking.
   B) A person is pulling the trolley.
   C) A person pushing a huge rock.
   D) A person is walking with luggage on his head.

Chapter 7

Thermal Energy

Introduction

- Where do we get heat energy from?
- How do we measure heat energy?
- What are the different effects of heat energy in our daily life?

Sun is the major source of heat energy. Heat energy is also called as thermal energy. We find that the word 'Thermo' taken from greek word 'thermos" is used in many terms like Thermometer, Thermostat, Thermos flask, Thermo scope, Thermal energy etc., All these terms are associated with a common phenomenon called Heat. Thermal energy is the form of energy which flows from hot body to cold body. You are surprised to know that our body is also source of heat energy.

Learning Outcomes

After completing this lesson you will be able to:

- Define heat and temperature
- Distinguish between heat and temperature
- Give examples for change of states observed in day to day life due to heat energy
- Describe the construction and working of a laboratory thermometer, clinical thermometer and Six's MMT.
- Convert temperature into different scales, viz, Fahrenheit, Celsius and kelvin.
- Define specific heat and explain the applications of specific heat.

7.1 Heat and Temperature

It is our common experience that we wear woolen clothes during winters. Woollen clothes keep us warm. We prefer to wear light coloured cotton clothes in summer (Fig. 1). These cotton clothes give us a feeling of coolness. You might have wondered why particular types of clothes are suitable for a particular season.

Fig - 1

In winter you feel cold inside the house. If you come out in the sun, you feel warm. In summer, you feel hot even inside the house. How do we know whether an object is hot or cold? How do we find out how hot or cold an object is? In this chapter we shall try to seek answers to some of these questions.

7.1.1 Heat a form of energy-Thermal energy

- **Hot and Cold**

  In our daily life, we come across a number of objects. Some of them are hot and some of them are cold. List some objects you use commonly in Table - 1. Mark these objects as hot or cold.

Table - 1

Object	Cold/Cool	Warm/Hot
Ice cream		
Spoon in a tea cup		
Fruit juice		
Metal chair kept in the sun		
Ice cube in the fridge		

We find that some objects are cold while some are hot. The terms hot and cold are relative and give us a basic idea about heat.

Now, what happens when we touch a hot or cold body? When you touch a spoon taken out from hot tea cup, we feel spoon is hot because heat flows into our body. Similarly, when we touch an ice cube, we feel cold because heat flows out of our body into the ice cube.

Heat is defined as a form of energy which flows from a hot body to a cold body. The objects are either hot or cold due to the possession of heat in them. When a hot body is brought in contact with a cold body, the hot body loses energy to the cold body.

Heat is measured in the units of joules (J) or calories (cal). The SI unit of heat is joule (J) and CGS unit is calorie (cal).

The amount of heat required to raise the temperature of 1gram of water by 1°C is called calorie.

1 cal = 4.186 joules.

7.1.2 Transformation of energy

Consider the following examples:

- Heat is produced when you rub your palms.
- Iron becomes hot when it is beaten hard with a hammer.
- Heat is produced when we touch a soap nut seed which is rubbed on a stone.

In all the above cases, mechanical energy is converted into heat energy.

- Electrical heating devices like water heater, geyser, iron box convert electric energy into heat energy.

Fig - 2

Fig - 3

Fig - 4

Fig - 5

Fig - 6

- When fuels like wood or coal is burnt, chemical energy is converted into heat energy. A gas stove also converts chemical energy into heat energy.

Fig - 7

In the above examples, different kinds of energies are being Transformed into heat energy. In the same way, heat energy is converted into other forms of energy.

- A steam engine converts heat energy into mechanical energy.
- Solar cells directly convert heat energy into electric energy.

7.1.3 Temperature

Why do you feel hot or cold when you touch a metal piece or wooden piece?

It is because heat energy is transferred from metal piece to your body of from your body to the metal piece. You can test this by bringing your finger near the flame of a matchstick.

Temperature is defined as the degree of hotness or coldness of a body. The hot bodies are said to be at higher temperature and the cold bodies are said to be at lower temperature. Temperature determines the direction of flow of heat. Heat always flows from a body at higher temperature to a body at lower temperature. Heat and temperature are not the same but are relative to each other. Heat is the form of energy which keeps the body hot or cold whereas measuring hotness or coldness is called temperature. Heat is the cause whereas temperature is the effect.

7.1.4 Thermal equilibrium

When two bodies are placed in thermal contact, heat energy will be transformed from the hotter body to the colder body. This transfer of heat energy continues till both bodies attain the same degree of hotness or coldness. At this stage, we say that the bodies have achieved thermal equilibrium. Thus, the state of thermal equilibrium denotes a state of a body where it neither receives nor gives out heat energy.

If you are neither feeling hot nor cold in your surroundings, your body is said to be in thermal equilibrium with the surrounding atmosphere. Similarly, the furniture in the room is in thermal equilibrium with air in the room. So, we can say that the furniture and the air in the room are at the same temperature.

Check your Progress

- Are heat and temperature the same?
- Write the units of heat?

7.2 Measurement of Temperature

7.2.1 Thermometer – device used to measure Temperature

- When you go to a doctor, what is the device he uses to measure your body temperature?
- What is the device that is used to do thermal screening during the covid - 19.

Fig. 8

- What is the device that is used to measure temperature in laboratory?
- What is the device used to measure maximum and minimum temperature of a place?

Fig. 9

In all the above cases, the device used to measure temperature is called **Thermometer.**

7.2.2 Types of Thermometers

There are different types of thermometers. These are classified based on their usage in different purposes.

Clinical Thermometer

The thermometer that a doctor uses to measure the temperature of human body is called Clinical thermometer. It consists of a thin glass tube and a glass bulb filled with mercury. There is a constriction (kink) near the bulb. It prevents mercury level from falling on its own and thus helps to read the human body temperature accurately. A clinical thermometer is usually calibrated in Fahrenheit scale. It has a range of values from 95°F to 110°F. The temperature of human body would vary with in this range only. Clinical thermometers are also calibrated in Celsius scale as well. In Celsius scale, a clinical thermometer reads temperature from 35°C to 42°C.

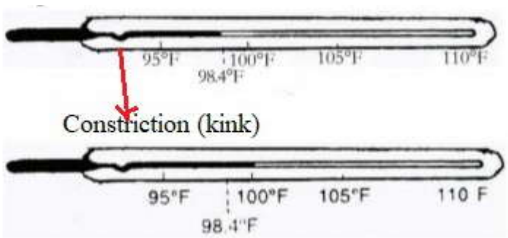


Fig - 10 : Clinicalthermometer

Laboratory Thermometer

The Thermometer that we use for measuring temperature in science experiments is called **laboratory thermometer**. It also consists of a thin glass tube and a glass bulb filled with mercury. It is calibrated in Celsius scale. Various ranges of values are used in laboratories of thermometers from -10°C to 100°C or 110°C. In some laboratory thermometers alcohol is used which is preferred for measuring low temperatures.

Fig - 11 : Laboratory thermometer

Six's Maximum and Minimum Thermometer (MMT)

The thermometer that the **meteorologists** use for determining the maximum and minimum temperature during a day is called **Six's maximum–minimum thermometer**. It consists of a U-shaped glass tube connected to two glass bulbs. In this thermometer mercury and alcohol are used. It has two iron indices I_1 and I_2 which indicate the maximum and minimum temperatures respectively. It is calibrated in Celsius scale.

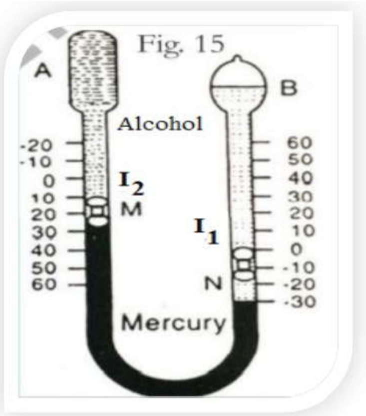


Fig - 12 : Maximum – minimum thermometer

Digital thermometer

There is a lot of concern over the use of mercury in the thermometers. Mercury is a toxic substance and is very difficult to dispose off if a thermometer breaks. So, these days **digital thermometers** are being used for measuring the temperature of human body. A digital thermometer doesn't consist of mercury so it is safe and easy to handle. I reads the temperature in Fahrenheit as well as in Celsius scale. It is also used for different other purposes.

Fig - 13 : Digitalthermometer

Thermistor Thermometer

It is also one kind of digital thermometer which doesn't consists of mercury in it. It is also used to measure the human body temperatures, particularly of infants and children.

Fig - 14 Thermistor Thermometer

Infrared Thermometer

An Infrared thermometer is also a kind of digital thermometer which measures the temperature of the surface without any contact with the object. So, it is also called a non-contact thermometer. It is widely used to screen the human body temperature during the COVID – 19 pandemic situation. It is used to measure the temperatures in industrial purposes also.

Fig - 15 : Infrared Thermometer

Check your Progress

- Give examples of contactless thermometer.
- Which liquids are used in Six's Maximum and Minimum thermometer (MMT)?

7.3 Scales used in Thermometers

Every thermometer has a lower fixed point and an upper fixed point. The space between these two marks is divided into equal number of divisions. Different scales are developed for measuring temperature.

Three such scales are shown in Fig - 16. These are: Celsius scale, Fahrenheit scale and kelvin scale.

- In Celsius scale the lower fixed point (ice point) is marked as 0, the upper fixed point (steam point) is marked as 100 and the intervening space is divided into100 equal parts.
- In Fahrenheit scale the lower fixed point is marked as 32, the upper fixed point as 212 and the intervening space is divided into180 equal parts.
- In case of a kelvin's scale the lower fixed point is marked as 273, the upper fixed point as 373 and the space between them is divided into 100 equal parts.

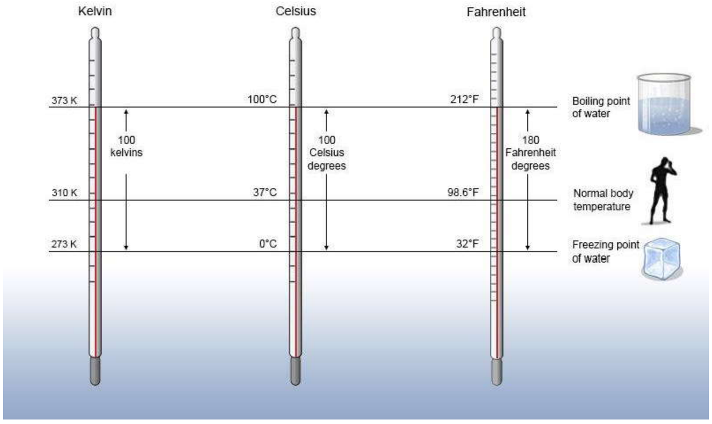


Fig - 16 : Different scales of temperature

- So, in Celsius scale there are 100 divisions, in Fahrenheit scale there are 180 divisions and in Kelvin scale there are 100 divisions.
- SI unit of temperature is kelvin(K). It can be expressed as degree Celsius (°C)
- 0°C = 273 K.
- How do you convert degrees Celsius to kelvin?

  Temperature in kelvin = 273 + temperature in degree Celsius.

  $$K = 273 + °C$$

Note : Temperature measured on kelvin scale is called absolute temperature.

Relation between different scales of temperature – conversion of one scale into another.

This is clear from the above figure that the three scales are related by the formula

$$\frac{C}{100} = \frac{F\text{-}32}{180} = \frac{K}{100}$$

Example : The temperature of an object in degree Celsius scale is 55°C. What is its temperature in Fahrenheit scale?

The relation between Celsius scale and Fahrenheit scale is $\frac{C}{100} = \frac{F\text{-}32}{180}$

Substituting C = 55 in the above formula, we have, $\frac{55}{100} = \frac{F\text{-}32}{180}$

$$F - 32 = \frac{55 \times 180}{100}$$

$$F - 32 = 99$$

$$F = 99 + 32 = 131$$

So, 55°C = 131 ^{o}F.

Check your Progress

- What is the equivalent temperature of 40 °C in kelvin scale?
- Write the normal temperature of human body in Celsius scale and in Fahrenheit scale.

7.4 Effects of Heat

When a body is heated, changes may occur in some of its properties. These changes are the effects of heat. Some of the effects of heat which we observe in our day to day life are:

7.4.1 Rise in temperature

When a body is heated its temperature increases, that is why it appears warmer when touched.

7.4.2 Change in state

Take some ice cubes in a vessel and heat it on a stove continuously. Place a thermometer in the vessel using a stand. What do you observe?

We find that the temperature gradually increases and stops at a particular point. At this constant temperature, we find the mixture of ice cubes and water in the beaker.

Why did the rise in temperature stop though we continued to heat the vessel all the time?

The continues supply of heat to substances brings a change in their state. This is the effect of heat. These effects in a material is associated with a certain temperature. Let us know about them.

Melting Point

When heat is continuously supplied to a solid substance, its temperature gradually rises and stops at a particular temperature. At this particular temperature, the substance completely changes into liquid state without any further change in its temperature.

This characteristic constant temperature at which a solid changes into its liquid state is called **melting point** of the solid. The melting point of a substance is a characteristic constant value and different substances may have different values of melting points.

Boiling Point

This characteristic constant temperature at which a liquid changes into its gaseous state is called **boiling point** of the liquid. The boiling point of a substance is a characteristic constant value and different substances may have different values of boiling points.

On cooling, change of state may take place in reverse order. The adjacent chart illustrates the various events of change of state.

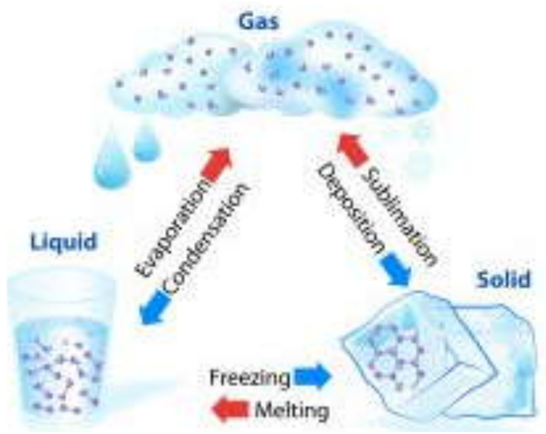


Fig - 17 : State of Matter

Change of state of matter

- Boiling: The process of heating a liquid continuously till it gets converted into gas.
- Melting: The process of conversion of a solid into liquid by absorbing the heat.
- Freezing: The process of conversion of a liquid into a solid by losing heat.
- Sublimation: The process of conversion of a solid directly into a gas by absorbing heat.
- Deposition: The process of conversion of a gas directly into a solid by losing heat.

Effect of heat on atmosphere/Climate

As we know that heat brings changes in the climate on earth. The following are some of those phenomena:

- **Evaporation :** The process of escaping of molecules from the surface of a liquid at any temperature. (or) The process of conversion of a liquid into gas at any temperature.
- **Condensation :** The process of conversion of a gas into liquid by losing heat.
- **Humidity :** The amount of water vapour present in air is called humidity.
- **Dew :** Dew is small drops of water that are formed on the ground and on other surfaces in outdoors during the night.
- **Fog :** The tiny drops of water in the air which form a thick cloud and make it difficult to see things is called fog.

Besides the above effects, heat causes some more effects through which the heat energy is transferred. Those effects are Conduction, Convection and Radiation. Sea Breeze and Land breeze occur due to the convection of heat.

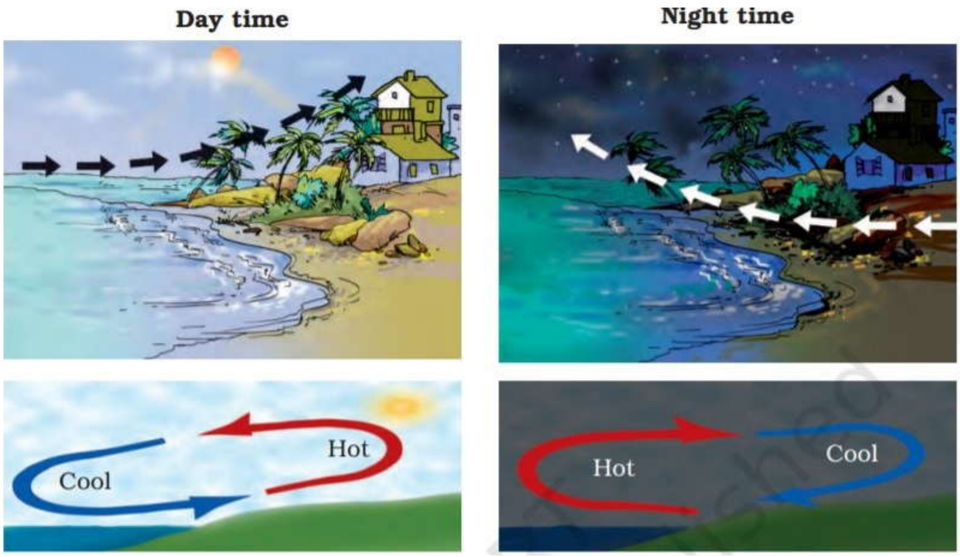


Fig - 18 : Sea breeze and Land breeze

Check your Progress

- Can we convert a solid into a gas directly? If so, what is the process called?

7.5 Specific Heat

7.5.1 Factors affecting the quantity of heat absorbed by a body.

Activity - 1 :

Take two beakers of equal volume and take 250 grams of water in one beaker and 1 kg of water in another beaker. Note down their initial temperatures using a thermometer (initial temperatures should be the same). Now heat both the beakers till the temperature of water in the two beakers rises to 60°C. Note down the time required to raise the temperature of water to 60°C in each beaker.

- Which beaker needed more time?

You will notice that you need more time to raise the temperature of 1 kg of water when compared to the time taken by 250 g of water. That means you need to supply more heat energy to greater quantity of water than lesser quantity of water for the same change in temperature.

For the same change in temperature, the amount of heat (Q) absorbed by a substance is directly proportional to its mass (m).

$$Q \propto m \quad (\text{ when } \Delta T \text{ is constant}) \; ...... \; (1)$$

Now take 1 litre of water in a beaker and heat it over a constant flame. Note the temperature changes (ΔT) for every two minutes.

- What do you notice?

You will notice that the change in rise of temperature with time is proportional, that means, for the same mass (m) of water, the change in temperature is proportional to amount of heat (Q) absorbed by it.

$Q \ \alpha \ \Delta T$ (when m is constant) …….. (2)

From equation (1) and (2), we get

$Q \ \alpha \ m \Delta T$ implies $Q = m s \Delta T$

Where 's' is a constant of proportionality which depends on the nature of the substance of the body. It will be constant for a given substance. This is called specific heat or specific heat capacity of the substance.

$$s = \frac{Q}{m\Delta T}$$

7.5.2 Definition of specific heat - units

The specific heat of a substance is the amount of heat required to raise the temperature of unit mass of the substance by one unit.

CGS unit of specific heat is cal g^{-1} °C^{-1} and SI unit is J $kg^{-1}K^{-1}$.

$$1 \text{ cal } g^{-1}{}^\circ C^{-1} = 1 \text{ k cal } kg^{-1} K^{-1}$$
$$= 4.2 \times 10^3 \text{ J } kg^{-1} K^{-1}$$

7.5.3 Specific heats of some materials

Different materials have different values of their specific heat capacities. Table - 3 gives the specific heat of some materials.

From the table - 2 it is clear that of all substances water has highest value of specific heat.

We have seen that the rise in temperature depends on the nature of the substance. Higher the value of specific heat of a substance lower will be the rate at which it is heated or cooled as compared to the substance of lower specific heat under identical conditions. It gives us an idea of the degree of 'reluctance' of a substance to change its temperature.

Table - 2 : Specific heats of some materials

Substance	Specific Heat	
	In cal $g^{-1}{}^\circ C^{-1}$	In J $kg^{-1} K^{-1}$
Lead	0.031	130
Mercury	0.033	139
Brass	0.092	380
Zinc	0.093	391
Copper	0.095	399
Iron	0.115	483
Glass (flint)	0.12	504
Aluminium	0.21	882
Kerosene oil	0.50	2100
Ice	0.50	2100
Water	1	4180
Sea water	0.95	3900

If we know the specific heat of a substance, we can determine how much heat (Q) is needed to raise the temperature of a certain mass of the substance through certain degrees by using the equation $Q = m s \Delta T$.

4.3.5.4 Applications of Specific heat capacity

1. **Specific heat of water on the earth moderates the climate on the earth:** The oceans can absorb large amounts of heat from sun at the equator without appreciable rise in temperature due to high specific heat of water. Ocean water transports the heat away from the equator to areas closer to the north and south poles. This transported heat helps moderate the climates in parts of the earth that are far from the equator.

2. **Water melon retains coolness for a longer time:** Water melon taken out of the refrigerator retains its coolness for a longer time than any other fruit because it contains a large percentage of water. This is because as the water has greater specific heat than its fibrous material.

Fig - 19 : Water melon

3. **A samosa is cool outside but hot inside:** A samosa appears to be cool outside but it is relatively hot inside when we try to eat it. This is because the curry inside the samosa contains ingredients (mostly with water) with higher specific heats than its out material.

Fig - 20 : Samosa

Check your Progress

- Samosa is cool inside but not outside. Why?
- Which is a good conductor of heat, a substance with less value of specific heat or a substance with high value of specific heat.

Key Points

- Thermal energy is a form of energy and like any other form of energy, it can be used to do work. Therefore, the SI unit of thermal energy is also joule (J).
- Temperature is a measure of degree of hotness or coldness of a body and is measured in degree Fahrenheit(°F) or degree Celsius(°C) or Kelvin (K) with the help of a thermometer.
- Relation between the three scales of temperature is $\frac{C}{100} = \frac{F-32}{180} = \frac{K}{100}$.
- The constant temperature at which a solid melts is called its melting point and the constant temperature at which a liquid boils is called its boiling point. Melting point and boiling point are characteristic properties of the substance.
- Heat energy flows from a body at higher temperature to a body at lower temperature till both of them acquire a common final temperature.
- The specific heat of a substance is the amount of heat required to raise the temperature of unit mass of the substance by one unit. Specific heat of water on Earth moderates the climate on earth.

Practice for Learning Outcomes

1. Distinguish between heat and temperature.
2. Why is mercury used as a thermometric liquid?
3. Why do we use ice for cooling our drinks and not water at 0°C?
4. During winter mornings why do people stand in the Sun? Explain.
5. What are the factors that affect the quantity of heat absorbed by a body?
6. Are boiling and evaporation the same processes?
7. Explain the construction and working of Maximum and minimum thermometer (MMT).

Multiple choice Questions

1. This type of thermometer does not contain mercury in it. ( )
   A) clinical thermometer
   B) laboratory thermometer
   C) maximum and minimum thermometer
   D) digital thermometer

2. The normal temperature of human body in celsius scale is ( )
   A) 38°C B) 37°C C) 39°C D) 98°C

3. Boiling point water ( )
   A) 70 °C B) 50 °C C) 0 °C D) 100 °C

4. To measure temperature of human body we use ( )
   A) Laboratory thermometer B) Clinical thermometer
   C) Maximum and minimum thermometer D) None of the above

Chapter 8

Light

Introduction

Almost every thing we see is made visible by the light as it falls and reflects from such sources. As we studied in earlier chapters light is also a form of energy. We know some sources of light like sun, lighted candle, glowing bulb etc.,

In this lesson we are going to learn how light propagates from source to the objects that we see, and how light get reflected from different surfaces. And also we are going to learn how light pass through the transparent objects such as lens and prism.

Learning outcomes

After completing this lesson you will be able to:

- explain the reflection of light with an example
- state the laws of reflection
- explain the mirror formula and magnification and the terms involved in them.
- solve the numericals based on mirror formula and lens formula
- explain the applications of different mirrors.
- explain the rules of sign convention
- demonstrate the formation of images due to mirrors and lenses
- give examples for the daily life applications of lenses.

8.1 Rectilinear propagation of light

✦ We select least time taken path to travel from one place to other generally. Is the light behaves same?

light travels in straight line in all directions around the source of light so as to reach in least time from one place to another place. This is called rectilinear propagation of light. By observing shapes and sizes of shadows formed for different objects, people came to an understanding that light travels in a straight line. Some instruments like pinhole camera supports the idea that light travels in a straight line. As stated by Fermat principle light selects least time taken path while travelling from source to objects. This results to the straight line propagation.

Even though light travels in the form of wave, it follows the straight line path in all media. The speed of light in vacuum and in air medium is 3,00,000 km/sec i.e., 3×10^8 m/s .

Check your Progress

- What is the shape of path of light? Why is it like that ?
- How people arrived at an understanding about the rectilinear propagation of light ?

8.2 Reflection of light

- ✦ We have learnt that light travels in a straight line. Then, how light enters into our house in the afternoon even the roof is obstructing the light?

You might have played with mirrors or with steel vessels in your child hood days and focused sunlight to the faces of your friends. Smooth objects like mirrors turns the path of light in different directions. When light falls on smooth objects it returns back. This is called reflection of light. The ray of light falling on the mirror is called the **"incident ray"** and the ray returning from it is called the **"reflected ray"**.

Laws of Reflection

- ✦ Do you think that reflection of light takes place according to some rules ?
- ✦ Is there any relationship between the direction of the incident ray and the direction of reflected ray ?

To get some understanding let us do an activity.

Activity - 1

Take a sheet of blank paper. Draw a line segment 'AC' across the middle. Draw another straight line at right angles (90 degrees) to the line segment AC. The second line should bisect the segment AC at point B. We shall call this line as "Normal: (See in figure -1(a)).

Draw two lines from point B on the left side of the normal and two on right side. The lines should be at angles of 30^0 and 60^0 respectively from the normal. Number these lines 1, 2, 3, 4 as shown in figure -1(b).

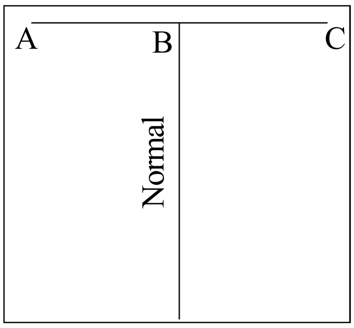


Fig - 1(a) : Normal

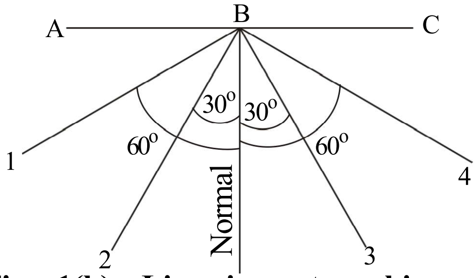


Fig - 1(b) : Line sigments making 30^o, 60^o angles with normal.

Place a mirror strip vertically on segment AC with its reflecting surface facing the normal. See that the back of the mirror coincides with the segment AC. Take a laser light torch and let its light ray fall along line 4. Now this ray is the incident ray for the mirror. The angle between the normal and the incident ray is called the "Angle of Incidence ($\angle i$)". Here it is 60^0. You can observe that the reflected ray fall on line 1, which is making an angle 60^0 with the normal. The angle between normal and the reflected ray is called the "Angle of Reflection ($\angle r$)". Adjust the laser light torch so that its light ray falls along line 3 and you can observe that reflected ray falls along line 2. In this case both angle of incidence and angle of reflection is 30^0. Once again adjust the laser light torch so that its light ray falls along normal. Here incident ray coincides with normal. So, the angle of incidence is 0^0. You can observe that in this case reflected ray will also coincides with normal. So the angle of reflection is also 0^0.

By this activity we can conclude that while reflection takes place angle of reflection is equal to the angle of incidence.

$$\angle i = \angle r$$

In this activity we used plane mirror, even for spherical mirror it is true that angle of reflection is equal to angle of incidence.

Activity - 2

Place a mirror (1 ft. × 1 ft.) on the floor. You and your friends A, B, C stand on four sides of the mirror as shown in figure 2.

Adjust your places of standing in such a way that each one of you can see image of the person opposite to you in the mirror kept on the floor.

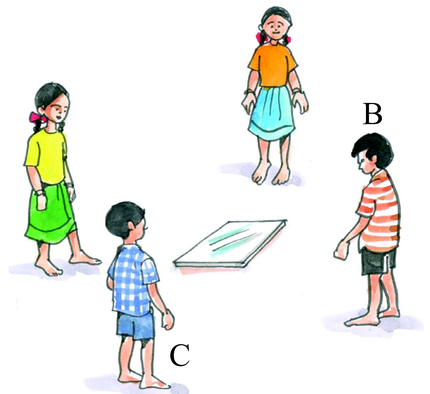


Fig - 2 : Observing images of each other in mirror

Your friends A, C are able to see images of each other in the mirror but your friend B or you can not see the image of A or C in the mirror.

Ask your friend B, who is infront of you to move a foot a side from his place. Then you can not see the images of each other.

Imagine a normal to the mirror. It would be perpendicular to the mirror as well as to the floor. Imagine an incident ray coming from your friend B falls on the mirror, then the reflected ray coming from the mirror while you both are able to see the images of each other in the mirror. Observe that the incident ray, normal and reflected ray lie in the same plane. When your friend move aside you should aline your place in such a way that incident ray, normal and reflected ray lie in the same plane. Then only you both can see images of each other in the mirror.

By this activity we can conclude that while reflection of light takes place, incident ray, normal and reflected ray lie in the same plane. This plane is called "plane of reflection".

By the above activities we arrive at laws of reflection given below.

1. Angle of reflection is equal to angle of incidence

$$\angle i = \angle r$$

2. Incident ray, normal and reflected ray lie in the same plane.

Check your Progress

- Explain angle of incidence and angle of reflection.
- State the laws of reflection.

8.3 Image formation by plane mirror

Observe the figure - 3 and observe the light rays. They will explain how the image of a candle is formed in the mirror and how we are able to see the image of the candle in the mirror.

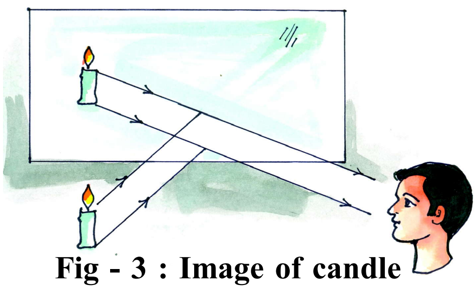


Fig - 3 : Image of candle

In figure - 4, 'O' is a point object. Some rays from 'O' reach the mirror and get reflected. When we look in to the mirror, the reflected rays seem to be coming from point 'I'. So point 'I' is the image of point 'O'.

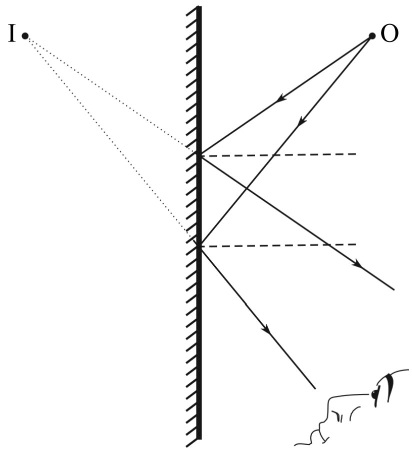


Fig - 4 : Image of a point object

Observe the distances of object 'O' and image 'I' from the surface of the mirror and try to compare these distances. We find that these distances are equal.

Let us assume that an object (OO') is kept infront of a mirror as shown in figure - 5. Draw a few incident rays from the object to the mirror and reflected rays from the mirror using laws of reflection.

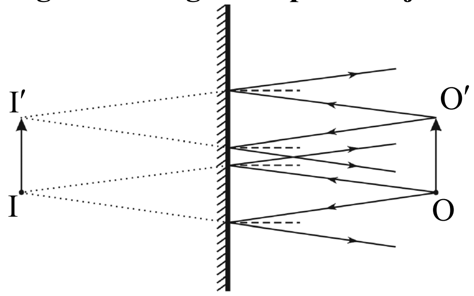


Fig - 5 : Formation of image by a plane mirror

In the figure, the rays starting from object OO' get reflected from the mirror and seem to be coming from II'. So we say II' is the image of the object OO'. By comparing the sizes of OO' and II' we find that these sizes are equal.

You also might have observed the right - left inversion of your image in a plane mirror (see figure - 6). This is called "Lateral inversion".

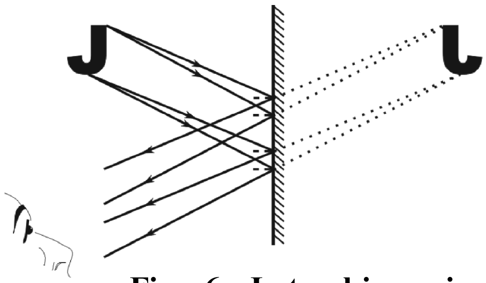


Fig - 6 : Lateral inversion

Characteristics of image formed by a plane mirror :

1. Object distance is equal to image distance
2. Object size is equal to image size
3. Image suffers lateral inversion.

Check your Progress

- State the characteristics of image formed by a plane mirror?
    - ✦ Are all the mirrors be of same kind?
    - ✦ Did you observe your image in bigger or smaller size than normal size in any mirror?

8.4 Spherical mirrors

You might have observed the rear view mirror beside the driver in motor vehicles like bus, car or motor cycle. These are one type of spherical mirrors. These are used by drivers to see vehicles which are moving behind or beside of the vehicle without turning their heads. You can observe that the size of the image formed in these mirrors are smaller than the size of the object.

Try to observe your image in a stainless steel spoon. You can see your inverted image on the inner portion (concave side) of the spoon and you see your erected & diminished image on the outer portion (convex side) of the spoon. (See fig - 7) surfaces of spoon acts as spherical mirrors.

Fig - 7 : Images with steel spoon

The mirrors which contain curved reflecting surface are called spherical mirrors. They are of two types.

1. Concave mirror 2. Convex mirror.

If the reflecting surface of a mirror is concave, it is called concave mirror. See figure-8a.

If the reflecting surface of a mirror is convex, then it is called convex mirror. See figure-8b.

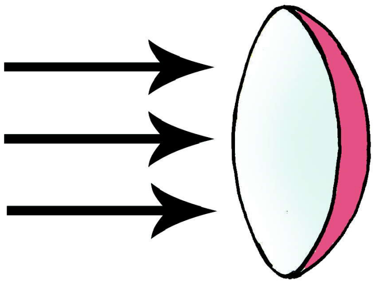


Fig - 8(a) : Concave mirror

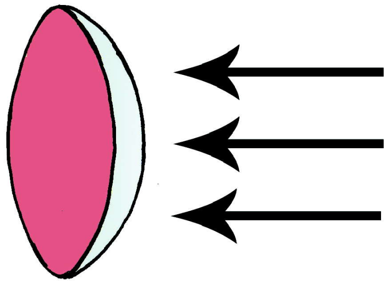


Fig - 8(b) : Convex mirror

Any convex or concave mirror is a part of a sphere. Hence these are called spherical mirrors.

Let us know some important terminology related to spherical mirrors.

1. The geometric centre of the spherical mirror is called "pole"(p)
2. The centre of sphere of which a spherical mirror is a part is called "centre of curvature" (c) of the spherical mirror.
3. The line joining pole and centre of curvature is called "principal axis".

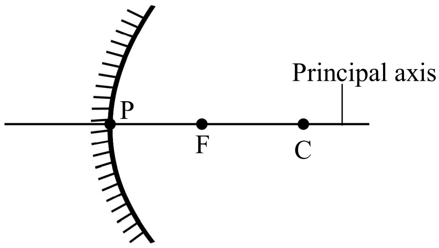


Fig - 9(a) : Principal axis of concave mirror

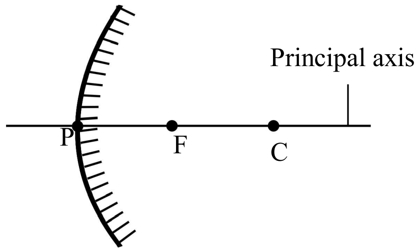


Fig - 9(b) : Principal axis of convex mirror

4. Light rays coming parallel to the principal axis reflected by concave mirror converges at a point on the principal axis. This point is called 'focus' or 'focal point (F)' of the concave mirror.

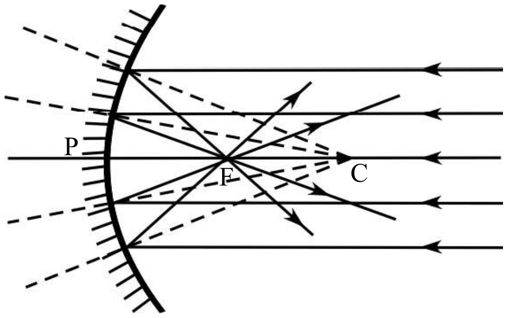


Fig - 10 : Focal point of concave mirror

5. Light rays coming parallel to the principal axis reflected by convex mirror seem to be diverges from a point on the principal axis. This point is called (inside the mirror) "focus" or "focal point" (F) of the convex mirror.

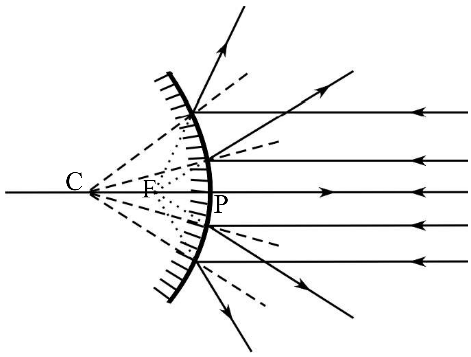


Fig - 11 : Focal point of convex mirror

6. The distance from pole to focus is called "focal length f)".

7. The distance from pole to centre of curvature is called 'Radius of curvature (R)'.
8. In the case of spherical mirrors R = 2*f*.

Check your Progress

- Why concave and convex mirrors are called spherical mirrors?
- Explain the terms pole, centre of curvature and focus of a spherical mirror.
- State the relation between focal length and radius of cuvature.
- Draw a concave mirror and show pole, centre of curvature, focus, principal axis of it.

8.5 Image formation by spherical mirror

Activity - 3 :

Place the concave and convex mirrors on two different V-stands. Put two candles of same size infront of them as shown in figure - 12. Adjust the position of candles to form clear images in the mirrors. You will find

The image in the convex mirror is smaller than the object.

The image in the concave mirror is bigger than the object.

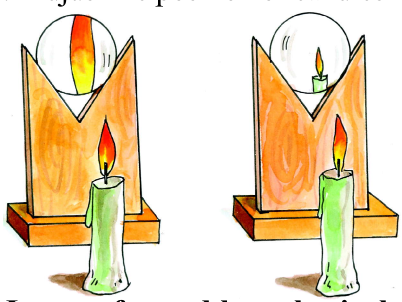


Fig - 12 : Images formed by spherical mirror

(a) Characteristics of image formed by concave mirror :

Activity - 4

Take a concave mirror of known focal length. Place it on a V-stand. Imagine the principal axis of the mirror at some height from the ground as shown in figure - 13. Draw a straight line on the floor infront of the mirror as like principal axis that is perpendicular to the V-stand base. Treat the place of V-stand as pole (P). Mark a point (F) on the straight line (drawn) at a distance equal to focal length (f) from the pole. Mark another point (c) on the straight line at a distance equal to R that is 2*f*. If you place a lighted candle on the principal axis you may get an image on a white screen as shown in figure - 13.

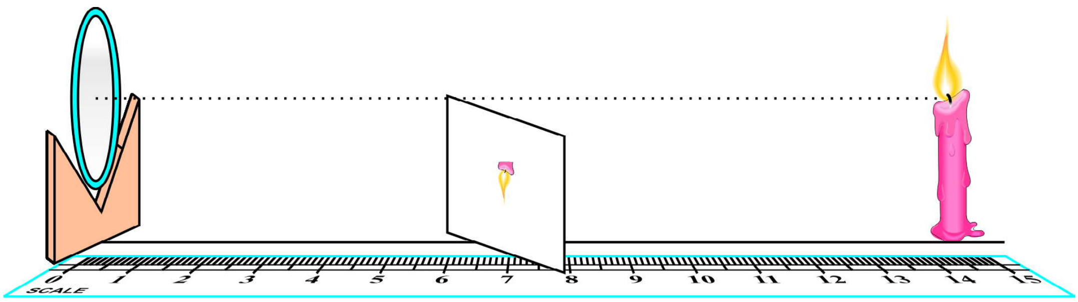


Fig - 13 : Formation of image by concave mirror

(i) If you place the candle beyond centre of curvature, you will get an image on the screen between Focus (F) and centre of curvature (C). The image caught on screen is called “real image”. This image is inverted and smaller in size (diminished) than object.

(ii) If you place the candle at ‘C’, you will get the image at ‘C’. This is real & inverted image. The size of the image is equal to the size of the object.

(iii) If you place the candle between F, C ; you will get the image beyond ‘C’. It is a real & inverted image and bigger than the object. (enlarged image)

(iv) If you place the candle at focal point F, you will not get any image on the screen at any distance. At the same time you can not see the image in the mirror also. So we can’t say the characteristics of the image. Simply we say the image formed at infinity.

(v) If you place the candle between pole (P) and focus (F), you can see image in the mirror. The image can be seen only in the mirror but not caught on screen is called “virtual image”. In this case we get virtual image. It is enlarged and erected.

b) Characteristics of image formed by convex mirror

Where ever you place the candle infront of the convex mirror you will get only a diminished, virtual and erected image in the mirror itself. The image looks like as it is formed between P, F.

Check your Progress

- What is real image? What is virtual image? Explain in your own words.
- State the characteristics of image when an object is placed between F, C on the principal axis of concave mirror.

8.6 Mirror formula, Magnification & Sign convention

✦ Can we guess the image distance for an object without doing an experiment?

Mirror formula : We can get a relation between object distance (u), image distance (v) and focal length (f) when we use a spherical mirror. The relation between u, v, f is given by

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

This is called “mirror formula”. While using this formula we have to follow sign convention.

Magnification :

The ratio of height of image (h_i) to the height of object (h_0) is known as “magnification (m)”. In case of mirrors magnification is equal to the ratio of image distance (v) to the object distance (u) with negative sign.

$$m = \frac{h_i}{h_0} = -\frac{v}{u}$$

While using this formula we have to follow sign convention.

Rules for sign convention :

(i) All the distances should be measured from pole.

(ii) Distances measured in the direction of incident light rays treated as positive and measured opposite to the incident light rays treated as negative.

(iii) Height of object, image are positive if measured upwards from the principal axis and negative if measured downwards.

Example 1 : An object 4cm in size is placed at 25 cm infront of a concave mirror of focal length 15 cm. At what distance from the mirror would a screen be placed in order to obtain a sharp image? Find the nature and size of the image.

Solution :

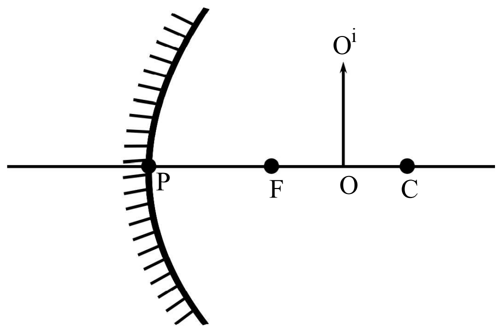


Fig - 14 : Object infront of concave mirror

According to sign convention :

focal length (f) = -15 cm

object distance (u) = -25 cm

object height (h_0) = + 4cm

image distance (v) = ?

image height (h_i) = ?

using $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$$\frac{1}{(-15)} = \frac{1}{v} + \frac{1}{-25} \Rightarrow \frac{1}{v} = \frac{1}{25} - \frac{1}{15}$$

$$\Rightarrow \frac{1}{v} = \frac{3-5}{75} \Rightarrow \frac{1}{v} = \frac{-2}{75}$$

$$\Rightarrow v = -37.5 \text{ cm.}$$

So, the screen should be placed at 37.5 cm from the pole of the mirror towards object. The image is real.

$$\text{Magnification } (m) = \frac{h_i}{h_0} = -\frac{v}{u}$$

$$\Rightarrow \frac{h_i}{4} = -\frac{(-37.5)}{-25}$$

$$\Rightarrow h_i = -\frac{4 \times 37.5}{25} \qquad \Rightarrow h_i = -\frac{150}{25}$$

$$\Rightarrow h_i = -6 \text{ cm.}$$

So, the image is inverted and enlarged.

Check your Progress

- State the mirror formula. Explain the terms in it.
- Explain magnification and write the formula for it.

8.7 Applications of mirrors

(a) Concave mirror

- It is used as a reflector behind the bulb in the head lights of vehicles.
- It is used as a shaving mirror
- It is used by dentists to observe the inner part of mouth.
- It is used in making solar cookers.

(b) Convex mirror

- It is used as a rear view mirror in motor vehicles.
- It is used at the turnings of "Ghat roads" to avoid accidents.

(c) Plane mirror

- It is used in our daily life for dressing up and make up.
- It is used in some shops to get multiple images by arranging many mirrors making some angle with each other.
- It is used in periscope.

Check your Progress

- Write the applications of concave mirror.
- Write the applications of convex mirror.

8.8 Refraction of Light

✦ If the light comes back after striking an object, that is reflection. What happens if the light passes through the object ? What may be the rules that followed by light then?

You might have observed that a coin kept at the bottom of a vessel filled with water appears to be raised. Similarly, a lemon kept in a glass of water appears to be bigger than its size. When a thick glass slab is placed over some printed letters, the letters appear raised when viewed through the glass slab. The reason behind these is refraction of light.

The process of changing speed at an interface when light travels from one medium to another resulting in a change in direction is "refraction of light". The process of refraction involves bending of light ray except when it is incident normally (see fig - 15(c))

When light ray travels from rarer medium to denser medium, then refracted ray moves towards the normal drawn at the interface of separation of two media. (see figure - 15(a))

When light ray travels from denser medium to rarer medium, it bends away from the normal. (see figure - 15(b))

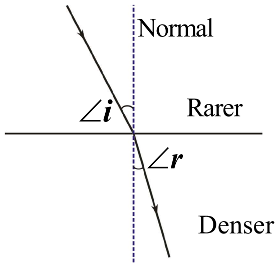


Fig - 15(a)

($\angle i > \angle r$)

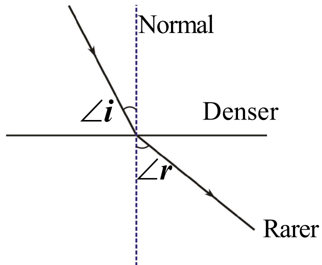


Fig - 15b

($\angle i < \angle r$)

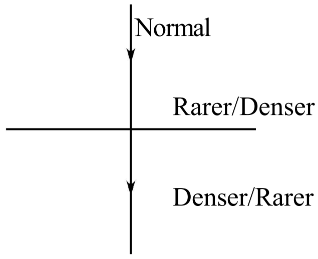


Fig - 15c

($\angle i = \angle r = 0^0$)

Here $\angle i$ is angle of incidence, $\angle r$ is angle of refraction. $\angle r$ in second medium related to $\angle i$ in first medium depends on the refractive indices of both media. The medium in which the speed of light is lesser is called denser medium. The medium in which the speed of light is greater is called rarer medium.

Check your Progress

- Explain refraction of light in your own words.
- Draw the ray passing from denser medium to rarer medium. Indicate $\angle i$, $\angle r$.

8.9 Formation of image by a lens

✦ What really a person with spectacles is seeing? An object or an image?

You might have played with magnifying lens to burn a paper with the help of sun rays. The lens that you used is convex lens. Lenses are of two types :

(i) Converging lens (ii) Diverging lens

convex lens (double convex lens) is a converging lens. Concave lens (double concave lens) is a diverging lens.

Let us know some important terminology related to lens.

1. The mid point of lens is optic centre (p)
2. Every lens has two focal points (F) on either side of lens.
3. The point (C) on either side of lens is a point at a distance of 2f from pole. They may not be centre of curvatures as like in the case of mirrors.
4. The line passing through P, F is principle axis.

This information is interpreted in the figures given below.

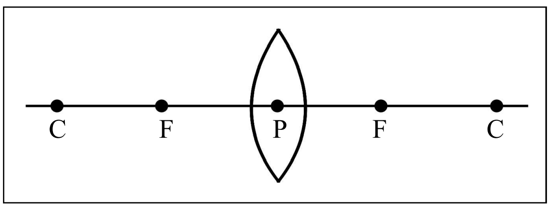


Fig - 16(a) convex lens

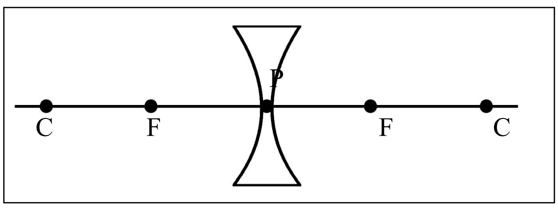


Fig - 16(b) concave lens

(a) Characteristics of image formed by a convex lens :

Activity - 5

Place a convex lens of known focal length on a V-stand. Draw a straight line on the floor. Indicate a point on the line as P. Place the V-stand at P. Locate point 'F' on either side of V-stand at a distance equal to focal length (f). Locate point 'C' on either side of lens at a distance equal to 2f (see figure - 17).

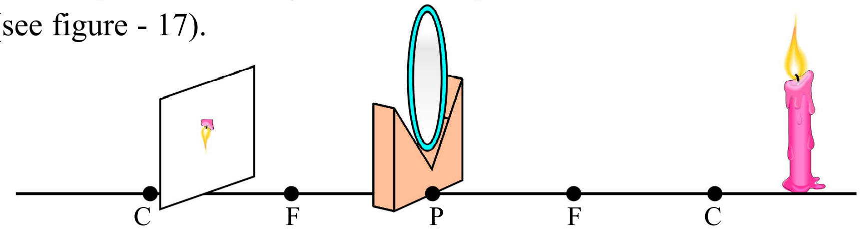


Fig - 17 : Formation of image by a convex lens

(i) If you place the lighted candle beyond 'C' you will get an image on the screen between F, C on the other side of the lens. This is real image, inverted image and diminished image.

(ii) When you place the candle at 'C' you will get an image on the screen at 'C' on the other side of the lens. This is real image, inverted image having equal size with the object.

(iii) When you place the candle between F, C you will get an image on the screen beyond 'C' on the other side of the lens. This is real, inverted and enlarged image.

(iv) When you place the candle at 'F' you won't get the image on the screen. So, we say the image is formed at infinity distance, and we can't explain the characteristics of the image.

(v) When you place the candle between P, F you won't get the image on the screen but you can observe the image in the lens from the other side of the lens. This is virtual image, erected and enlarged image.

(b) Characteristics of image formed by a concave lens

Where ever you place the candle infront of the concave lens you will get only a diminished, virtual and erected image in the lens itself. It seems to be located between P, F on the same side of the lens.

Check your Progress

- State the characteristics of the image when an object is placed beyond 'C' on the principal axis of convex lens.
- How can you get a virtual image using lens?

8.10 Lens formula, Magnification & Lens power

Lens formula

We can get a relation between object distance (u), image distance (v) and focal length when we use a lens. The relation between u, v, f in the case of lens is given by

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

This is called lens formula. While using the formula we have to follow sign convention.

Magnification

We already know that the ratio of height of image (h_i) to the height of the object (h_o) is called magnification (m). In the case of lenses magnification is equal to the ratio of image distance(v) to the object distance (u).

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

while using this formula we have to follow sign convention. Follow the rules for sign convention mentioned at spherical mirrors in this lesson.

Example 2 : An image of 2 cm size caught on the screen at a distance of 20 cm from the pole of a convex lens. If the focal length of the lens is 10 cm, find the position and height of the object.

Solution : According to sign convention

focal length (f) = 10 cm

image distance (v) = 20 cm

image height (h_i) = 2cm

object distance (u) = ?

Object height (h_0) = ?

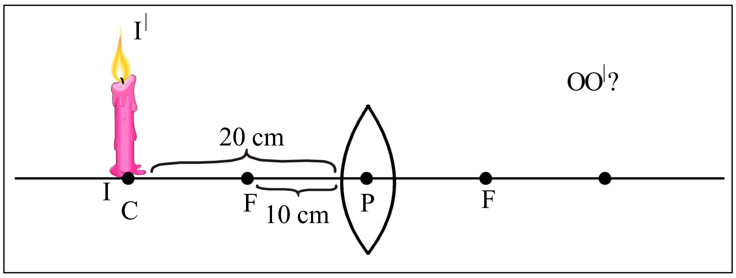


Fig - 18 : Image formed by convex lens

Substitute the above values in $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\Rightarrow \frac{1}{10} = \frac{1}{20} - \frac{1}{u}$$

$$\Rightarrow \frac{1}{u} = \frac{1}{20} - \frac{1}{10}$$

$$\Rightarrow \frac{1}{u} = \frac{1-2}{20}$$

$$\Rightarrow \frac{1}{u} = \frac{-1}{20}$$

$$\Rightarrow u = -20 \text{ cm.}$$

So, the object is at 20 cm distance on the other side of the lens.

$$\text{Magnification } (m) = \frac{h_i}{h_0} = \frac{v}{u}$$

$$\Rightarrow \frac{2}{h_0} = \frac{20}{-20}$$

$$\Rightarrow \frac{2}{h_0} = -1$$

$$\Rightarrow h_0 = -2 \text{ cm.}$$

$\therefore$ the object and image are inverted to each other having same height of 2cm.

Power of lens :

The degree of convergence or divergence of light rays that can be achieved by a lens is expressed in terms of its power. The reciprocal of focal length is called power of lens.

Let '*f*' be the focal length of lens.

Power of lens $P = \frac{1}{f\,(\text{in meters})}$ or $P = \frac{100}{f\,(\text{in cm})}$

The unit of power is diopter (D).

Check your Progress

- Doctor suggested a person to use 1.25 D lens. What is the focal length of the lens ?

Uses of lenses in daily life

1. Lenses are used in spectacles.
2. Convex lens is used as magnifying glass.
3. Lenses are used in cameras, microscopes, telescopes etc.,

8.11 Dispersion of Light

You might have enjoyed rainbow while it is raining at a near by place to you. Generally we observe 4 to 5 colours in a rainbow, but by a clear observation we know that there are 7 colours in a rainbow. These are violet, Indigo, Blue, Green, Yellow, Orange, Red. We can split the sunlight into seven colours using a prism also.

Spliting of white light into 7 colours is called 'dispersion of light'.

Fig - 19 : Rainbow

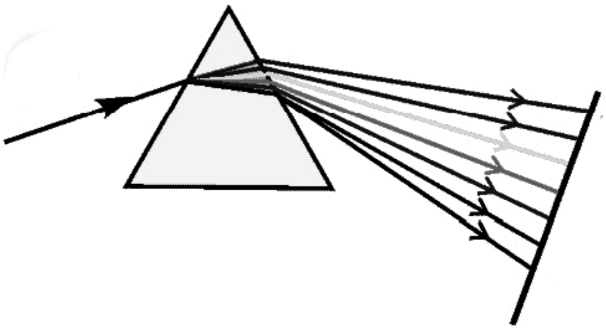


Fig - 20 : Prism

Key Points

- Light travels in a straight line, selecting least time taken path.
- When reflection of light takes place, $\angle i = \angle r$.
- Incident ray, reflected ray and normal lies in the same plane.
- In the case of plane mirrors:
  1. Object distance = Image distance
  2. Object size = Image size
- In the case of spherical mirrors, R = 2f.
- Mirror Formula $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$
- Magnification (for mirrors) $m = \frac{h_i}{h_o} = -\frac{v}{u}$
- When light travels from optically rarer medium to denser medium, it bends towards the normal. When light travels from optically denser medium to rarer medium it bends away from the normal.
- Lens Formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
- Magnification (for lenses) $m = \frac{h_i}{h_o} = \frac{v}{u}$
- Power of lens $p = \frac{1}{f(\text{in meter})}$ or $p = \frac{100}{f(\text{in cm})}$
- Splitting of white light into seven colours is called dispersion of light.

Practice for Learning Outcomes

1. Ravi said that, "light does not travel in a straight line, that's why it is entering into our class room". How can you correct him?
2. What is the normal to the mirror at a point on the mirror?
3. What is the relation between angle of incidence and angle of reflection?
4. What is the difference between real image and virtual image?
5. State the characteristics of the image when an object is placed beyond 'C' on the principal axis of the concave mirror.

6. How the human life would have been if there were no spherical mirrors?
7. Draw the ray passing from rarer medium to denser medium. Indicate $\angle i$ and $\angle r$.
8. What type of lens do you choose to get the real image? Where will you put the object to get the real image?
9. You have a concave mirror instead of convex lens. Is it possible to burn a paper with sun rays using the mirror? If possible, How?
10. An object is placed at a distance of 10 cm infront of a convex lens having focal length 20 cm. If the height of the object is 2 cm, find the height of the image.

Multiple Choice Questions

1. Mirror formula among the following ( )

   (a) $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$ (b) $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

   (c) $\frac{1}{u} = \frac{1}{f} + \frac{1}{v}$ (d) $\frac{1}{f} = \frac{1}{u} - \frac{1}{v}$

2. The geometric centre of the mirror is: ( )

   (a) Centre of curvature (b) Focus

   (c) Pole (d) Point of Incidence

3. The image we get with convex mirror ( )

   (a) Real Image (b) Diminished Image

   (c) Enlarged Image (d) Image of same size of object

4. Focal length of a lens is 100 cm. Power of that lens is ( )

   (a) 100 D (b) 50 D (c) 10 D (d) 1 D

5. R = 2f is applicable for ( )

   (a) Only for lenses (b) Only for spherical mirrors

   (c) Both for lenses and mirrors (d) Only for plane mirror

Chapter 9

Electric Energy

Introduction

We use electric current many ways. At home it is used to run fans ,air Coolers, lights, refrigerators,washing machines, television etc. i.e., the electric appliances work with flow of charge.

- What is electricity?
- How electricity is produced?
- How electric energy can be converted into other forms of energy?
- Can electric energy stored?

Learning outcomes

After completing this lesson you will be able to:

- Cite examples of static electricity from everyday life;
- Identify two kinds of electric charges and describe the Coulomb's law;
- Define the terms electrostatic potential, and potential difference;
- Define electric current;
- State Ohm's law and define electrical resistance of a conductor;
- Compute equivalent resistance of series and parallel combination of resistors;
- Appreciate the heating effect of current by citing examples from everyday life and
- Define the unit of electric power and electric energy and solve problems about these.

9.1 Electric Charges

You must have observed that a plastic comb when brought near a piece of paper does not pick up small pieces of a paper. But if you comb your dry hair and bring the comb close to a small pieces of paper, you will notice that the bits of paper are attracted towards the comb.

Do you know why it happens? This happens because the comb gets charged or electrified when you comb your dry hair.

Let us understand more with some simple activities.

Take a plastic rod and rub it against your hair. Now bring it near small bits of paper.

- what do you observe?

The small bits of paper will fly and stick to the plastic rod.

Why is it not attracted in first instance?

Why is it attracting after rubbing against hair?

Let us try to know about it.

Fig - 1 : Small bits of paper attracting plastic rod

When plastic rod rubbed against hair both plastic rod and hair acquire a small quantity of electric charge.

Dr. Gilbert set out to find the nature of electric charge on the bodies. He took two glass rods and rubbed against silk cloth and brought one near to the other and observed that two glass rods repel each other.

He observed the same when two ebonite rods rubbed against cats fur.

He also observed that attraction between glassrod rubbed against silk cloth and ebonite rod against cats fur. From his observations we can conclude there exists two types of charges. In the first two cases they repelled each other since they have the same charge. But in the last case they attracted each other because both the rods have different charges. Let us consider that glass rod has positive charge and ebonite has negative charge.

Therefore we conclude that there are two types of charges namely

1. Positive charge
2. Negative charge

Battery

Fig - 2 : Battery

You might have observed battery cell marking with positive and negative terminals to indicate these charges.

Have you ever experienced attraction of your hair while wearing a nylon or polyester shirt? Let us try to understand this.

Have you ever experienced any attraction of your hair towards CRT TV screen?

Why do these happen?

This is because of transfer of charges from shirt to body and CRT TV screen to hair.

The material, from which the negative charges have been transferred, gets an excess of positive charge and the one which receives the negative charge becomes negatively charged

Forces between charges.

Like charges repel , in terms of force it is force of repulsion. Unlike charges attract in terms of force it is force of attraction.

The force of attraction or repulsion between charged bodies is depends on magnitude of charge and distance between them. This is called Columb's Law.

Check your Progress

- What happens when glass rod is rubbed against silk cloth?
- What happens to force if the distance between charges increases

9.2 Electro Static Potential

A body becomes positively charged if it is added by positive charge. Initially the body is neutral,no force exerts by the body on adding the charge.when some positive charge is deposited on it ,it encounter a repulsion force on newly adding charges.

Work done in depositing additional charge to any charged body, which is stored as potential energy .This is called electro static potential.

If 'w' is work done in adding charge 'q' then electro static potential V=w/q.

When two charged bodies are kept in contact, positive charge will flow from high potential to low potential

The electric potential is measured in' volts'.

The potential difference between two points is the amount of work done in moving a unit positive charge from one point to the other.

If one joule of work is needed to move 1 coulomb of charge from one point to another then electric potential between two points is 1 volt, it is also called potential difference.

How can you measure electric potential?

The electric potential is measured by voltmeter.

Electric cell

Is it possible to allow the flow of charges continuously from one body to another body ?How?

Yes, an electric cell is needed to allow the charges to flow continuously from one body to another body. An electric cell is a device that maintains constant potential difference between its terminals. An electric cell converts chemical energy into electrical energy.

Check your Progress

- What happens to potential if a positive charge is added to a positively charged body?
- Name the instrument used to measure potential difference

9.3 Electric Current

What happens when you switch on a bulb?

Do motion of charges responsible for glowing of the bulb?

Yes, the charge carriers or electrons in a conductor are responsible for the electric current.

The amount of charge crossing any cross section of the conductor in one second is called electric current.

Let'Q" be the charge crossing through any cross section of the conductor in a time interval 't'

Then amount of charge crossing any cross section in one second is $\frac{Q}{t}$

Therefore Electric current = electric charge/time interval

$$I = \frac{Q}{t}$$

The S.I unit of electric current is Ampere and denoted by 'A'

1 Ampere = 1coulumb/second

How can we measure electric current?

The electric current is measured by an ammeter

A multimeter can also be used to measure electric potential and electric current.

Check your Progress

- Write the SI unit of electric current?
- Write the SI unit of charge?

9.4 OHM'S LAW

When a torch is used for several days, light becomes dim. what does it mean?

It means the potential difference across the terminals of cell has reduced. When you buy a new 1.5 V dry cell,the potential difference across its terminals is 1.5 V. When cell is used for long time the potential difference decreases,say 1.0 V therefore less charge flows through bulb and hence we get less current.

Therefore a relationship between potential difference and electric current is given by scientist George Simon Ohm and named as Ohm's law.

"At constant temperature the potential difference between ends of a conductor is directly proportional to electric current passing through it ."

$$V \propto I$$

$V = IR$, R is a constant called resistance.

Limitation of ohm's law

The ohm's law can be applied only to conductors and that too when its temperature and other physical conditions remain unchanged. If the temperature of the conductor increases its resistance also increases.

Resistance : The property of a material which obstructs the flow of electrons in a conductor is called resistance.

Resistance $R = \frac{V}{I}$

SI unit of resistance is $\frac{\text{Volt}}{\text{Ampere}}$ or 'Ohm'.

1 ohm is the resistance of a wire across which when 1V potential difference is applied, 1A current flows through the wire.

i.e. $1 \text{ ohm} = \frac{1 \text{ Volt}}{1 \text{ Ampere}}$

The resistance of a wire is 1 ohm when 1 volt potential difference applied across the ends of wire, which carries 1 Ampere current.

Factors affect the resistance

Do all the materials have the same resistance?

Why do we use thick wire for connecting heavy load appliances such as Air conditioners?

Do you know on what factors resistance of a wire depends?

The factor affecting the resistance of a material are

1. Length-longer the wire, more the resistance.
2. Area of cross section-thicker the wire, lesser the resistance, thinner the wire more resistance.
3. Temperature.
4. Nature of material.

Check your Progress

1. Write the SI units of resistance.
2. How is a volt related with ohm and ampere?

9.5 Electric Circuit

A Closed path with connecting wires, battery and resistance that allows the flow of electrons is called simple electric circuit.

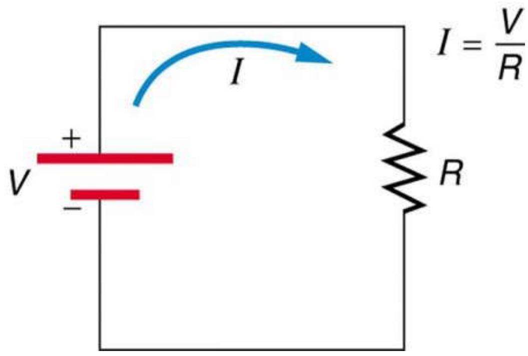


Fig - 3 : Circuit

Series combination of Resistors

In an electric circuit, resistors can be connected in two different ways namely.

1. Series combination-Resistors connected end to end consecutively
2. Parallel combination-Resistors connected between the same two points

Series Combination : Three resistors are connected in series with a cell and an ammeter. You will note that due to one path the same current i will flow through all of them.

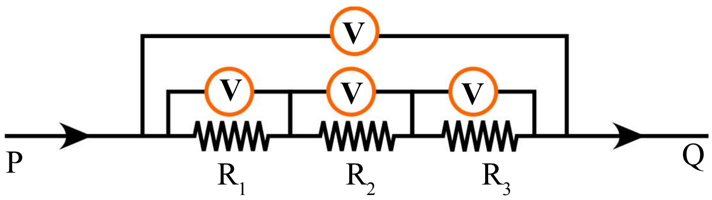


Fig - 4 : Series combination of resistors

Let the potential difference between the ends of the resistors R_1, R_2 and R_3 are V_1, V_2 and V_3 respectively.

By ohm's law potential difference across resistor R_1 is $V_1 = iR_1$

potential difference across resistor R_2 is $V_2 = iR_2$

potential difference across resistor R_3 is $V_3 = iR_3$

Now if the potential difference between P and Q be V then $V = V_1 + V_2 + V_3$

Substituting the values of the V_1, V_2 and V_3

$$V = iR_1 + iR_2 + iR_3$$

$$V = i(R_1 + R_2 + R_3)$$

Let total or equivalent resistance between P and Q is Rs. Then total potential difference

$V = iRs$

Comparing equations, we get

$$iRs = i(R_1 + R_2 + R_3) \text{ or } Rs = R_1 + R_2 + R_3$$

i.e. The equivalent resistance of three resistors connected in series is equal to the sum of their individual resistances.

- What happens if any one of the resistors breakdown in series connection?

In any one of the resistor breakdown , then circuit becomes open and current will not pass in the circuit. Do you know how the electrical appliances conneted in our houses? Let us know?

Parallel Combination of resistors : Three resistors connected in parallel with a cell and an ammeter. The potential difference between across each resistor is same but the current passing through each branch of a given resistance is different.

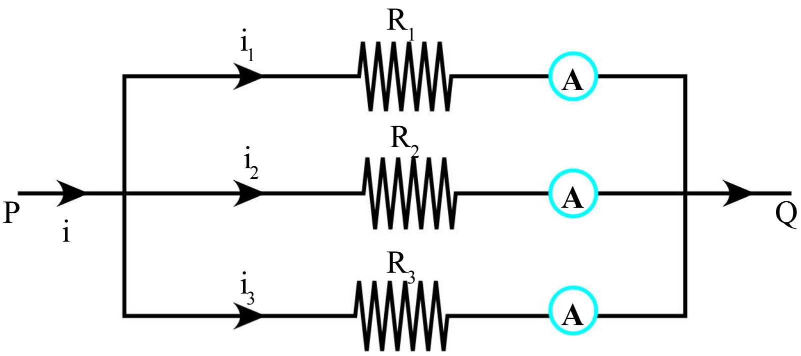


Fig - 5 : Parallel combination of reistors

If i_1, i_2 and i_3 respectively represent the current passing through the branches having the resistors R_1, R_2, and R_3 then the total current i in the main circuit will be $i = i_1 + i_2 + i_3$ if V is the potential difference across each of the resistors, then according to Ohm's law

$$i_1 = \frac{V}{R_1} : i_2 = \frac{V}{R_2}; \; i_3 = \frac{V}{R_3} \text{ and } i = \frac{V}{R_p}$$

If R_p is the equivalent resistance of the resistors connected in parallel having the same potential difference V, then

$$\frac{V}{R_p} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

i.e. the sum of the reciprocals of the individual resistances is equal to the reciprocal of equivalent resistance Rp.

- How do we connect electric appliances in our house?

Normally all the appliances in our household circuits are connected in parallel Inside the houses wiring is done in parallel mode such that when one lights an appliance in a room it doesn't affect the strength of current in another room.

But the chain of small bulbs that we use for decoration on Deepawali has the bulbs connected in series.

Check your Progress

1. A number of bulbs are connected in a circuit. Decide whether the bulbs are connected in series or in parallel, when (i) the whole circuit goes off when one bulb is fused (ii) only the bulb that get fused goes off.
2. When the potential difference across a wire is doubled, how will the following quantities be affected (i) resistance of the wire (ii) current flowing through the wire?

9.6 Heating effects of Electric Current

How do you feel when you touch a glowing bulb? is it hot?

When electric current passing through the filament of an electric bulb, it gets heated and glows brightly. We can feel the heat by touching.

Similarly on passing current through the filament of electric iron, an electric heater, the coil of the heater becomes red hot. Do you know why? It is because in an electric circuit, electrical energy is converted into heat energy. This effect is known as **thermal effect of electric current or Joule's heating.**

Heat Energy Produced in Conductor or Electrical Energy

Suppose an electric current 'i'passes through a conductor AB of resistance R. Then the potential difference between ends A and B is

$$V = iR$$

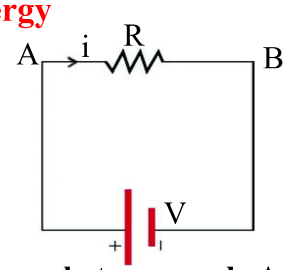


Fig - 6 : Potential difference between ends A and B

If the charge Q is to be transferred from point A to B, the work is done in moving the charge Q across the ends of the conductor.

$$W = QV$$
$$W = (it)\,(iR)$$
$$W = i^2Rt$$

Here the work done in moving the electric charge across a resistance appears in the form of heat. Therefore, the heat produced in the conductor is $H = i^2Rt$.

Hence, the amount of heat produced in a conductor on passing the current i is

(a) directly proportional to the square of the current (i^2),

(b) the resistance of the conductor (R) and

(c) the time (t) for which the current flows through the conductor.

This is known as Joule's law of heating. SI unit of heat is joule (J), 1 cal = 4.18 J

Electric Power

How can you estimate the power of the electric water pump?

The rate at which electric energy is consumed or dissipated is termed as electric power.

Electric power P =Work done X time of flow of current

$$P = W \times t$$

$$P = VQ \times t; \qquad \text{since } Q \times t = i$$

$$\therefore \; P = Vi$$

Unit of electric power is watt (W) .

For electric power another bigger unit horse power (hp) is also used.

1 (hp) = 746 W

Kilo watt hour (kWh) or BOARD OF TRADE UNIT

How do calculate power consumption in your house?

The consumption of electrical energy in our houses is measured by a special unit called Kilo Watthour

$$1\text{kilowatt hour (kWh)} = 1 \text{ kilowatt} \times 1 \text{ hour}$$

$$= 1000 \text{ watt} \times 3600 \text{ second}$$

$$= 1000 \text{ joule/second} \times 3600 \text{ second} = 36 \times 10^5 \text{ joule}$$

$$1 \text{ kWh} = 3.6 \times 10^6 \text{ J}$$

kWh is also known as Board of Trade (BOT) unit or simply a unit of electric energy. Therefore, the commercial unit of electric energy is kilowatt hour (kWh).

- Electrical appliances based on thermal effect of electric current

There is a long list of household appliances based on thermal effect of electric current e.g electric iron, electric kettle, electric immersion rod/heater, electric geyser, electric oven, electric toaster, electric stove, room heater, etc.

Beside appliances, heating effect of electric current is also used in electric fuse, electric welding and electric arc.

Check your Progress

- How will the heat produced in a conductor change when the current flowing through the conductor is doubled.
- Name two household electric devices based on thermal effect of electric current

9.7 Household Circuits

Till the poles near our houses, electricity reaches through the distribution system. Two wires from the poles come to our houses. Among these one wire is called as 'phase' while the other is called as neutral.

In the phase wire the voltage is 220V while in the neutral the voltage is zero same as that of earth. It is represented as N. Usually the phase wire has a red coloured insulation over it while neutral wire has insulation of any colour other than red or green.

In household circuits use another wire that has green coloured insulation over it which is called as earth wire. All the appliances are connected to through this wire to the earth.

Precautions to be taken while using Electrical Energy

If electricity is used in a careful and safe manner it is the largest and most convenient form of energy. If one uses it carelessly it will become lethal.

1. Before working with electricity one must ensure whether it is AC or DC current. DC of the same voltage as of AC is more dangerous.
2. Do not touch electricity supply wires with your bare hands. One may even die due to shock from current. One must separate a person who has received a current shock with the help of a safe nonconductor eg. (rubber, stick, shoes, gloves)..
3. Never use water to extinguish the fire caused due to electrical spark but we can use sand.
4. Ensure that the safety measures of earthing and fuse are properly done in your household electrical circuit.
5. All switches can be switched off by simply closing the single large main switch so that current flow to all appliances is cut off in the emergency.

Accidents Caused by Electricity

You may have often heard that several dangerous accidents have occurred due to electricity at homes or industries. Such accidents by electricity occur due to the following reasons; leakage of current, short circuit and over load.

1. **Leakage of Current** Often due to continuous flow of electric current the insulation over wires gets affected and is scraped off and the wires are left bare. Current leakage occur through such bare wires. .When a person touches such appliances gets a severe shock.
2. **Short Circuit** If somehow the main and neutral wire come in contact with each other there is a sudden huge spark occurs that takes the form of fire.
3. **Overload** If the value of current flow goes above the required value of the circuit then the wire fails to bear the load of electric current. This is called overloading. This leads to fire accidents.To protect from over loading we use electric fuses or MCB and proper earthing has to be done.

Safety Devices used in Electrical Circuits

1. **Electrical Fuse** A piece of wire made of lead and tin alloy is used in making fuse. It have its melting point lower and high resistance then that of electrical wire. Due to this, if current in a circuit increase above a particular point the fuse wire gets heated and burnsout.
2. **Miniature Circuit Breaker (MCB)** These days MCB is attached to the household circuit wirings. MCB is a self regulatory switch which saves the circuit from overloading as well as from short circuits.

3. **Earthing of Electrical Appliances** Leakage of electric current in electrical appliances can harm us and may get electrical shock by touching them. Thus as a precaution there is another wire other than phase and neutral which is called as earth wire. The metallic end of all appliances is connected to one end of this wire and the other end is attached to a copper plate and burried deep in the ground.

Check your Progress

- How many kinds of wires used in house - hold wiring what are they.
- Which is more dangerous A.C (or) D.C.
- Which device is used to protect the appliances from overloading?

Key Points

- ❖ When two bodies are rubbed together in contact, they acquire a peculiar property of attracting small bits of paper. We say the bodies are electrified or charged.
- ❖ Charges are of two types. Charge acquired by a glass rod rubbed with silk is positive and that acquired by an ebonite rod rubbed with fur is negative.
- ❖ Like charges repel each other and unlike charges attract each other.
- ❖ The closer the charges are, the stronger is the electrostatic force between them.
- ❖ Potential is the electrical state of a conductor which determines the direction of flow of charge when the two conductors are either placed in contact or they are connected by a metallic wire.
- ❖ Potential energy per coulomb of charge at a point is called potential. Positive charge always moves from a higher potential to a lower potential and vice-versa.
- ❖ The potential at a point is the amount of work done in bringing a unit positive charge from infinity to that point.
- ❖ The potential difference between two points is the amount of work done in moving a unit positive charge from one point to the other.
- ❖ Electric current is the charge passing through a given cross section per unit time.
- ❖ Electric cell is a device with the help of which we can apply a potential difference between the two ends of a wire due to which current will flow through the wire.
- ❖ Ohm's law states that at constant temperature the potential difference applied across the ends of a conductor is directly proportional to current flowing through it .
- ❖ The obstruction offered to the flow of current by the wire is called its resistance. Mathematically ratio of voltage applied across a conductor and the current flowing through it is called resistance of the conductor. SI unit of resistance is ohm.

- Resistors may be connected in two different independent ways (i) in series and (ii) in parallel.
- In series, total resistance of the combination is equal to the sum of the individual resistances.
- In parallel, reciprocal of the combined resistance is equal to the sum of the reciprocals of the individual resistances.
- When current is passed through a conductor, heat energy is developed along the resistor. Which is called joule's heating
- Commercial unit of electrical energy is kW h and that of electric power is HP.
- The safety devices used in electric circuit are electrical fuse, MCB and proper earthing.

Practice for Learning Outcomes

1. How many types of electric charge exist?
2. What is the potential difference between the terminals of a battery if 250 J of work is required to transfer 20 C of charge from one terminal of the battery to the other?
3. Define electric current and state its units? How can ohm's law be used to define ohm?
4. Why do we use fuses in household circuits?
5. Why should we connect electric appliances in parallel in a house hold circuit?
6. Write the precautions to be taken while using electric energy?

Multiple Choice Questions

1. JC^{-1} is the unit of
   A) Current B) Charge C) Resistance D) Potential
2. Which of the following materials is an electrical insulator?
   A) Mica B) Copper C) Tungsten D) Iron
3. The device which converts chemical energy into electrical energy is called
   A) Electric fan B) Electric generator
   C) Electric cell D) Electric heater
4. The resistance of a conductor does not depend on its
   A) Temperature B) Length C) Thickness D) Shape

Chapter

10

Magnetic effect of Electric Current

Introduction

Magnets are fascinating. Bring a pair of magnets close together and they attract together and stick. Turn one of the magnets around and they repel each other. A magnet will stick to a iron nail, but it won't stick to an aluminium sheet. Magnets come in all shapes and sizes. They are popular as toys, are utilized as compasses and are essential elements in electric motors and generators.

Learning Outcomes

After completing this lesson you will be able to:

- explain the poles of a magnet
- explain the magnetic field in your own words.
- draw the magnetic field lines formed due to current carrying solenoid.
- explain the working process of electric bell
- explain electromagnetic induction in your own words.
- state the difference between AC and DC and the advantage of AC.

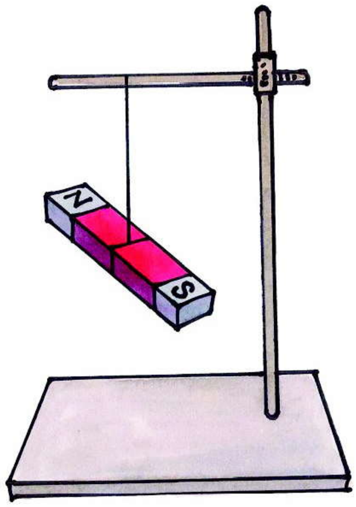
10.1 Magnets and Magnetic Field, Field Lines

✦ When do people first know about magnets?

Magnetism was found in certain rocks called "load stones" more than 2000 years ago in the region of Magnesia in Greece. In the twelth century, the chinese used them for navigating ships. In the eighteenth century, the French pysicist Charles coulomb studied the forces between load stones. We now know that load stones contain iron ore.

✦ Is the strength of magnet same through out the magnet? Where the strength of magnet will be more?

Magnetic poles



Magnets exert forces on one another. They can both attract and repel each other without touching, depending on which end is held near the other. The strength of their interaction depends on the distance of separation of the two magnets. The regions called "magnetic poles" produce magnetic forces.

If you suspend a bar magnet from its center by a piece of string it will act as a compass. The end that points north is called the north pole (north seeking pole) and the end that points south is called south pole (south seeking pole). All magnets have both a north and a south pole. For a simple bar magnet the poles are located at the two ends. See Figure -1.

Fig - 1 : Identification of magnetic poles

Like poles (north - north or south-south) repel, and opposite poles (north-south) attract each other. Magnetic poles cannot be isolated. A north magnetic pole never exists with out the presence of south pole and vice versa. If you break a bar magnet in half, each half still behaves as complete magnet. You can continue breaking the pieces in half and never isolate a single pole.

Magnetic field, field lines

✦ Can we see that how the force of magnet is spread out in it's filed?

Activity - 1

Place a sheet of white paper over a bar magnet and sprinkle iron filings on the paper. The filings will tend to trace out an orderly pattern of lines that surround the magnet. The space around the magnet, in which a magnetic force is exerted is called "Magnetic field". See figure 2.

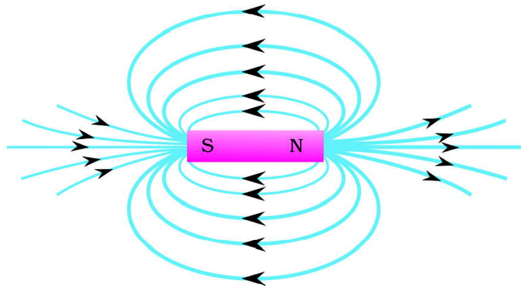


Fig - 2 : Magnetic field lines of barmagnet

The shape of the field is revealed by magnetic field lines. Magnetic field lines spread out from one pole, curve around the magnet, and return to the other pole. Magnetic field is three dimentional. The direction of the field out side the magnet is from the north to the south pole. Where the field lines are closer together, the field strength is greater. We see that the magnetic field strength is greater at the poles. If we place a small compass any where in the field, its poles will tend to line up with the magnetic field. The compass shows the magnetic field direction at the point where it is placed.

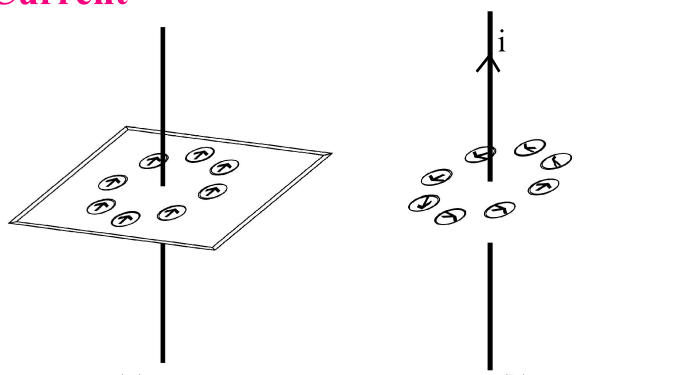
Check your Progress

- Explain magnetic field in your own words.
- What can you say about like poles and unlike poles?
- What happens to the compass needle when it is placed in a magnetic field?

✦ Is there any relation between magnet and electric current?

10.2 Magnetic effect of electric Current

A moving charge produces magnetic field. Many charges in motion (an electric current) also produces magnetic field. The magnetic field that surrounds a current carrying conductor can be demonstrated by arranging an assortment of magnetic compasses around a wire, and passing the current through it. (See figure - 3b)

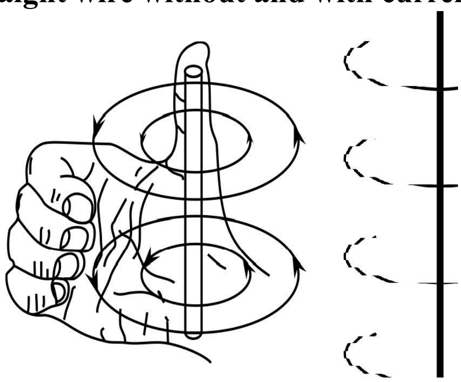


(a) (b)

Fig - 3(a), (b) : Straight wire without and with current

The compasses line up with the magnetic field produced by the current and show it to be a pattern of concentric circles about the wire. When the current reverses direction, the compasses turn completely around, showing that the direction of the magnetic field changes also.

We can easily find the arrangement of magnetic field lines related to the current, using right hand thumb rule. As shown in fig - 4(a), if the current is in the thumb direction of right hand, the folded figures shows us the arrangement of field lines around the current carrying wire.



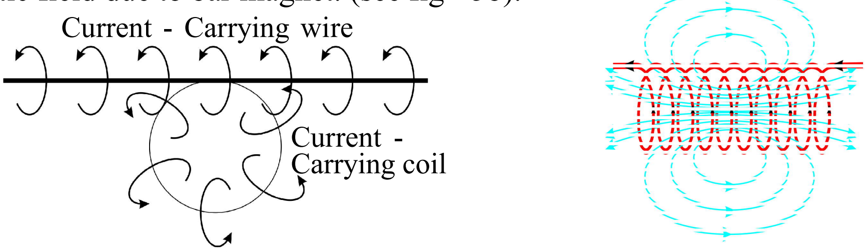
(a) (b)

Fig - 4(a) Right hand thumb rule, (b) Direction of Magnetic field lines around a straight wire

✦ Is it possible to get the magnetic field around a current carrying coil as like a current carrying straight wire?

Magnetic field due to current carrying solenoid

If the current carrying wire bent into a loop, the magnetic field lines become bunched up inside the loop. (see figure - 5a). If the wire is bent into many loops overlapping the first, the concentration of magnetic field lines inside the loop (now that is coil) increases. If we strech the coil and make it like a spring it is called solenoid. Magnetic field due to current carrying solenoid resembles the magnetic field due to bar magnet. (see fig - 5b).



(a) (b)

Fig - 5 : (a) Magnetic field lines due to current carrying coil, (b) Magnetic field lines due to current carrying solenoid

We can explain the direction of magnetic field due to current carrying solenoid using righthand thumb rule. If the fingers of right hand are folded in the direction of current in the solenoid, the thumb indicates the direction of magnetic field.

Check your Progress

- Draw the diagram showing magnetic field lines due to current carrying wire.
- Which rule helps us to know the direction of magnetic field due to current?

  ✦ Is there any magnet that works when switch is on and stops when switch is off as like an electric bulb?

10.3 Electro magnet - Electric bell

A current carrying coil of wire with many loops is an electromagnet. It works as a magnet until current is in it. When the current in it stops it will remain as simple wire coil. This nature of electromagnet is used in many appliances like electric cranes, electric bells, loud speakers etc. If we insert an iron piece in the middle of the coil, it works as a strong magnet when current is in it.

Electric bell :

See figure 6. In an electric bell the main part is electromagnet. When current is allowed in the wire wound to the U-shaped iron rod it becomes an electromagnet. Due to the magnetic field around it, it attracts the iron rod which is fixed to a spring and having a metal ball at one end. The rod acts as a hammer for the bell. When the rod is attracted by the electro magnet, the metal ball strikes the metal boul and we get sound. At the same time because of the slight movement, the electric circuit of the bell will be breaked at the place of screw. (See diagram). So, coil looses it's magnetism. Then the rod comes to the initial position. Once it come back to it's original position circuit will be closed and current passes through the circuit. Then the electromagnet starts it's work to pull the rod. This process will continue until and unless the current is put off by the switch.

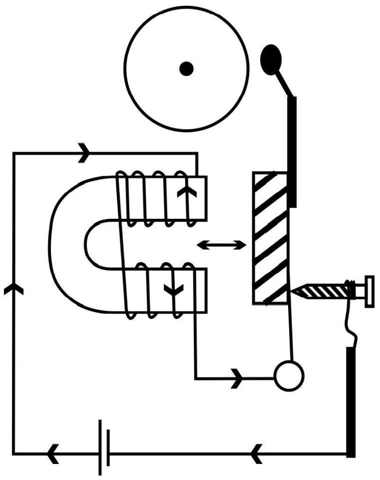


Fig - 6 : Electric bell

Check your Progress

- What is an electromagnet? Explain in your own words.
- Draw the circuit of electric bell.

  ✦ Are the magnet and the electric current apply force on each other?

10.4 Force on a current carrying conductor placed in a magnetic field

A charged particle at rest will not interact with a static magnetic field. But if the charged particle moves in a magnetic field, it experiences a deflecting force. Similarly, a current carrying conductor (contains moving charged particles) also experiences a deflecting force when it is placed in a magnetic field.

If the direction of current in the wire is reversed, the deflecting force acts in the opposite direction. See figure - 7. The force is maximum when the current is perpendicular to the magnetic field lines. The direction of force is perpendicular to both magnetic field lines and current. So just as a current carrying wire deflect a magnetic compass, a magnet will deflect a current carrying wire.

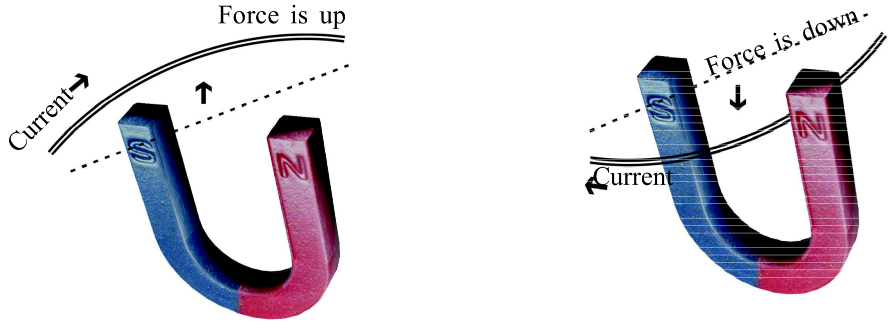
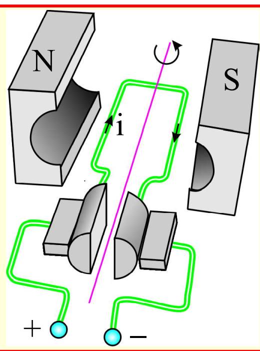


Fig - 7 : Force on a current carrying conductor placed in a magnetic field

Electric motor

Electric motor is a device which converts electrical energy into mechanical energy. It works on the principle that when a rectangular coil is placed in a magnetic field and current is passed through it, a force acts on the coil which rotates it continueously.



Check your Progress

- What happens when a current carrying conductor is placed in a magnetic field?
- In which direction the force will act on a current carrying conductor placed in a magnetic field.

✦ We know that electric current produces magnetism. Is it possible to produce electric current with a magnet?

10.5 Electromagnetic Induction

Electric current could be produced in a wire by simply moving a magnet in or out of wire coil. See figure 8. No battery or other voltage source is needed, only the motion of a magnet in a coil or in a single wire loop is enough for this.

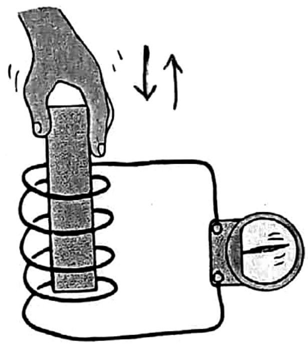


Fig - 8 : Electromagnetic Induction

It does't matter which moves, the magnet or the coil. It is the relative motion of the coil with respect to the magnetic field that induces voltage. It so happens that any change in the magnetic field around a conductor induces a voltage. This phenomenon of inducing voltage by changing the magnetic field around a conductor is "electromagnetic induction".

The amount of voltage induced depends on how quickly the magnetic field changes. Quick motion induces a greater voltage. And, the greater the number of loops of wire that move in a magnetic field, the greater the induced voltage and the greater the current in the wire.

Electromagnetic induction can be summerised in a statement that is called "Faraday's Law"; The induced voltage in a coil is proportional to the product of the number of loops and the rate at which the magnetic field changes with in those loops.

Check your Progress

- Explain electromagnetic induction in your own words.
- State the Faraday's law of electromagnetic induction.

✦ Are the electric currents same that we get from batteries and the current that we use in our houses daily?

10.6 Direct current and Alternating Current

There are two types of electric current. One is direct current (DC) and another is alternating current (AC).

The current which we get from battery is direct current. If flows in a single direction in the electric circuit. Whereas alternating current alternates in direction. Let us know clearly about AC using our understanding of electromagnetic induction.

If one end of a magnet is plunged in and out of a coil of wire, the induced voltage alternates in direction. As the magnetic field strength inside the coil is increased (magnet entering), the induced voltage in the coil is directed one way. When the magnetic field strength diminishes (magnet leaving), the voltage is induced in the opposite direction. The greater the frequency of field change, the greater the induced voltage. Rather than moving the magnet, it is more practical to move the coil. This is best accomplished by rotating the coil in a stationary magnetic field (see figure - 9). This arrangement is called generator.

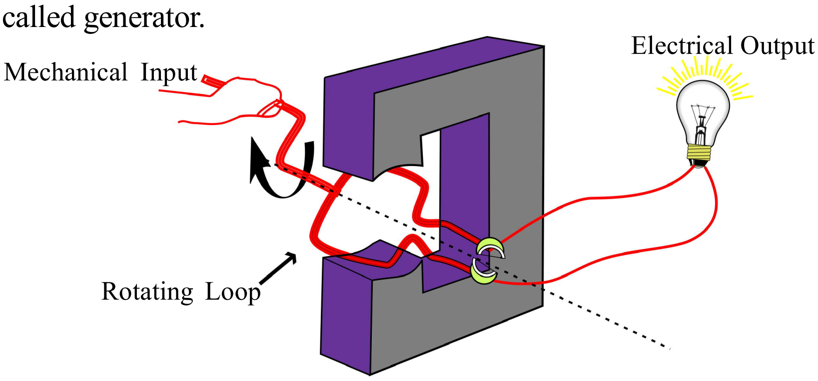


Fig - 9 : Electric Generator

As rotation continues, the magnetic field inside the loop changes in cyclic fashion. The voltage induced by the generator alternates and the current produced is alternating current (AC).

Frequency of AC

The current changes magnitude and direction periodically as the coil in the generator rotates. The frequency of alternating current is equal to the frequency of rotating coil that is the number of complete rotations of the coil per second. The standard alternating current in India changes its magnitude and direction during 50 complete cycles per second. So, the frequency of AC in India is 50 hertz.

Advantage of AC over DC

In power transmission, power may be carried from power plants to cities about hundreds of kilometer. There will be much wastage of power if high currents are transmitted to such distances. So, usually power is transmitted at high voltages and correspondingly low currents. After reaching the cities the voltage will be step downed using transformers. It is easy to step up or step down the voltage with AC whereas it is difficult to do that with DC voltages.

AC electricity also allows for the use of many devices like capacitor and inductor with in electric or electronic circuit.

So, AC electricity was proven to be better than DC, primarily because the voltages can be transformed and AC also allows for other devices to be used, opening a wide range of applications.

Check your Progress

- Explain the difference between AC and DC in your own words.
- What is the advantage of AC over DC? Explain in your own words.

Key Points

- ❖ Like poles repel and unlike poles attract each other.
- ❖ The space around the magnet in which a magnetic force is exerted is called magnetic field.
- ❖ Electric current produces magnetic field.
- ❖ Right Hand Thumb Rule explains direction of field lines associated with current carrying wire.
- ❖ An electric bell works with the help of Electromagnet
- ❖ A current carrying wire experiences a deflecting force when it is placed in a magnetic field
- ❖ Inducing of voltage by changing the magnetic field around a conductor is known as electromagnetic induction.
- ❖ Faraday's law of electromagnetic induction : The induced voltage in a Coil is proportional to the product of the number of loops and rate at which the magnetic field changes with in those loops.
- ❖ DC flows in single direction. The direction of AC alternates periodically.
- ❖ We can transform the voltage of AC easily.

Practice for Learning Outcomes

1. Explain magnetic poles in your own words.
2. Draw the field lines formed by a bar magnet.
3. Explain the direction of magnetic field due to current carrying solenoid using Right Hand Thumb Rule.

4. Explain the working process of electric bell with a diagram.
5. Explain the difference between AC and DC.
6. Can we produce electric current in a loop using a magnet? How?
7. What is the advantage of AC over DC?
8. Explain the direction of deflecting force on the current carrying wire shown in the diagram.

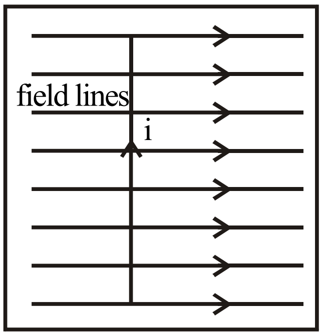


Fig.

9. Can a current carrying wire attracts an iron nail? Explain the reason.
10. Draw the field lines due to current carrying straight wire.

Multiple choice questions

1. Choose the correct answer about the nature of magnetic poles ( )
   (A) South Pole attracts South Pole (B) North pole attracts north pole
   (c) South Pole repels South Pole (D) North pole repels South Pole
2. The device which does not depend on Electromagnet ( )
   (A) electric crane (B) electric bell
   (C) electric bulb (D) loudspeaker
3. Choose the correct answer based on the statements ( )
   (1) Current carrying wire deflects a magnetic compass
   (2) A magnet deflects the current carrying wire
   (A) both 1, 2 are correct (B) both 1, 2 are wrong
   (C) 1 is correct, 2 is wrong (D) 1 is wrong, 2 is correct
4. To induce voltage in a coil ( )
   (A) magnet should move in or out of wire coil
   (B) coil should move relative to magnet
   (C) either A or B
   (D) neither A nor B
5. Magnetic field due to current carrying solenoid resembles the magnetic field due to ( )
   (A) current carrying straight wire (B) current carrying ring
   (C) U-shaped magnet (D) bar magnet

Chapter

11

Sound - Communication

Introduction

In our everyday life we hear the sounds produced by human beings, animals and as well nonliving things like musical instruments. We recognize the voices without seeing them. Sound plays an important role in our life. It helps us to communicate with one another.

These days we are using sound waves to speak to persons without moving from our house, who stays in different countries.

To address big gathering louder voice is required, with technology we can enhance the volume of the sound.

Learning out comes

After completing this lesson you will be able to :

- Describe the characteristics and nature of the wave.
- Distinguish different types of waves- the mechanical (sound) and the electromagnetic waves.
- Explain the uses of different kinds of waves.
- Explain uses of waves in communication device (SONAR).
- Describe the need and importance of communication.
- Identify and appreciate different type of communication systems.

11.1 Nature of Sound

Make a list of sounds you hear in your surroundings.

How is sound produced?

When a tightly stretched band is plucked, it vibrates and produces sound. When it stops vibrating, it does not produce any sound.

Activity - 1

To prove that sound is produced by a vibrating body

Take a metal bell and hang it at a convenient place in such a way that it does not touch any wall. Now strike it with a stick. Touch the bell gently with your finger. Do you feel the vibrations? Again strike the bell with the stick and hold it tightly with your hands. Do you still hear the sound? Now touch the bell after it stops producing sound. Can you feel the vibrations now?

Fig - 1 : Hanging plate

Activity - 2

Vibrations in Tuning Fork : It is a U-shaped steel device with a stem at base. The tuning fork is held on its stem and struck one of the prongs with rubber hammer. This causes prongs to vibrate and produce sound.

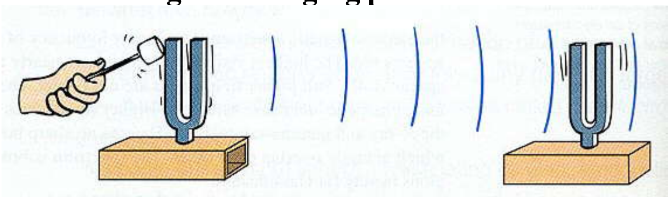


Fig - 2 : Vibrations in Tuning Fork

Sound Produced by Humans:

While you are speaking or singing put your hand on your throat. Do you feel any vibrations? In humans, the sound is produced by the voice box or the larynx. Put your fingers on the throat and find a hard bump that seems to move when you swallow. This part of the body is known as the voice box. It is at the upper end of the windpipe. Two vocal cords, are stretched across the voice box or larynx in such a way that it leaves a narrow slit between them for the passage of air.

When we pluck the string of an instrument, the sound that we hear is not only that of the string. The whole instrument is forced to vibrate, and it is the sound of the instrument that we hear.

Similarly, when we strike the membrane of a mridangam, the sound that we hear is not only that of the membrane but of the whole body of the instrument.

Sound is produced by a vibrating body. When a particle moves to and fro about its mean position, it is said to be vibrate.

Fig - 3 : Musical Instruments

When sound is produced by a body, how does it travel from one place to another? When a body is vibrating then these vibrations are transmitted in medium like a wave.

How do we hear sound? Why some sounds louder than others? We shall discuss such questions in this chapter.

A wave transfers energy from one point to the other without moving the particles of the medium. Thus wave is clearly different from particle.

Check your Progress

- How the sound is produced?
- How does the sound is produced in human beings?

11.2 Characteristics of the sound wave

We need to describe a friend by name, height, colour, gender etc. for identifying. Similarly, we have to specify some qualities for wave describing the nature of wave. When disturbance is propagating in the medium it has some qualities. We name these qualities as characteristics of wave. They are,

1. Amplitude
2. Wave length
3. Time period
4. Frequency
5. Velocity of sound

1. **Amplitude:** The maximum displacement of particles of medium from mean position is called amplitude

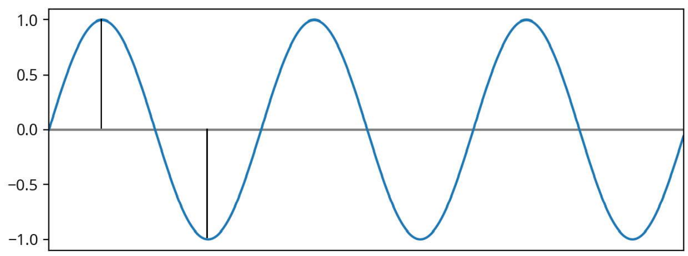


Fig - 3 : Amplitude

2. **Wavelength :** The distance between two adjacent troughs or adjacent crests is known as wave length, λ (lambda). For longitudinal wave, it will be distance between two successive rarefactions or compressions.

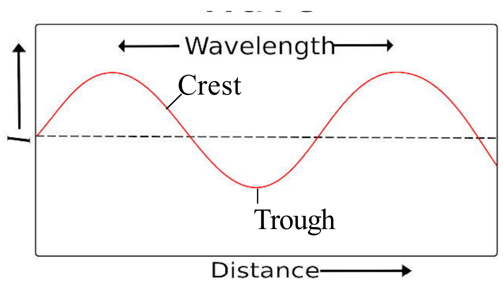


Fig - 4 : Wavelength

3. **Time Period:** The time taken for one complete oscillation to takes place in the given medium is called time period. It is measured in seconds (s).

4. **Frequency :** The number of complete oscillations that pass a point in the given medium in one second is called frequency. It is measured in Hertz (Hz).

5. **Velocity of sound :** Velocity of sound is defined as the distance travelled by a wave disturbance in one second and is measured in metre/second (m/s)

   Time period and frequency can be related as $T = 1/n$ where 'n' is frequency.

   Velocity, frequency and wave length can be related by $V = n\lambda$

   Velocity of sound can be expressed as product of frequency and wavelength.

Check your Progress

- What is the SI unit of frequency?
- If the velocity of sound is 330 meter per second (ms^{-1}), what will be wavelength if the frequency is 100 Hz?

11.3 Different types of waves

Based on requirement of medium waves are of two types

1. Mechanical waves
2. Electromagnetic waves

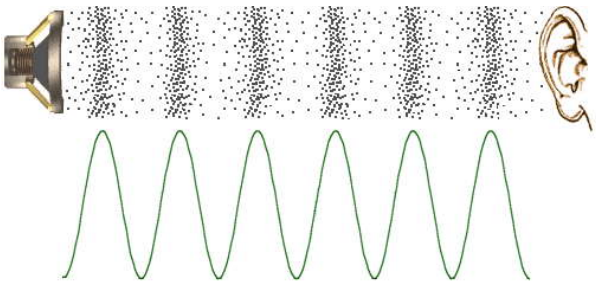


Fig - 5 : Sound waves in air

Mechanical wave: The waves which requires the medium for propagation are called mechanical waves.

Ex: sound waves in air

The sound waves travel very slowly in air, it travels approximately about 330 m/s.

Its speed is dependent on the properties of the medium such as inertial and elastic properties. The speed of the wave in the medium will depend on ability to displace the particles(linear mass) and on how those particles regain their original positions.(Elasticity)

Electromagnetic wave : The waves which do not require a medium for propagation are called electromagnetic waves.

Ex: Light waves

The electromagnetic wave has electric and magnetic fields associated with it. The two fields, electric and magnetic, are perpendicular to each other and also to the direction of propagation

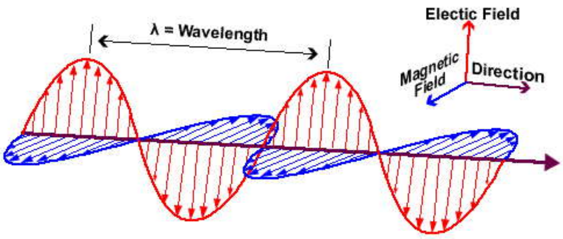


Fig - 6 : Electromagnetic wave

They travel with the velocity of light that is about 3 lakh km/s in air or vacuum.

Why thunder heard after the flash of lightening ?

The speed of light in air is more than speed of sound in air. Therefore when lightening takes place it is seen instantly but thunder takes some time to reach us.

Check your Progress

- Give an example of mechanical waves.
- Which waves do not require a medium for propagation?

11.4 Transverse and longitudinal waves

The waves are classified into two types based on vibration of particles in medium. 1. Longitudinal waves 2. Transverse waves

Longitudinal waves : A longitudinal wave is a wave in which vibrations of the particles of medium takes place in the direction of the propagation of the wave.

In longitudinal waves compressions and rarefactions are formed. The distance between two successive compressions or rarefactions is called wave length.

Let us take a slinky and fix one end to a rigid support. The free end of slinky is pushed to and fro, the movement of disturbance is along the slinky but the particles of slinky remain at same place.

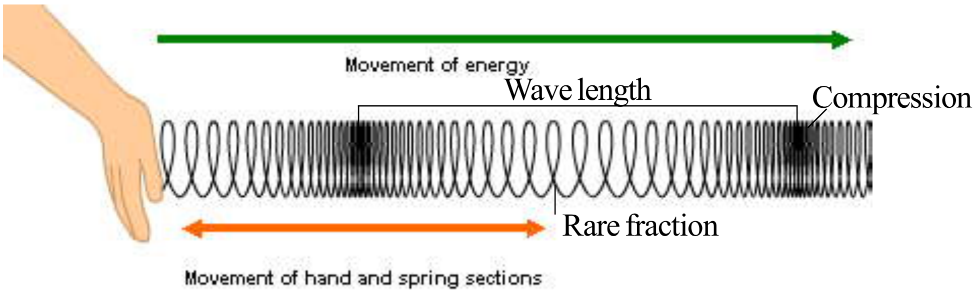


Fig - 7 : Longitudinal waves

Transverse waves : The transverse wave is a wave in which vibration of the particles of the medium takes place in the direction of the propagation of the wave.

In transverse waves crests and troughs are formed .The distance between two successive crests and troughs is called wave length.

In the given figure the slinky is moved up and down at free end, the propagation of waves are perpendicular to the vibration of particles of slinky.

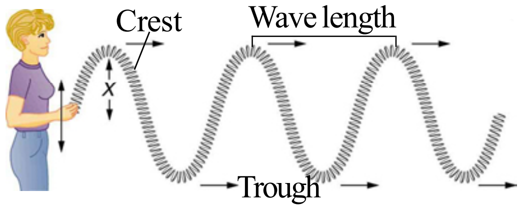


Fig - 8 : Transverse waves

Check your Progress

- Explain longitudinal waves?
- Give examples for transverse waves

11.5 Propagation of sound

If there is no medium, then produced sound will not be able to push any medium-molecules and sound will not move. That is the reason why we can't hear on moon; there is no air in Moon's atmosphere and sound can't travel.

Activity - 3

Does Sound require a medium for propagation

Bell jar experiment

1. Take a bell jar and an electric bell is fitted in it through a air tight cork.

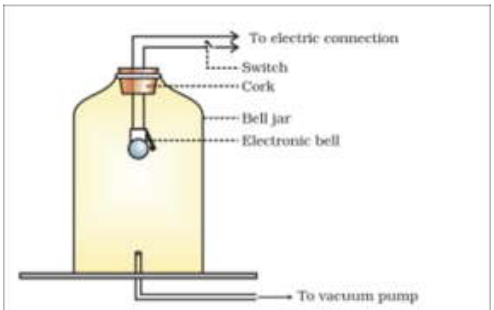


Fig - 9 : Bell jar experiment

2. Connect a battery through a switch. When switch is pressed the bell begins to ring then you hear the bell sound.
3. Using the vacuum pump if we withdraw the air from jar through bell ringing the loudness of bell decreases gradually and finally we cannot hear the sound of bell.
4. Again allow the air into jar the loudness gradually increases

Conclusion: sound cannot travel in vacuum, it requires a medium for propagation

Sound can travel through liquids

Take a squeaking plastic doll and put inside a clear plastic bag. Tie the mouth of the bag with strong cotton thread tightly. Place the plastic bag in bucket filled with water. Squeeze the plastic doll. Do you hear the sound? Yes, a faint sound is heard.

When keep your ear against the sides of bucket and squeeze the doll? You can hear a clear and louder sound.This shows that sound travels faster in liquids than gases.

Sound can travel through solids

If you place ear close to a railway track, you can hear the sound of incoming train even from the large distance. When you stand at the same position you cannot hear the sound. Because the sound travels faster in solids than in gases.

The speed of sound in different media : The speed of sound changes with respect medium. The velocity of sound in solids is highest, less in liquids and least in gases.

State of matter	Substance	Speed in m/s
Gases	Air	330
Liquids	Water	1530
Solids	Steel	5960

Check your Progress

- We cannot talk to one another on the surface of moon. Give reason?

11.6 Characteristics of sound

Why the sounds of humming bee and mosquito is different from roaring of lion? Why the sound produced by male is different from female? Why the sounds of various musical instruments are different?

The sound note produced by any vibrating should possess some characteristics. The charactaristics of sound note are : 1. Loudness 2. Pitch 3. Quality

1. **Loudness :** It is the property of sound which differentiate a weak sound from louder sound

   It depends on the amplitude of sound wave.

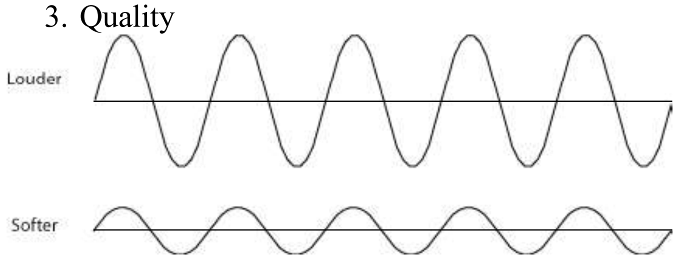


Fig - 10 : Louder and Softer sound

Larger the height of wave, more the loudness

The loudness of male voice is greater than female voice

The loudness of sound is measured in decibel (dB). It signifies the sound pressure level. Humans can hear loudness from 10dB to 180dB

- The loud ness is normal between 50 dB to 60 dB.
- The loudness above 80 dB is painful and causes hearing problems

2. **Pitch :** Ptich of the sound is the sensation conveyed to our brain by the sound waves.

It depends on the frequency of sound. The wave which completes more oscillations in a given time has more pitch.

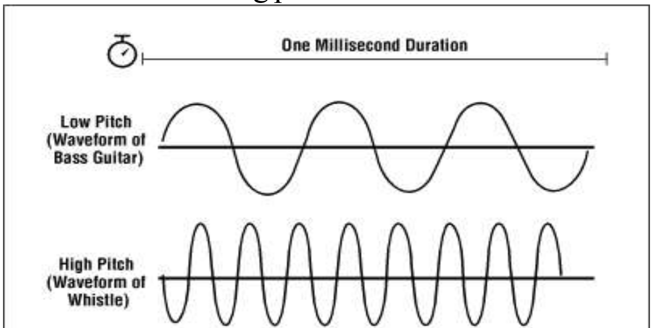


Fig - 11 : Low and High pitch

The pitch of female voice is greater than that of male voice. The vocal cords vibrate fast in female than in male.

3. **Quality or Timbre :** You might be noticed the sounds produced by different musical instruments such as violen, piano. Do they produce same sounds?

The ability of human ear to differentiate two sounds of same loudness and frequency is called quality of sound

The sound of voilen is different from piano that is quality of sound is different. The quality of sound depends on the wave form

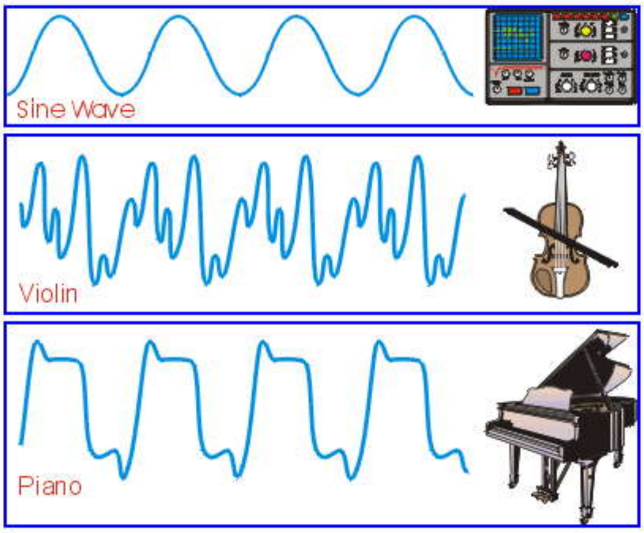


Fig - 12 : Wave forms of sound

Musical sound and noise

In our daily life we hear different sounds like road traffic,barking of animals,sound of areoplane etc. Are they pleasant to hear? How do we feel when you hear sounds of musical instruments?

Musical sound : The sound which is pleasant to hear is called musical sound.

Noise : The sound which is unpleasant to hear is called noise

In our day to day life man depends on various kinds of machines at home, work place or factories. This dependence has contributed to noise pollution.

Sources of noise : Loud speakers, jet and aeroplanes, transport vehicles, television, factories etc.

Measures to control noise pollution

1. The machines are designed such that they produce minimum noise.
2. The factories should relocate from residential areas.
3. Automobiles are fitted with silencers to reduce noise.
4. The loud speakers, televisions must be played in less volume.
5. Grow more trees.

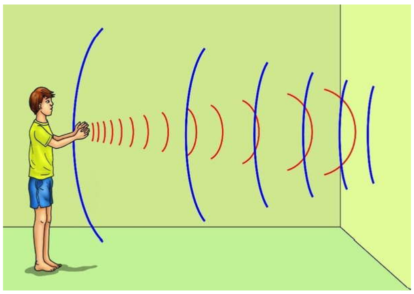
Check your Progress

- What is the unit to measure sound intensity?
- Why does the sound of female differ from male?

11.7 Reflection of sound (Echo)

If you stand in front of a high building or a hill such that you are at a distance of more than 20 m and shout loudly you will notice that you can hear your own sound. It is because the sound is reflected back. This phenomenon is called echo.

Have you ever been to a valley and shouted or clapped to hear echo of your voice or of clapping sound? Even in a very huge hall or between two fairly distant walls you can hear echo.



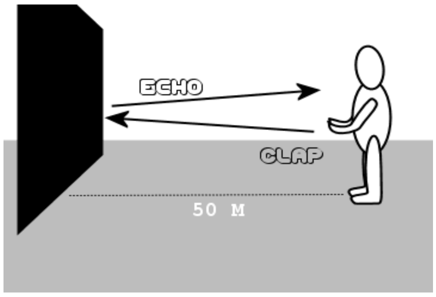


Fig - 13 : ECHO

A reflection of sound, arriving at the listener in more than 0.1s after direct sound is called an echo.

When the reflection is from a far away object, we can distinguish it as an echo. We can hear direct sound and reflected sound separately if the time interval between them is more than 0.1 second.

If 'd' is the distance of obstacle from source of sound, 't' is the time interval to hear an echo then velocity of sound is $v = 2d/t$

Velocity of sound in air is $v = 330$ m/s minimum distance between direct sound and reflected sound is

$$d = \frac{vt}{2}$$

$$= \frac{330 \times 0.1}{2}$$

$$= 16.5 \text{ meter}$$

The minimum distance of obstacle is $d = 16.5$ metres to hear an echo if speed of sound in air $= 330$ m/s

Uses of reflection of sound

1. **Mega phone :** A mega phone, horns, musical instruments such as trumphets,shehnai and loud speakers a re all designed to send sound in particular direction without spreading .

Fig - 14 : Mega phone

Stethoscope

It is a medical instrument used for listening sounds produced in heart and other parts of human body based on principle of echo.

Range of hearing

Ultrasonics and infrasonics

Are you able to hear all sounds produced by vibrating bodies. The waves that produce a sense of sound for living beings are called sound waves or audible waves.

Depending on age we can hear only those sounds those waves that have frequencies lying in the range of 20 Hz to 20 kHz. This is known as human range of hearing.

Infrasonics : The sound waves whose frequencies below 20 Hz are called infrasonic waves. Animals like elephants, giraffe, and whales can communicate with infra sonic waves

Ultrasonics : The sound waves whose frequencies above 20 kHz are called ultrasonic waves.

Animals like bats, dogs are able to produce and sense ultra sonic waves. The maximum frequency of these animals is upto 40 kHz.

Medicinal applications of ultra sound

Imaging of organs:

1. **ECG (Echo cardiography)** is a technique in which ultrasonic waves reflected from various parts of the heart, forms an image of heart. USG (ultrasonography) is generally used to see the images of organs like liver, gall bladder and detect the abnormalities using echo technique.

Fig - 15 : Echo cardiography

2. It is also used to monitor the growth of fetus inside the mother's womb.

Fig - 16 : Ultra sound scan

3. The ultra sonics waves used as cutting tool due to its high frequency. It also employed in cutting stones in kidneys and helps in cataract surgery.

Check your Progress

- What is the minimum distance to hear an echo if speed of sound is 330 m/s?
- Give examples for animals which can hear ultrasonic sounds.

11.8 Communication applications

SONAR stands for Sound Navigation and Ranging. A device fitted in a ship to find the depth of sea and detect objects under water by means of reflection of sound waves is called SONAR. It works on the principle of echo.

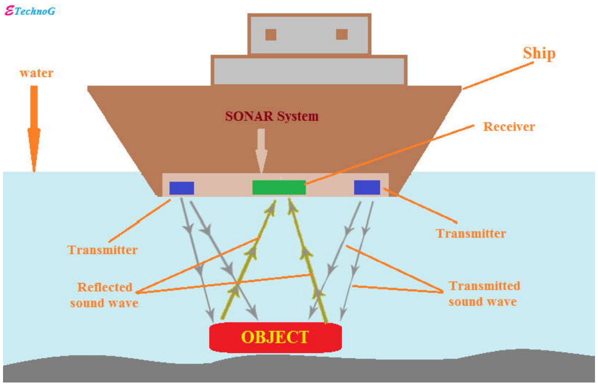


Fig - 17 : SONAR

Working of SONAR: The SONAR system consists of a transmitter and a receiver which are installed at observation center on board of ship. The ultrasonic waves of frequency 100 kHz are sent in all directions from transmitter into water. These waves reflected by any hidden object or from sea bed received by receiver on board of ship. By knowing speed of sound in water and time gap between transmitted and received waves we can find position of hidden object .

The advantage of using sonar wave(Ultra sonic wave) over electromagnetic waves is that electromagnetic waves lose energy fast in the ocean water because water can conduct electricity. In contrast sonar waves can travel farther in water.

Different type of communication systems and devices

Let us discuss some common devices for sound communication like 1. Microphone and speaker 2. Telephone and Mobile phone 3. Computer and Internet communication.

1. **Microphone and speakers :** The microphones (mike) and the speakers are very common equipments. You see in public meetings and conferences. You come across them even when you use your phone. The work of a microphone and a speaker are opposite to each other. A microphone converts sound into electrical entity(voltage) while a speaker converts the voltage into sound.


Fig - 18 : Microphone

2. **Telephone and Mobile phones** : Mobile phones have brought great convenience in daily life. The basic working principle in all communication devices is same. But for them, the sound doesn't travel through cables or wires. It travels as electromagnetic wave through space via antennas.

3. **Computer and internet in communication** : Today computers are inevitable in daily life. Computers play a major role in publishing industry; designing of houses, controlling the functioning of cars and garments; computerized machining, regulating air traffic etc.

Fig - 19 : Computer

Computer technology used in majority of the gadgets using at home like television, automatic washing machine, microwave oven,

Computers are used for communication to aircrafts, ships, and even huge boat, in money transactions and in maintaining and processing financial records such as in Automated Teller Machine (ATM) and banks.

Using e-mail, one can send a message, chat live (that is send and receive text) and even talk instantly which has revolutionized communication.

Check your Progress

- Write the uses of ultra sonics?
- Name the principle involved in SONAR?

Key Points

- ❖ Sound results from vibration and needs a medium to travel, it may be gas (like air), solid or liquid.
- ❖ Sound travels faster in solids than in liquids and is the slowest in the gases.
- ❖ Electromagnetic radiations are the waves which can travel through vacuum.
- ❖ A wave is described in terms of amplitude, wavelength, time period ,frequency and speed or velocity.
- ❖ Velocity is equal to the product of wavelength and frequency.
- ❖ The charactaristics of sound note are loudness,pitch and quality.
- ❖ The range of audible sounds is 20Hz to 20KHz.The sounds less than 20Hz are called Infrasonics and more than 20KHz are called Ultrasonics

- Sounds are of two types : 1. Musical sound 2. Noise.
- SONAR stands for Sound Navigation and Ranging.
- The inventions of microphone, moble phone, computer and internet have revolutionized communication.
- A microphone (mic) converts sound into electrical signal, while the speaker converts electrical signal into sound.

Practice for Learning Outcomes

1. Describe an activity to show sound needs a medium to travel.
2. Write the relationship between velocity, wavelength and frequency.
3. Write the differences between longitudinal and transverse sound waves.
4. Describe the velocity of the sound propagation in solids,liquids and gases.
5. Write the differences between ultrasonic waves and infrasonic waves.
6. How does SONAR help in estimating the distance of an object?

Multiple Choice Questions

1. Sound travels fastest in [ ]

   A) Solid B) Liquid C) Gas D) Vaccum

2. The minimum distance between two adjacent crests is called [ ]

   A) Wave length B) amplitude C) displacement D) wave pulse

Matter in Our Surroundings

Chapter 12

Introduction

We know that what we eat, drink, or breathe is the matter. All of us are surrounded by matter. All the things around us which exist in a variety of shapes, sizes and texture are also examples of 'matter'.

- What do you mean by the term 'matter'?

For example, consider a bicycle. It is made up of Iron, rubber, plastic etc. What are Iron, plastic, and rubber?

We know that the air in our surroundings is a mixture of many gases.

- What is meant by a 'mixture'?
- Can we separate the constituent gases from air?

We know that water is a liquid, Ice is a solid and water vapour is a gas. Do substances exist like this?

We have come across some words like iron, aluminium, oxygen, hydrogen etc. These are all called elements. Can we consider water as an element? Why?

Let us find the answers for all these questions in this chapter.

Learning Outcomes

After completing this lesson you will be able to:

- Explain the matter and its states and also explain with reasons why matter exists in three states
- Explain the properties of matter and perform activities to understand the properties of matter
- Explain with reasons why matter changes its state, effect of temperature in changing the state of matter
- Differentiate between elements, compounds, and mixtures and give examples for them
- Give examples for homogeneous and heterogeneous mixtures
- Suggest suitable methods for separation of mixtures

The Universe is composed of matter and energy. Matter consists of substances.These substances are used to make different articles. We observe so many articles around us like chair, door, wall, fan, table, book etc. Among these, some are made with only one substance, Ex: plastic chair, some are made with more than one substance, Ex: door.

What is the substance used to make a plastic chair? Of course, your answer is plastic, but what is plastic? Similarly, we say that doors are made of wood, iron, etc., but what are wood, iron etc.?

To understand all these, we have to know about matter.

- What is matter?

The word matter is derived from the Latin word 'materia' meaning "wood" or "timber" in the sense material as distinct from 'mind' or 'form'.

"Anything that occupies space and has mass is considered as matter"

Scientists believe that matter is made of tiny particles. We cannot see these particles.We can see the matter in the form of articles like door, bench, chair, water, bag, air etc. Matter has mass. The heavier an object, the more mass it has. Matter occupies space it means matter has volume.

- Iron, water, gold, oxygen etc., can we consider them as matter?

Yes, but they are pure kind of matter having one kind of constituent particles (atoms or molecules). These are called substances. **"All substances are matter but all forms of matter are not substances".**

For example, Lemonade is a form of matter, but not a substance.

- What is the nature of matter?

12.1 Nature of matter

Ancient Greek philosopher Aristotle in his book "Metaphysics" says that matter is continuous and its piece of any size can be broken or subdivided into smaller pieces. For example, take a small piece of chalk and break it into smaller pieces and break them smaller pieces into till smaller pieces. This process can be repeated any number of times.

Indian sage **Kanada** and Greek philosophers **Leucippus** and **Democritus** believed that the process of sub division of matter can be repeated only for limited number of times. A stage would be reached when the tiny particles of matter so obtained cannot be further subdivided. They believed that all matter is composed of very tiny particles, which cannot be further divided. Democritus named these indivisible particles **"atoms".** The word 'atom' is derived from a Greek word 'a-tomio' which means indivisible.

Check your Progress

- What is matter?
- Who believed that atom is indivisible?
- What is matter according to Aristotle?

12.2 States of matter

We have learnt that this universe is composed of many substances. We have not only the visible substances, but also a lot of invisible substances like microbes, cells in living organisms etc. These are also made of different types of matter. In our daily life we use water, air, food, clothes, etc. They are made of different types of matter.

- What is the state of matter?

The physical existence of matter under given temperature and pressure is called the state of the matter. We know that water can exist in all these three states. They are Water (liquid), Ice (Solid)and water vapour (Gas).

Matter can exist in three states, based on physical properties. They are

- Solids
- Liquids
- Gases
- Why matter exists in three states?

We know that matter is made of tiny particles knosn as "atoms" or molecules. The characteristic properties of different states of matter depend on inter molecular forces. **The forces holding molecules together are called intermolecular forces.** The difference in the intermolecular forces is responsible for the matter to exist in three different states.

- Are the properties of different states of matter the same?

Observe wood and iron. Both are solids, but their properties are different.

Similarly, milk and petrol. How can we consider that wood and iron are solids or milk and petrol are liquids? What properties lead us to decide? Let us see.

12.3 Properties of matter

12.3.1 Shape and Volume

Activity-1

Take two solid items; say a pen and a stone. Take a tumbler. First keep the pen in the tumbler.

- Do you observe any change in shape of pen?

Similarly, keep the stone in the tumbler. Do you observe any change in its shape?

Keep the pen and stone on the floor. Do they flow from one place to another?

What do you observe from the above activity?

We observe that **solids have definite shape and volume.**

Activity-2

Take a measuring jar and containers of different shapes as shown in the figure.

Take any liquid like water oil or milk. First take water with a measuring jar and pour it in one container. Observe the shape. Pour the same water in another container and observe the shape. Repeat this process till you complete all the containers.

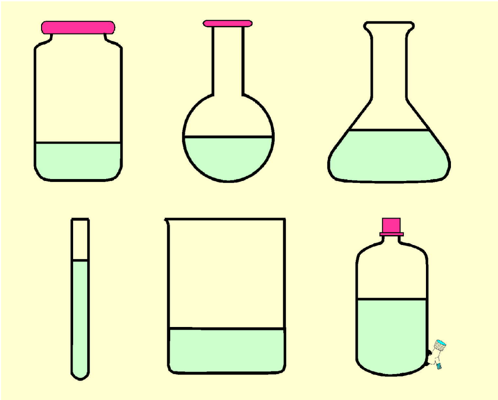


Fig - 1 : Liquids take the shape of containers

- What is the shape of water in all containers? Is it the same in all the containers?
- What shape does the water take if it spills on ground?

Now take 50ml of water (measure with measuring jar) and pour it in a tumbler. Mark the level of water in the tumbler. Now remove water and pour 50ml of milk and observe the level of milk in the tumbler. Now remove milk and pour 50ml of oil in the tumbler. Observe the level of oil.

- What do you observe?

We can observe that the level of liquid does not change.

From this activity we can conclude that liquids take the shape of containers. So **liquids do not have definite shape but have fixed volume**. Liquids can flow from one place to another easily. Hence, they are called **"fluids"**

Gases are stored in cylinders. Observe the LPG cylinder or CNG (Compressed Natural Gas). When a gas is filled in the cylinder, it occupies the entire volume of the cylinder, irrespective of its size. Hence, we can say that **gases do not have fixed shape or fixed volume.**

12.3.2 Compressibility

Activity - 3

Take a syringe. Draw the piston to suck in air. Place your finger on the nozzle and press. Observe depth of piston moved into the syringe.

- Is it easy or hard to press?
- Do you find any change in the volume of air in the syringe?

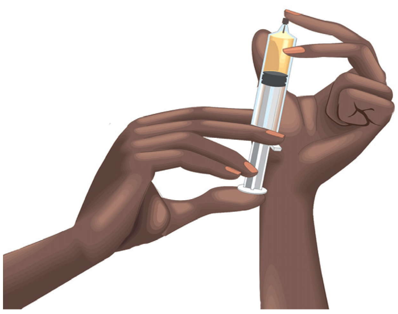


Fig - 2 : Compressibility

Now fill water in the syringe and press the piston.

- When is it easier to press the syringe with water or air?

Now take a piece of wood and press it with your thumb.

- Is there any change in its volume?

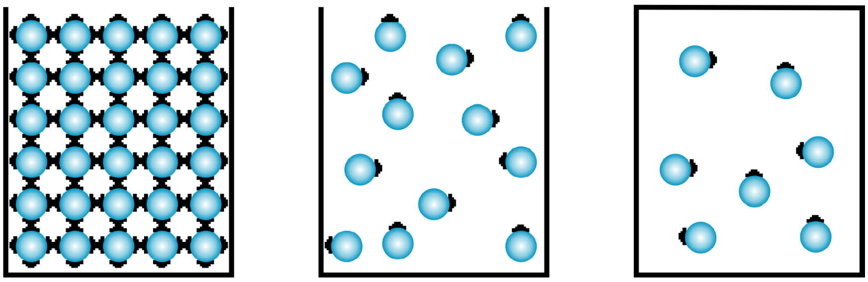
We can observe that gases are highly compressible as compared to liquids and solids. Observe the LPG, which we use in our house. A large volume of gas is compressed and stored in a cylinder of small volume to make it portable.

Table - 1 : Different characteristics of three states of matter

States of matter	Shape	Volume	Compressibility
Solid	Has fixed shape	Has fixed volume	Negligible
Liquid	Has no definite shape. It takes the shape of container	Has fixed volume	Very small
Gas	Has no definite shape	Has no fixed volume	Highly compressible

Let us see the reason for difference in shape and volume of solids, liquids, and gases.

We know that matter is made of small tiny particles called atoms. The arrangement of atoms is responsible for this difference in properties.



Solid Liquid Gas

Fig - 3

Observe the above figure. In solids the constituent particles are present very close to each other and the inter molecular forces operating between the constituent particles are very strong and they are capable of keeping molecules in fixed position. This is the reason why solids are rigid and hard, also solids cannot be compressed.

In liquids the intermolecular forces are weaker than that in solids but stronger than in gases. In liquids the constituent particles do not occupy fixed positions as in solids, they have freedom of movement but only to small extent. So, liquids do not have definite shape but have fixed volume.

In gases, the inter molecular forces are weaker than solids and liquids and unable to keep the gas molecules in bulk. We can bring them closer by applying pressure. Hence gases have no definite shape and volume, but highly compressible.

Check your Progress

- Why do the liquids take the shape of containers in which we pour them?
- We can observe three states of matter in water. Give another example for this.
- Why do gases are stored in closed containers?

12.4 Change of state of matter

We know that matter exists in three states. We can observe that water can exist in all the three states. We can observe many other materials like this. For example, consider coconut oil, which is usually a liquid, but on cooling it becomes solid.

Consider camphor, which is usually a solid. When it is kept in air for some time, it disappears, means it becomes vapour. Similarly, observe Naphthalene balls, which we keep in between our clothes. The smell remains for some time even the balls disappear. This is because the Naphthalene balls have changed from solid to gaseous state.

Generally, solids will change to liquids and then to gaseous state.
Eg : Ice $\rightarrow$ water $\rightarrow$ water vapour

In some cases, solid changes its state directly to gaseous state without forming liquid state.
Eg : Camphor $\rightarrow$ Camphor vapour (Gas)

The change of state of solid directly into gas is called **sublimation**.

- Why do the substances change their state?
- Is there any relation to intermolecular force and change of state?

The inter molecular forces in solids, liquids, and gases are different and this is responsible for existence of matter in different states. If we consider a solid for eg. Ice, when it is converted into water and then into water vapour, the intermolecular forces are changing.

- Which factor is effecting the change in intermolecular forces?

12.5 Factors effecting the change of state of matter

Activity-4

Take some Ice cubes. Keep the ice cubes in a glass jar and heat the jar. When heat is supplied, the ice (Solid) melts and changes into water (liquid). Go on heating further (supply of thermal energy). The water boils and gets converted into water vapour (gas). Here the main factor is increase in temperature.

Now allow the water vapour (gas) through cooling tube. It becomes water (liquid). Further keep the water in a refrigerator. It changes into ice (solid). Here the main factor is decrease in temperature. Temperature is one factor that changes the state of the matter.

We can observe that the change in temperature (increase or decrease) leads to the change of state of matter.

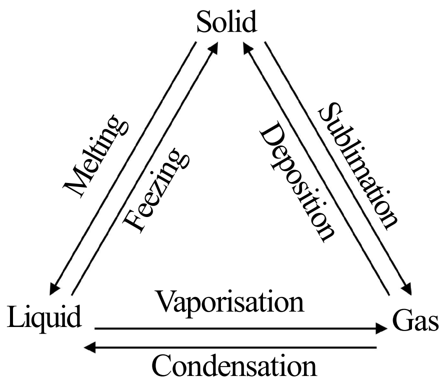


Fig - 4 : Inter conversion of states of matter.

- Why the changes in temperature effect the state of matter?

When solid is heated (increase in temperature), it expands. The expansion is very small. The particles become more energetic, on further heating they leave their fixed positions and the solid melts. Once a solid became liquid it can be poured into a container. When liquid is further heated, the kinetic energy of particles become so high that they can overcome the intermolecular forces within the liquid. Therefore, the liquid is converted into gas.

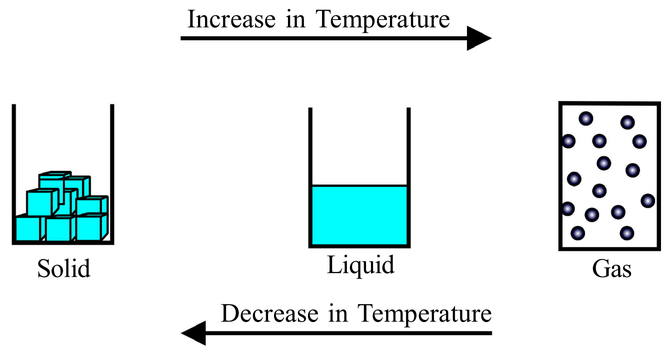


Fig-5: Inter conversion of states: from solid to liquid, liquid to gas and vice versa with change in temperature.

Solid can be converted into liquid at a particular temperature at given pressure. The particular temperature where a solid can be converted into liquid is called **"melting point"** of that particular solid. Similarly, when a liquid boil and gets converted into a gas at a particular temperature at given pressure. This particular temperature is known as **"boiling point"** of that particular liquid. When liquid cools down, it converts into solid at a particular temperature at given pressure. This particular temperature is called **"freezing point"**

Ex: Freezing point of water is 0 ^oC, and boiling point is 100 ^oC

Check your Progress

- What is sublimation?
- What are the boiling and freezing points of coconut oil?
- What is the reason for melting of ice, when we kept outside even though we do not supply any heat energy?

12.6 Elements, compounds, and mixtures

Pure substances are classified into two classes: elements and compounds. This division was achieved about a century and a half ago. A physical combination of element and element, element and compound or compound and compound, results in the formation of mixtures.

12.6.1 Elements

Robert Boyle used the term element. French chemist Lavoisier was the first to establish a useful definition of an element.

According to Lavoisier, an element is a basic form of matter that cannot be broken down into still simpler forms by physical and chemical changes, Elements based on their respective properties are classified in to metals and non- metals.

- Write the names of some metals that we use in our daily life.

Henning Brand, German alchemist boiled urine to discover phosphorus in 1669. Sir Humphrey Davy, was extremely successful in discovering many elements – Sodium, magnesium, boron, chlorine and many more. Now 118 elements have been discovered and are widely used in so many fields. Some of them are only synthetic elements.

Examples for elements : iron, gold, copper, oxygen, hydrogen, sulphur, etc.

12.6.2 Compounds

A compound is a substance that consists of atoms of two or more different kinds in intro molecules. These atoms of two or more different kinds must be present in a definite ratio, since substances are usually defined as having a definite composition.

Some daily life examples of compounds and the elements present in them

S. No	Common name of the compound	Chemical name of the compound	Elements present in it
1	Water	Di hydrogen monoxide	Hydrogen, Oxygen
2	Common Salt	Sodium chloride	Sodium, Chlorine
3	Toilet cleaner	Hydrochloric acid	Hydrogen, Chlorine
4	Washing soda	Sodium carbonate	Sodium, Carbon, Oxygen
5	Baking soda	Sodium hydrogen carbonate	Sodium, Hydrogen, Carbon, Oxygen

The physical and chemical properties of elements are lost, when they chemically combine to form compounds and, compounds have their own characteristic properties.

Ex: Hydrogen is a gas, and oxygen is a gas but when these two combines to form water molecule, then it is a liquid.

- Give some more examples for compounds.
- List out some compounds which we use in our daily life and write their uses.

12.6.3 Mixtures

In our daily life we use several materials, but most of them are not pure substances (elements or compounds). They are the mixtures of two or more substances. Hence, we can divide substances into two categories namely pure substances (elements and compounds) and mixtures.

When a scientist says that something is pure, he means that the composition of the substance does not change, no matter which part of the substance you take for examination from its bulck amount.

For example, whichever part of a pure gold biscuit is taken as a sample, the composition is found to be same throughout i.e., only gold atoms.

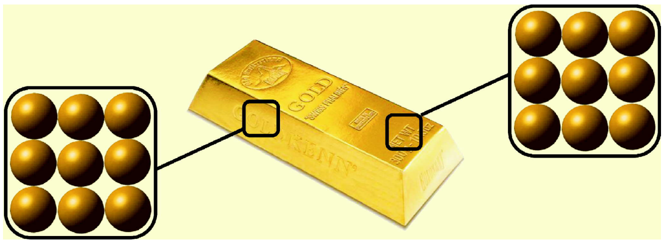


Fig - 6 : Pure form of Gold

But the composition in mixtures need not be the same. The composition in some mixtures change, depending on the part you have taken as a sample.

Fig - 7 : Mixture

A mixture is generally made of two or more elements or elements and compounds or compounds and compounds that are not chemically combined. The substances in a mixture retain their own properties and they can be physically separated.

Examples of mixtures : Lemon juice, tea, Curry, Soap, Water and sand mixture, mixture of iron filings and sulphur etc.

- What is the difference in the mixtures like tea and mixture of iron filings and sulphur?

Check your Progress

- Classify the following substances as elements, compounds, mixtures and write in a table.

  Salt, Iron, Sodium hydroxide, tea, gold, orange juice, sulphuric acid, mud paste, dry lime, soap water, water, phenolphthalein solution, soda water, Oxygen, carbon di oxide, potato curry, brass, copper
- Which element has been extracted by boiling urine?
- Who gave a useful definition to element? What is it?

12.7 Types of mixtures

We have learnt about mixtures. You know that air is a mixture and sand solution is also a mixture. What is the difference that you observe in both of them?

What are the types of mixtures?

Activity-5

Take two glasses and fill more than half of its level with water. Add one spoon salt to one glass and one spoon sand to another glass.

- What do you notice?

In the first glass you can observe that the salt dissolves completely. Such type of mixtures are called **"homogeneous mixtures"**. In other glass, the sand is not dissolved. This type of mixtures are called **"heterogeneous mixtures"**.

12.7.1 Homogeneous mixtures

In a homogenous mixture the components of mixture are uniformly distributed throughout it. The components of a homogeneous mixture are too intimately mixed up that it will be difficult to distinguish them from one another by visual observation. For example, air is a homogeneous mixture of many gases.

You know about lemonade. It is a mixture of water, sugar, lemon juice and salt. Is it homogeneous or not? If you taste a spoonful of lemonade, it tastes the same throughout. The particles of sugar, lemon juice and salt are evenly distributed in this solution and we cannot see the components separately. We call such mixtures as homogeneous mixtures.

Table - 2: Different types of homogeneous mixtures

Type of mixture	Description	Examples	Write another example
Solid + Liquid	Solid dissolves in liquid to form transparent solution	Sugar in water / Salt in water etc	
Liquid + Liquid	Forms a single transparent mixture	Mixture of water and ethyl alcohol	
Gas + Liquid	Gas completely dissolves in a liquid to form a transparent solution	Soda water	
Gas+Gas	Mixture of two or more gases	Air	
Solid + Solid	Some metal alloys	Brass, Bronze	

12.7.2 Heterogeneous mixture

In the activity – 5, we have observed that sand is not dissolved in water. Such type of mixtures are called "heterogeneous mixtures". A heterogeneous mixture is a mixture made up of different substances, or the same substances in different states which are not uniformly distributed in it.

For example, the mixtures "oil and vinegar", "Naphthalene and water" are heterogeneous mixtures.

Different types of heterogeneous mixtures that may result by mixing different substances have been shown in the following table.

Table – 3: Different types of heterogeneous mixtures

Type of mixture	Description	Examples	Write another example
Suspension	Solid + Liquid	Flour in water	
Gel	Liquid trapped in solid	Fruit jelly	
Emulsion	Mixture of tiny droplets of one liquid suspended in another	Milk	
Aerosol	Small droplets of liquid or particles of Solid dispersed in a gas	Cloud, Smoke	
Foam	Gas in liquid : Small bubbles of gas trapped in liquid Gas in Solid : Small bubbles of gas trapped in solid	Shaving foam Polystyrene foam (Thermo coal)	

Check your Progress

- Give examples to the homogeneous mixtures of two solids.
- What is the main difference between homogeneous and heterogeneous mixtures?
- Give example for a heterogeneous mixture of two liquids.

12.8 Separation of mixtures

Till now we have discussed different types of mixtures. Have you seen removal of unwanted material like stones or dust particles from rice at home? Here we are separating stones or dust particles from rice. This is separation of mixtures. In the same way, you might have observed the process of winnowing to separate lighter and unwanted particles from paddy at fields. Similarly, we can separate unwanted tea powder from tea. This is by filtration. These are some physical methods of separation of mixtures.

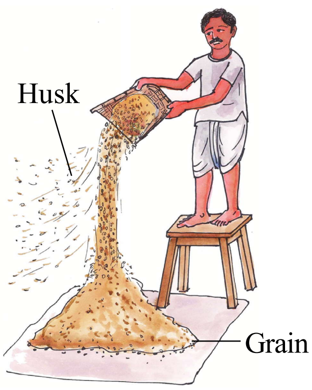


Fig - 8 : Winnowing

All the separation techniques are based on difference in the physical properties of the components present in the mixture. The following two factors decide the best possible techniques to be adopted for separation.

(i) The type of mixture, (ii) The component which you want to collect.

We shall discuss some of the common techniques of separation of mixtures.

12.8.1 Filtration

Generally, we use a strainer to separate unwanted tea powder from tea. You might have observed flour being sieved in the kitchen. The flour particles are very fine and pass through the holes of the sieve and the husk particles being large are being left on the sieve.

- How can we separate mud from muddy water using a sieve?

We have to use filter paper to separate them. Filtration through filter paper is a better method for separating solids from liquids in heterogeneous mixtures. In filtration the solid material is collected as a residue on filter paper and the liquid is obtained as filtrate.

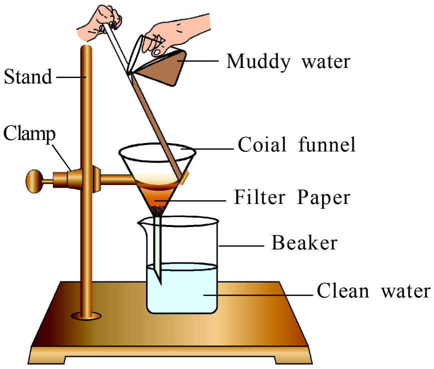


Fig - 9 : Filtration

> ***Filter paper***
>
> ***Filter paper is a sieve made of paper, which has very fine holes. We can filter very small particles using this type of sieve.***

12.8.2 Evaporation

Activity-6

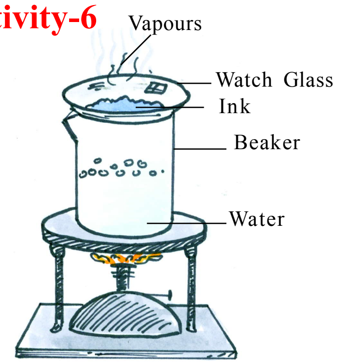


Fig - 10 : Evaporation

Take a beaker and fill it to half its volume with water. Keep a watch glass on the mouth of the beaker as shown in the figure. Put few drops of ink on the watch glass. Heat the beaker and observe the watch glass. Continue heating till you do not observe any further change on the watch glass.

- What is evaporated from the watch glass? Is there any residue on the watch glass?

We know that ink is a mixture of a dye in water. We can separate the components in the ink using evaporation.

- Think of other mixture that can be separated through evaporation.

12.8.3 Separation of immiscible and miscible liquids.

A liquid is said to be miscible if it dissolves completely in another liquid. For example, alcohol is miscible in water.

An immiscible liquid is one which doesn't dissolve in the other liquid but forms separate layer. It can be separated easily. Eg: oil is immiscible in water.

Now let us discuss the methods of separation of miscible and immiscible liquid.

Separation of immiscible liquids

Let us separate a mixture of oil and water. This is an immiscible mixture oil and water forms two seperate layers. To separate these two, we use a **separating funnel.**

Activity - 7

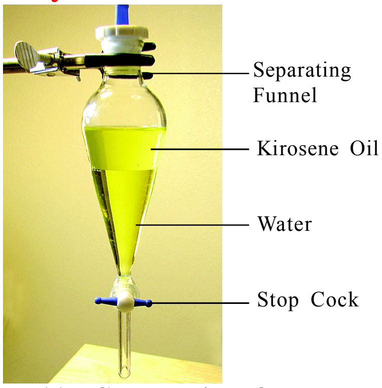


Fig -11 : Separating funnel

Take a separating funnel and pour the mixture of oil and water in it. Let it stand undisturbed for some time. So that separate layers of oil and water are formed. Open the stopcock of the separating funnel and pour out the lower layer (water) carefully. Close the stopcock of the separating funnel as the oil reaches the stopcock. These two liquids separate out into layers depending on their densities.

Separation of miscible liquids by distillation

The mixture of miscible liquids can be separated by distillation method. The mixture is boiled in a distillation flask (see fig-). The vapour is condensed by passing through a water- cooled tube called condenser and collected as liquid called distillate. This separation is based on the fact that the liquids will have different boiling points and there is a large difference between the boiling points of two liquids.

Activity-8

Acetone and water are miscible liquids. Take a mixture of acetone and water in a distillation flask. Fit it with a thermometer and clamp it to a stand. Attach the condenser to the flask and on the other side of the condenser keep a to collect distillate. Heat the mixture slowly keeping a close watch on the thermometer. Acetone vaporizes and condenses when passed through the condenser. Acetone can be collected from the condenser outlet. Water remains in the distillation flask.

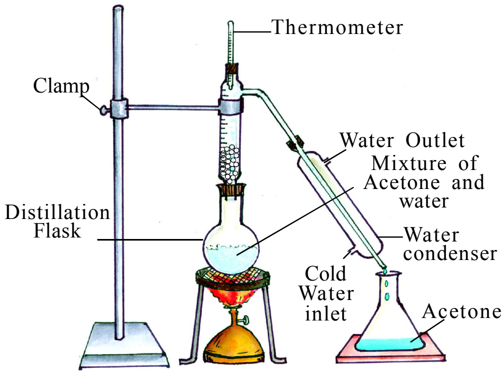


Fig - 12 : Distillation

12.8.4 Crystallization

A mixture of sugar and water can be separated by the crystallization process. Take solution of sugar in a beaker. Heat the solution with stiring a glass rod. Continue heating till all water in the beaker is completely evaporated. Sugar in the form of a powder is left behind in the beaker.

2.1.8.5 Magnetic separation

Take some sand and a magnet. Wrap the magnet with a paper and just roll it in the sand. We find some dark particles are attached to the two ends of the magnet. Now gently remove the paper. The dark particles so obtained are iron filings. Similarly, we can separate iron filings from a mixture of sugar and iron filings. The property that we use here is attraction by a magnet. Here one component of the mixture is magnetic and the other non-magnetic.

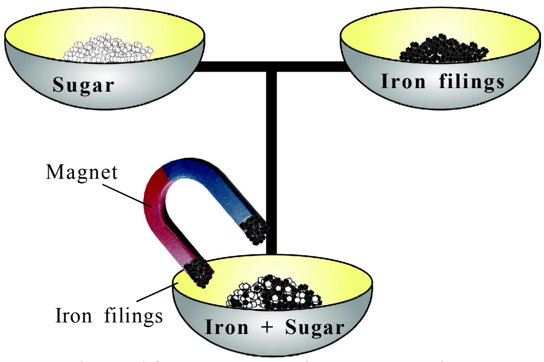


Fig - 13 : Magnetic separation

Check your Progress

- Explain a method to separate the mixture of kerosene and water.
- How can we choose a proper method for separation of components from a mixture?

Key Points

- Anything that occupies space and has mass is considered as matter.
- Matter is made up of small tiny particles called atoms.
- Matter exists in three states viz., solids, liquids, and gases.
- Solids have fixed shape and definite volume
- Liquids have no definite shape but have a fixed volume.
- Gases neither have fixed shape nor fixed volume.
- Two or more atoms combine to form compounds.
- A mixture contains more than one substance (element and / or compound) mixed in definite proportion.
- Mixtures are two types. Heterogeneous mixtures and homogeneous mixtures.
- Some commonly used separation methods of mixtures are filtration, evaporation, distillation, crystallization, separating funnel, and magnetic separation.

Practice for Learning Outcomes

1. Compare the properties of solids, liquids, and gases.
2. Why do we call liquids and gases as fluids?
3. Classify the following substances into elements, compounds, and mixtures:
   Water, milk, washing soda, sugar solution, Gold biscuits, Gold ornaments, Carbon dioxide, air, silver, brass, diamond, bronze, aluminium, ink, soap.
4. What is the method of separation do you suggest to separate oil and water? Explain the process.
5. Explain the difference between compound and mixture with examples.
6. Draw a schematic diagram showing the arrangement of atoms in solids, liquids, and gases.

Multiple Choice Questions

1. Matter has i) mass, ii) volume ( )
   A) (i) only B) (ii) only
   C) both (i) and (ii) D) Neither (i) nor (ii)
2. Which of the following is a fluid? ( )
   A) Ice B) LPG C) Wood D) Chair
3. Conversion of solid directly into gaseous state without changing into liquid state is known as ( )
   A) Melting B) Freezing C) Sublimation D) Boiling
4. Highly compressible substance among the following is ( )
   A) Wood B) Aluminium C) Milk D) Carbon di oxide
5. The lighter unwanted particles from paddy can be separated by ( )
   A) Filtration B) Winnowing C) Crystallization D) Distillation

Chapter

13

Atoms, molecules

Introduction

In the previous chapter we discussed about matter around us. We already discussed properties of solids, liquids and gasses such as state, volume, compressibility, diffusion. Matter consist of molecules and atoms. The idea of divisibility of matter was considered long back in India around 500 B.C. Maharishi Kanada, an Indian Philosopher discussed it in his Vaisesik Darshan. He said if we go on dividing matter, we shall get smaller and smaller particles. A stage would come beyond which further division will not be possible. He named these particles as 'PARMANU'.

Around the same era, Democritus (460 – 370 BC) and Leucippus suggested that if we go on dividing matter, a stage will come when further division of particles will not be possible. Democritus called these individual particles **'atoms'**. The meaning of 'Atom" is indivisible. However, today we know what an atom is?

In this chapter, we shall study about atoms and molecules and related aspects like atomic and molecular masses, mole concept and molar masses. We shall also learn how to write chemical formula of a compound.

According to the law of conservation of mass. ***In every chemical reaction is equal to the mass of all the products total mass of all the reactants is equal to the total***. According to the law of constant proportions **"in a given chemical compound, the proportions by mass of the elements that compose it are fixed, independent of the origin of the compound or its mode of preparations."**

- ✓ Can we see the atoms and molecule with our naked eye? Why?
- ✓ What is it that makes one atom different from another?
- ✓ How the Hydrogen atoms differ from carbon or oxygen atom?

Learning out comes

After completing this lesson you will be able to:

- Explain the law of conservation of mass.
- Explain the law of constant proportions.

- Differentiate between atom and molecule.
- Give some examples of atoms and molecules.
- Explain the size of atom.
- Explain the molecular mass and calculate the molecular mass of elements.
- Explain the mole concept.
- Identifies the symbols and write the elements and its symbols.
- Explain the molar mass.
- Calculate the molecular mass of the elements.
- Write the valency of the element.
- Explain about radicals / ions, able to give examples.
- Write the formula of the compounds.

13.1 Atoms and molecules

Very often you may have heard that atoms are the building blocks of all matter. But what does it mean? It means that matter is composed of tiny particles known as atoms. These atoms are so small that we cannot see them even with a high-powered microscope. The number of atoms present even in a small amount of matter is very large.

We know that substances are made up of atoms or molecules. Atoms are the most fundamental of all particles that can have an independent existence. Sometimes two or more atoms combine to form a big particle. When atoms combine, they form molecules. When the particles of a substance contain only one type of atoms, that substance is called an element. In elements the smallest particle may be atom or molecule.

There are many elements whose smallest particle is an atom. Iron, copper, zinc, aluminium, silver, gold, etc are examples of substances in which the smallest particle is an atom.

Oxygen and nitrogen are examples of substances in which the particles are a combination of two identical atoms. The smallest particles of elements that are stable are known as molecules. For example one sodium molecule has one sodium atom but one oxygen molecule has two oxygen atoms. Sodium atom is stable and has free existence, but oxygen atom has no free existence and oxygen exists as a diatomic molecule.

Atoms of same elements or of different elements can join together to form molecules. If atoms of different elements join together they form a new substance known as compound. So we can have molecules of elements and molecules of compounds. A molecule can be defined as the smallest particle of a substance that has independent existence and retains all the properties of that substance.

From the above discussion, we understand that atoms are the smallest particles of elements which may or may not have free existence but molecules are the smallest particles of elements and compounds which have free existence. Atoms of the elements which have free existence are also the molecules of those elements.

Eg. (i) Sodium atom is symbolised as 'Na'
Sodium molecules is also 'Na'

(ii) Oxygen atoms is symbolised as 'O'
Oxygen molecules is also 'O_2'

(iii) Water, a compound exists as molecules H_2O

compounds do not have free atoms.

What is the necessity of naming elements?

Do you know what Iron is called in your language? But in other languages it would have a different name. There are so many languages in the world that it is not possible to know the different names of each element in different languages. To help scientists communicate without confusion, we must have one name for each element that is accepted by everyone in the world.

Do you know?

John Berzelius suggested that initial letter of an element from its name in English written in capitals should be the symbol of that element, Eg. 'O' for oxygen, 'H' for Hydrogen and so on.

13.2 Symbols of elements

We observe many chemical reactions that take place in day to day life. We cook food on the stove by burning LPG, involving chemical changes. Like this lot of chemical reactions involve in chemistry. It is a waste of time to write the full name of the elements and compounds every time to describe a reaction. To avoid this we use some shortcuts. Using short forms or symbols for naming the elements is one solution. 118 elements have been discovered so far, though some of them are synthetic. How do we decide their symbols?

(a) Capital letters : The symbol of some elements is represented by a capital letters. In the symbol of the element, if there is only one letter, the letter is written in capital.

For example: Symbol for Hydrogen element is **H**
Symbol for Potassium element is **K**
Symbol for Boron element is **B**
Symbol for Carbon element is **C**
Symbol for Oxygen element is **O**
Symbol for Fluorine element is **F**

Table - 3

S.No.	Name of the Element	Symbol
1	Nitrogen	N
2	Vanedium	V
3	Sulphur	S
4	Boron	**B**
5	Phosphorus	P

(b) First letter capital while the second is small : The symbols of some elements are represented by first letter capital and second letter small. For many elements first two letters of the name of the elements are used to denote the element in short form and some elements the first letter (capital) the second letter (small) selected is not exacting other letter that has more pronounciation effect is heard see the symbol for magnesium.

For example:

- Symbol for Barium element is '**Ba**'
- Symbol for Helium element is '**He**'
- Symbol for Calcium element is '**Ca**'
- Symbol for Magnesium element is '**Mg**'

Table - 4

S.No.	Name of the Element	Symbol
1	Neon	**Ne**
2	Chlorine	**Cl**
3	Aluminum	**Al**
4	Silicon	**Si**
5	Argon	**Ar**

(c) Latin Names : For some elements the first letter or first two letters of the Latin names of the element is used as the symbol some symbols taken from Latin names are given below let use observe in alular form.

Table - 5

S.No.	Name of the Element	Greek name of the element	Symbol
1	Sodium	**Natrium**	**Na**
2	Pottassium	**Kalium**	**K**
3	Silver	**Argentum**	**Ag**
4	Iron	**Ferrum**	**Fe**
5	Gold	**Aurum**	**Au**
6	Lead	**Plumbum**	**Pb**
7	Mercury	**Hydrargyrum**	**Hg**
8	Tungsten	**Wolfram**	**W**

Writing symbols of atoms

In standard notation to represent an atom, the atomic number, mass number and symbol of the element are written as:

Atomic mass number

No. of protons + No.of neutrons

No. of protons

Atomic number

$$^{4}_{2}He$$

Activity-3

Write the symbols for given elements

Observe table and try to find the symbols for the given elements in table and write them against their names.

Table - 6

S.No	1	2	3	4	5	6	7	8	9
Name of the element	**Sodium**	**Iron**	**Mercury**	**Helium**	**Carbon**	**Magnesium**	**Gold**	**Chlorine**	**Oxygen**
Symbol									

Elements with more than one atom in their molecules

We have learnt that several elements have more than one atom in their smallest constituent particles. It means these elements contains two or more atoms combined together to form a molecule. Oxygen, hydrogen and nitrogen are examples of such elements.

For example, a molecule of oxygen has two atoms. We need a formula to represent such a molecule in a simple way. The formula for oxygen molecule is O_2.

- **Why don't we write it as 2O ?**

Writing a formula in this way indicates two separate atoms of oxygen. Hence first write the symbol for oxygen, and then write 2 as a subscript after the letter O. Subscript number indicates number of atoms of Oxygen combined to form its molecule. You might have heard about Ozone gas. This gas is found in large quantities in the upper layers of the earth's atmosphere. It protects us by shielding the earth from harmful ultra violet rays of the sun. Every molecule of ozone has three atoms of oxygen and its formation is O_3.

- **Can you write the formula of ozone?**

13.3 Atomicity

Molecules of many elements, such as Argon (Ar), Helium (He), etc are made up of only one atom of that element. But this is not the case with the most of non metals. In non metals the molecules contain more than one atom of same element. The number of atoms constituting a molecule is known as the atomicity of that element or compound.

For example, a molecule of hydrogen consists of two atoms of hydrogen. Here the atomicity is two; hence it is known as diatomic molecule. Helium (He), Argon (Ar) exist as single atom. Hence they are known as monatomic

Monatomic : Molecules consisting of one atom is known as monatomic molecules He

Diatomic : Molecules consisting of two atom is known as diatomic molecules O_2

Triatomic : Molecules consisting of three atom is known as triatomic molecules O_3

Tetratomic : Molecules consisting of four atom is known as tetratomic molecules P_4

Octatomic : Molecules consisting of eight atom is known as octatomic molecules S_6

Activity-4

Observe the following table to know atomicity of molecules of few elements and try to write the symbol of molecule based on its atomicity.

Table - 7

S.No	Name of the element	Formula	Atomicity
1	Ozone	O_3	Triatomic
2	Chlorine	Cl_2	
3	Hydrogen	H_2	
4	Nitrogen		Diatomic
5	Carbon	C	
6	Sodium		Monatomic
7	Sulphur		Octatomic
8	Silicon	Si_4	

To understand the atomicities of molecules of elements and compounds we need to understand the concept of valency.

- What is valency?

Valency

Till now, there are 118 elements known. These elements react with each other to form compounds. Every element has a definite combining capacity. Every element reacts with atoms of other element according to its combining capacity number. This combining capacity number is called valency.

Note:

After understanding the electronic configurations of atomes of elements valency us attributed to the electronic structures.

(i) The valency of an element can be defined as the number of electrons donated or accepted by an atom of an element to achieve stable electronic configuration (Octet in outer most shell)

(ii) The number of electrons lost, gained or shared with one atom of that element is known as valency of that element.

(iii) As valency concept was introduced before knowing the electronic structurer of atoms, its value for any element is without + or – sign.

Valencies of some elements.

Table - 8 : Monovalent Elements

Element	Valency
Hydrogen	1
Chlorine	1
Potassium	1
Sodium	1
Lithium	1
Bromine	1

Table - 9 : Bivalent Elements

Element	Valency
Oxygen	2
Calcium	2
Magnesium	2
Sulphur	2
Zinc	2

So atoms of the elements have power to combine with atoms of other elements. This is known as its valency.

Note: There are some elements which possess valences even more than one.

Ex. Iron exhibits valencies - 2, 3

Gold exhibits valancies - 1, 3

Some elements exhibits more than 2 valancies.Ex. Sulphur exhibits valances of 2,4,6.

What is an ion?

Compounds formed by metals and non metals contain charged particles. The charged particles are known as ions. A negatively charged ion is called anion and the positive charge ion is cation. For example sodium chloride (common salt) does not contain discrete molecules as its constituent units. Its constituent particles are positively charged sodium ions (Na^+) and negatively charged chloride ions (Cl^-).

Ions may be a charged independent atoms or a group of atoms (polyatomic) that have a net charge on them. Hence ions are charged particles.

Table - 11

Some common, simple and polyatomic ions.

Valency	Cation	Symbol	Anion	Symbol
1 Unit	Hydrogen	H^+	Hydride	H^-
	Sodium	Na^+	Chloride	Cl^-
	Potassium	K^+	Bromide	Br^-
	Silver	Ag^+	Iodide	I^-
	Copper*	Cu^+		
	Ammonium	NH_4^+		
2 Units	Magnesium	Mg^{+2}	Oxide	O^{-2}
	Calcium	Ca^{+2}	Sulphide	S^{-2}
	Zinc	Zn^{+2}		
	Copper*	Cu^{+2}		
	Iron*	Fe^{+2}		

Note: * elements which show variable valency.

Valency of an ion is equal to the magnitude of its charge. For Example valency of chloride ion (Cl^-) is 1.

Table - 12

Compound ions

Valency	Cation	Symbol	Anion	Symbol
1 unit	Ammonium	NH_4^{+1}	Hydroxide	OH^{-1}
			Nitrite	NO_2^{-1}
			Nitrate	NO_3^{-1}
2 units			Sulphate	SO_4^{-2}

Check your Progress

1. Mention atomicity of the following elements.

   (i) Carbon (ii) Fluorine (iii) Helium (iv) Gold

2. Mention the cation and anion symbols/formulae for the following

   (i) Sulphide (ii) Chloride (iii) hydroxide (iv) carbonate

   (v) Calcium (vi) Ammonium

13.4 Formula

The representation of a molecule of a substance (element or compound) in terms of symbols and subscript numbers is known as**formula**.

Example: O_2 is the formula of Oxygen.

Cl_2 is the formula of chlorine

HCI is the formula of hydrochloric acid.

Method to write a formula from the knowledge of Valency: (CRISS- CROSS Method)

To write a formula, follow the steps given below. This method of writing formula is called Crisss- Cross method.

Step-1 : Write the symbol of positive ion or the radical to the left and for the negative ion or radical to the right.

Step-2 : Put the valency number of each radical or the ion on its top right. Divide the valency numbers by highest common factor, if any, to get simple ratio. Now ignore the (+) and (-) symbols. Interchange the valency numbers of radicals or ions.

Step-3 : Shift the valency numbers to lower right side of radical or ion. If the radical receives a number more than 1, enclose it within brackets. Do not enclose ions within brackets.

Examples

1. **Formula of Magnesium oxide**

Step-1 : Write the symbol of positive ion i.e Magnesium to the left and for the negative ion Oxide to the right.

2 **2** ← Valency

Mg **O** ← Element

Spet 2 : Ignore the charges. And know criss-cross the valancies.

2 **2**

Mg **O**

Spet 3 : Formula of magnesium oxide is

MgO

2. **Formula of Aluminum oxide**

Step-1 : Write the symbol of positive ion i.e Aluminium to the left and for the negative ion Oxide to the right.

3 **2** ← Valency

Al **O** ← Element

Spet 2 : Ignore the charges. And know criss-cross the valancies.

$$\overset{3}{Al} \times \overset{2}{O}$$

Spet 3 : Formula of magnesium oxide is

Al_2O_3

Activity : 5

Observe the given compound and using criss-cross method and write the formula of the compound.

Table-13

Compound	Symbols with valencies		Criss-Cross	Formula
1. Hydrogen chloride	H^1	Cl^1	$\overset{1}{H} \times \overset{1}{Cl}$	**HCl**
2. Menesium chloride	Mg^2	Cl^1	$\overset{2}{Mg} \times \overset{1}{Cl}$	**$MgCl_2$**
3. Calcium Oxide	Ca^2	O^2	$\overset{2}{Ca} \times \overset{2}{O}$	**CaO**
4. Calsium Hydroxide	Ca^2	OH^1	$\overset{2}{Ca} \times \overset{1}{OH}$	**$Ca(OH)_2$**
5. Calcium Carbonate	Ca^2	CO_3^1		
6. Zinc oxide	Zn^2	O^2		
7. Aluminium hydroxide	Al^3	OH^1		
8. Lead Nitrate	Pb^2	NO_3^1		

In this method we can write the formulas of the compounds. Try to write more formulas of different compounds.

Significance of a formula: Like the symbols, a formula has also qualitative as well as quantitative significance. Qualitative Significance:

(i) It saves time and space.

(ii) It represents the name of the substance.

For Example : The name of the substance NaCl is Sodium chloride (Common salt)

(iii) It represents the name of different elements present in the substance. For

Example : The name of different elements present in H_2O are hydrogen and oxygen.

Check your Progress

- Write the formula of the given compound.
  - (i) Sodium carbonate
  - (ii) Calcium chloride
  - (iii) Lead iodide
  - (iv) Barium chloride

13.5 Molecular mass

We have already discussed the concepts of atomic mass. This concept can be extended to calculate molecular masses. The molecular mass of a substance is the sum of the atomic masses of all the atoms present in a molecule of the substance. As atomic mass is a relative, it is therefore the molecular mass is also relative. Mass of a molecule expressed in unified Mass (u).

For Example : Calculate the molecular mass of H_2SO_4.

Solution

= 2 (atomic mass of hydrogen) + (atomic mass of sulphur) + 4(atomic mass of oxygen)

$= (2 \times 1) + 32 + (4 \times 16) = 98$

Table-14

Atomic masses of a few elements

S.No	Name of the element	Atomic mass
1.	Hydrogen	1
2.	Carbon	12
3.	Nitrogen	14
4.	Oxygen	16
5.	Sodium	23
6.	Aluminum	27
7.	Magnesium	24
8.	Phosphorus	31
9.	Sulphur	32
10.	Chlorine	35.5
11.	Potassium	39
12.	Calcium	40

Ex : Calculate the molecular mass of H_2O

Hydrogen mass= 2, Oxygen mass = 16

H_2O mass = 2(mass of H) + 1(mass of O)

= 2(1) + 1(16) = 2 + 16 = 18

Activity - 6

Observe the following table and find the molecular mass of the given compound.

Table - 6

S.No	Compound name	Molecular mass
3	HCl	
4	KOH	
5	$Mg(OH)_2$	
6	$C_6H_{12}O_6$	

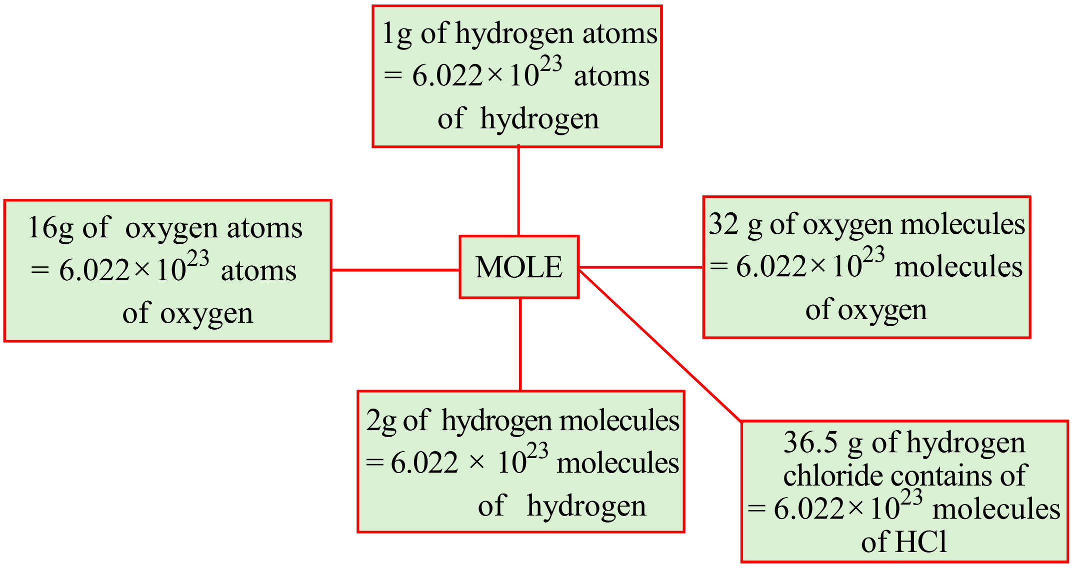
13.6 Mole concept

We have learnt that atoms and molecules are extremely small in size and their number is really very large. Even in a small amount of any substance we find very large number of atoms or molecules. How many molecules are there in 18 grams of water? How many atoms are there in 12 grams of carbon? You will be surprised to know that the number of molecules in 18 grams of water and no.of atoms in 12 grams of carbon as the same. This number is very large. To handle such large numbers, a unit called mole is introduced. This is a numerical quantity. One mole of a substance is the amount of the substance which contains as many particles (atoms, molcules, ions ....etc) or entities that are equal to the atoms present in exactly 12 grams of ${}^{12}_{6}C$ isotope. The number of particles (atoms or molecules) present in one mole of any substance has a fixed value of 6.022×10^{23}. This number is called Avogadro constant (NA) named in honour of the Italian scientist, Amedeo Avogadro.

1 mole oxygen = 6.022×10^{23} molecules

1 mole chlorine = 6.022×10^{23} molecules

1 mole carbon = 6.022×10^{23} molecules



13.7 Molar mass

Having defined mole, it is easier to know the mass of 1 mole of substance. The mass of 1 mole of a substance which is expressed in grams is called its molar mass.

The molar mass and molecular mass are numerically equal but molar mass has units grams and molecular mass has unified mass units. Eg H_2O has molecular mass 18 u bit molar mass 18 g.

Molar mass of water = 18 g.

18 u water has only one molecule of water.

But 18 g water has one mole molecules of water that is 6.022×10^{23} molecules.

Check your Progress

1. Find the Molar mass of the given compound.
   (i) Sodium bi carbonate
   (ii) Sodium chloride
   (iii) Calcium hydroxide
   (iv) Ammonia

Key Points

- "The number of protons present in nucleus is called atomic number of the element".
- **Mass number (A) = Number of protons (P) + Number of neutrons (N)**
  = Atomic number (Z) + Number of neutrons (N)
  A = Z + N
- The symbol of some elements is represented by first letter capital and second letter small. Per many elements the first letter of first two letters of the name of the elements are used to donate the element in short form.
- For some elements the first letter or first two letters of the Latin names of the element is used as the symbol some symbols taken from Latin names are given below let use observe in alular form.
- The number of atoms constituting a molecule is known as its atomicity.
- Every element reacts with atoms of other element according to its combining capacity number. This combining capacity number is called valency.
- As the number of electrons lost, gained or shared with one atom of that element is known as valiancy.
- Compounds formed by metals and non metals contain charged particles. The charged particles are known as ions.
- A negatively charged ion is called anion and the positive charge ion is cation.
- The representation of a molecule of a substance (element or compound) in terms of symbols and subscript numbers is known as**formula**.
- The number of particles (atoms or molecules) present in one mole of any substance has a fixed value of 6.022×10^{23}. This number is called Avogadro constant.

Practice for Learning Outcomes

1. What information does the compound formula gives us?
2. Why do we write the compound formula?
3. Write any five elements symbols which have single capital letter.
4. Write five elements symbols which are representing by its Latin name.
5. Complete the following table with suitable symbols of given elements.

S.No	1	2	3	4	5	6	7	8
Name of the elements	Chromium	Copper	Boron	Silicon	potassium	Tin	Gold	Lithium
Symbol								

6. Write the formula of the given compound.
   (i) Calcium oxide (ii) Ferric oxide (iii) Copper sulphate
   (iv) Auric chloride (v) Zinc carbonate
7. Find the Molar mass of the given compound.
   (i) Aluminum hydroxide (ii) Ammonium hydroxide (iii) Sodium sulphate
   (iv) Sulphuric acid (v) Sucrose(Sugar)
   (Hint Formula of sucrose = $C_{12}H_{22}O_{11}$)
8. Calculate how many oxygen molecules are present in 32 grams of oxygen?
9. Calculate how many molecules are present in 88 grams of carbon-di-oxide?
10. Write the compound formula using criss-cross method for the following compounds
    (i) Potassium iodide (ii) hydrogen bromide
    (iii) Magnesium chloride (iv) Zinc sulphide.

Multiple Choice Questions

11. Which of the following represents the symbol of silver ( )
    A) Si B) S C) Ag D) Au
12. 32 grams of oxygen contains ( )
    A) 32 molecules oxygen B) 2 moles oxygen
    C) $1 \times 6.022 \text{ x } 10^{23}$ molecules D) $32 \times 6.022 \times 10^{23}$ molecules
13. 1 mole of hydrogen atoms contains ( )
    A) 6.022×10^{23} hydrogen molecules B) $2 \times 6.022 \times 10^{23}$ Atoms
    C) $2 \times 60.22 \times 10^{23}$ molecules D) 6.022×10^{23} hydrogen Atoms
14. Correct formula from the following is ( )
    A) Mg_2O_2 B) Mg_2O C) MgO D) MgO_2

Chapter 14

Chemical Reactions, Equations

Introduction

In our surroundings many types of changes we can observe. For example Ice converts into water, water converts into water vapours. Condensation of water vapour gives liquid water and freezing of water gives ice. This type of changes we can observe the change of state only. Iodine directly sublimates and changes from solid to gaseous state. This is also change of state. We are get curd from milk, ghee from cheese. This type of change we cannot get milk from curd and cheese from ghee. This is a permanent change. This type of changes is known as chemical changes. Both physical and chemical changes are integral part of our daily life. In this chapter we are going to discuss about the physical and chemical changes and We can present these changes in the form of an equation and we shall discuss how to write the balanced chemical equation. We will discuss about the types of chemical reactions.

Learning out comes.

After completing of this lesson you will be able to:

- Explain the changes of matter.
- Explains the physical change and chemical change.
- Differentiate between physical and chemical changes.
- Gives examples for both physical and chemical changes they observed in day to day life.
- Express the chemical reaction in the form of chemical equation.
- They can explains what information does the chemical equation gives.
- Identifies the types of chemical reactions and classify them.
- Gives reason for why we are balancing the equation.

Changes around us.

- Changes in matter in our surround same?
- What difference you observed?
- What kind of changes you noticed?
- Are the changes temporary or permanent?

- Give examples for some changes you observed.

  Eg. Burning of a wood piece.
  - Which type of change is this?
  - Can we get the wood piece from ash?

  We cannot get original substance (wood) in this reaction. This is a permanent change. This

  This type of change is known as Chemical change.

  Eg. Rusting of iron pieces
  - Which type of change is this?
  - Can we get the wood piece from ash?

We cannot get original substance (Iron) in this reaction. This is a permanent change. This type of change is known as Chemical change.

Eg. Take a piece of chalk and making powder.

In this action only texture of the chalk is changed. This is a physical change. In the Physical change shape, state, colour, texture, temperature etc will be change and we get original substance and this is a temporary change.

Let us discuss about chemical changes.

- In the above changes what changes do you think that the products poses the properties of the reactants even after the chemical change.
- Only new products will produce in the reactions? Is there any changes?

Now we will do some activities.

Activity-1

Take 2 to 3 cm long magnesium piece. Clean the magnesium ribbon with a piece of sand paper. Hold the ribbon firmly with a pair of tongs. Heat it over a spirit lamp until it burns. Keep the ribbon as far as possible from your eyes.

What do you observe?

- The magnesium ribbon burns with a dazzling light and liberates a lot of heat.
- It is soon converted into a white powdery substance.

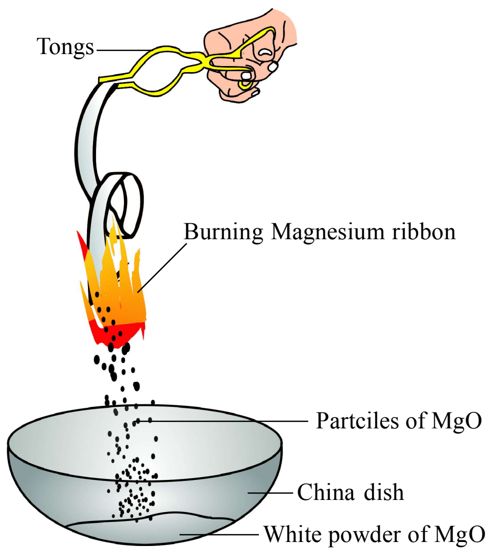


Fig - 1 : Burning of Magnecium ribbon

We can represent the above chemical change as following.

Megnesium + Oxygen $\rightarrow$ magnesium oxide .... (1)

The left hand side Magnesium and oxygen are present they are known as reactants and right hand side compound is known as products.

Reactants: Magnesium, oxygen, Products: Magnesium oxide.

14.1 Writing a Chemical Equation

The description to express the chemical reaction is long.

Can we write this equation in any another shorter way? How?

Generally we using the symbols / formulas of atoms/molecules participating in the reaction .Chemical equations can be made more precise and useful if we use chemical formulae instead of words. Generally, a compound is written by giving its chemical formula, which lists the symbols of the constituent elements and uses the subscript to indicate the number of atoms of each element present in the compound. If no subscript is written the number 1 is understood.

The symbolic representation of chemical reaction in terms of chemical formula is called Chemical Equation.

Let us Discuss **activity -1**, try to write that reaction in shorter way.

The chemical equation in words

Megnesium + Oxygen → magnesium oxide

Megnesium symbol = **Mg**

Oxygen formula = $\mathbf{O_2}$

Magnesium oxide formula = **MgO**

Let us write the Equation

$$\mathbf{Mg + O_2 \rightarrow MgO} \qquad .... (2)$$

- In the above chemical equation, count the number of atoms of each element on left side and right side of arrow.
- Is the number of atoms of each element are equal on both sides?

Observe the following reactions and their chemical equations.

Calcium oxide reacts with water to yield calcium hydroxide.

Calcium Oxide + Water → Calcium Hydroxide. + Q (Heat) ..... (3)

Formula of Calcium oxide = **CaO**

Formula of Water = $\mathbf{H_2O}$

Formula of Calcium hydroxide = $\mathbf{Ca(OH)_2}$

The chemical equation is

$$\mathbf{CaO + H_2O \rightarrow Ca(OH)_2} \qquad ..... (4)$$

Check your Progress

- Butane (C_4H_{10}) is combusted with oxygen to form carbon dioxide and water. Write the chemical equation for this reaction.

14.2 Balancing Chemical Equations

- Observe the equation (4) though nuber of all the atoms (Ca,O,H) equal?
- This is against to the law of **conservation of mass**.
- According to the law of conservation of mass, the total mass of the products formed in chemical reaction must be equal to the total mass of reactants consumed.
- As per the law of conservation of mass the number of atoms of each element before and after reaction must be the same.
- All the chemical equations must be balanced, because atoms are neither created nor destroyed in chemical reactions.
- A chemical equation in which the number of atoms of different elements on the reactant side (left side) are same as those on product side (right side) is called a balanced reaction.
- **Formula units:** Balancing a chemical equation involves finding out how many formula units of each substance take part in the reaction as the name implies, is one unit – whether atom, ion or molecule – corresponding to a given formula.

Example:

1. Write the balanced equation for the preparation of oxygen when potassium chlorate is decomposed. Products are potassium chloride and oxygen.

   Reactants: potassium chlorate. Its formula:$KClO_3$

   Products : potassium chloride.Its formula :KCl; oxygen its formula O_2.

   Guess and write the chemical reaction for the above reaction?

Chemical raction.

$\mathbf{KClO_3 \rightarrow KCl + O_2}$ .... (6) (Unbalanced chemical equation is known as skeleton equation.)

- Observe the reactants and products. Is the number of K, Cl, O elements are same in the reactants and products?

Table - 1

LHS		RHS	
K	1	K	1
Cl	1	Cl	1
O	3	O	2

The equation is balanced with respect of Potassium and chlorine atoms since they are equal in number of atoms on their side.

- Multiply the $KClO_3$ by 2 and oxygen by 3 and rewrite the equaton.

$$2KClO_3 \rightarrow KCl + 3O_2 \qquad .... (5)$$

Table - 2

LHS		RHS	
K	2	K	1
Cl	2	Cl	1
O	6	O	6

- In the above equation oxygens are balanced. Now balance the K and Cl. Multiply KCl with 2 then both sides K and Cl atoms will be balanced and rewrite the equation.

$$2KClO_3 \rightarrow 2KCl + 3O_2 \qquad .... (6)$$

Table - 3

LHS		RHS	
K	2	K	2
Cl	2	Cl	2
O	6	O	6

Now the above equation is balanced.

Ex.2 : Combustion of Methane (CH_4)

Formula of Methane is CH_4. Write the chemical equation for the combustion reaction of Methane. The reactants are Methane and oxygen and the products are Carbon dioxide and water.

Reactents : Methane. Its formula : CH_4, oxygen- formula : O_2

Products : Water.Its formula : H_2O,
Carbon dioxide- fomulae CO_2

Do You Know?

Formulae represent a compound and symbol represents an element.

Chemical raction.

Step 1 : Write the unbalanced equation using correct chemical formulae for all substances.

$$CH_4 + O_2 \rightarrow H_2O + CO_2 \quad .... (7) \qquad \text{(skeleton equation.)}$$

Step 2 : Compare number of atoms of each element on both sides.

Table - 4

LHS		RHS	
C	1	C	1
H	4	H	2
O	2	O	3

Number of carbon atoms are equal both sides in the equation.H,O atoms are to be balance.Multyply with 2 to the water molecule and rewrite the equation.

$$CH_4 + O_2 \rightarrow 2H_2O + CO_2 \qquad .... (8)$$

Table - 5

LHS		RHS	
C	1	C	1
H	4	H	4
O	2	O	4

Step 3 : Compare number of atoms of each element on both sides. Oxygen molecules are not balanced. Mutlypling by 2 to the Reactens side O_2 molecue.

$$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2 \qquad .... (9)$$

Table - 6

LHS		RHS	
C	1	C	1
H	4	H	4
O	4	O	4

The equation is balanced.

Think that in any information will give by the representation of chemical equation.Let us observe the following chemical reaction.

Check your Progress

- Ethane (C_2H_6) is combusted with oxygen to form carbon dioxide and water. Write the chemical equation for this reaction and balance it.
- Aluminum reacted with iron oxide and iron, zinc oxide are formed. Write the chemical equation for this reaction and balance it.

14.3 Making Chemical Equations more informative

Chemical equations can be made more informative by expressing following characteristics of the reactants and products.

(i) Physical state

(ii) Heat changes (exothermic or endothermic change)

(iii) Gas evolved (if any)

(iv) Precipitate formed (if any)

(i) Expressing the physical state : To make the chemical equation more informative, the physical states of the substances may be mentioned along with their chemical formulae. The different states ie., gaseous, liquid, and solid states are represented by the notations (g), (l) and (s) respectively. If the substance is present as a solution in water, the word ‘aqueous’ is written. In the short form it is written as (aq).

The balanced equation (.......) is written along with the physical states as

Eg. **:** Write the equation for the reaction between Magnesium and dil.H_2SO_4 and balance it.

Reactents **:** Sodium - Symbol : Mg –physical state- Solid

Water - formula : H_2SO_4- physical state- Aqueous

Products **:** Magnessium sulphate - Formulae : $MgSO_4$

Hydrogen - formula : H_2

Write the unbalanced equation using correct chemical formulae for all substances.

$Mg_{(s)} + H_2SO_{4\,(aq.s)} \rightarrow MgSO_{4(s)} + H_{2\,(g)}\uparrow$ .... (10),

$Fe_2O_3(s) + 2Al(s) \xrightarrow{\Delta} 2Fe(s) + Al_2O_3\ (s)$ ...... (11); represents heating.

(ii) Expressing the heat changes : Heat is liberated in exothermic reactions and heat is absorbed in endothermic reactions. See the following examples.

1. $C(s) + O_2\ (g) \rightarrow CO_2\ (g) + Q$ (exothermic reaction) .... (12)
2. $N_2(g) + O_2(g) \rightarrow 2NO\ (g) - Q$ (endothermic reaction) .... (13)

‘Q’ is *heat energy* which is shown with *plus* (+) sign on product side for exothermic reactions and *minus* (–) sign on product side for endothermic reactions.

(iii) Expressing the gas evolved : If a gas is evolved in a reaction, it is denoted by an upward arrow ‘$\uparrow$’or (g)

Eg : $Zn\ (s) + H_2SO_4\ (aq) \rightarrow ZnSO_4\ (aq) + H_2(g)$ .... (14)

(iv) Expressing precipitate formed: If a precipitate is formed in the reactions it is denoted by a downward arrow .

Eg: $AlCl_3\ (aq) + NH_4OH\ (aq) \rightarrow Al(OH)_3(s) + NH(OH)_4(aq)$ .... (15)

Sometimes the reaction conditions such as temperature, pressure, catalyst etc., are indicated above and/or below the arrow in the equation.

For example,

$2AgBr(s) \xrightarrow{\text{sunlight}} 2\ Ag\ (s) + Br_2(g)$ .... (16)

$6CO_2\ (g) + 6H_2O(l) \xrightarrow[\text{Chlorophyll}]{\text{sunlight}} C_6H_{12}O_6(s) + 6O_2(g)$ .... (17)

(glucose)

Interpreting a balanced chemical equation

- A balanced chemical equation tells us about the substances which react and the products formed by the chemical reaction.
- A balanced chemical equation also tells as about the symbols and formulae of all substances involved in a chemical reaction.

- A balanced chemical equation tells us about the number of atoms or molecules of all substances involved in a chemical reaction.
- A balanced chemical equation tells us about the mass of all substances involved in a chemical reaction.

Check your Progress

1. Why do you balance the chemical equation?
2. Write two examples for endothermic, exothermic reactions that are observed in day to day life.

14.4 Types of Chemical Reactions

When one or more substances /elements/compounds undergo a chemical reaction with absorption /liberation of energy, so as to form one or more new products then the changes taking place.

The chemical reactions can be classified in to the following types.

1. Chemical combination
2. Chemical decomposition
3. Chemical displacement
4. Chemical double displacement.

1. Chemical combination : When two or more substances react chemically to form only one new product. These types of chemical reactions are known as chemical combinations reactions.

Activity - 1

Take 2 grams of sulphur powder in a deflagrating spoon. Take a glass jar.

Burn the sulphur in the air and place the deflagrating spoon as shown in the figure. Sulphur burns with blue flame and forms sulphur dioxide with pungent smell.

$$\underset{\text{Sulphur}}{S(s)} + \underset{\text{Oxygen}}{O_2(g)} \rightarrow \underset{\text{Sulphur dioxide}}{SO_2(s)}$$

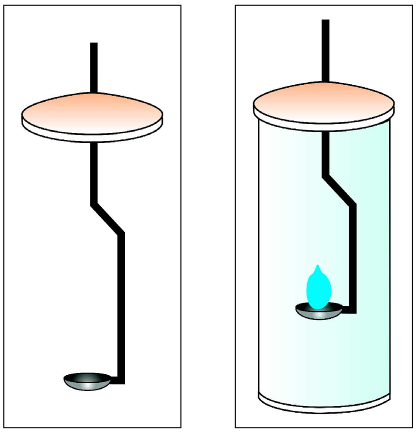


Fig - 2 Burning of sulphur

Eg. 1 : Magnesium ribbon burning in the air to form magnesium oxide

$$\underset{\text{Magnesium}}{Mg(s)} + \underset{\text{Oxygen}}{O_2(g)} \rightarrow \underset{\text{Magnesium oxide}}{MgO(s)} \quad .. (18)$$

Eg. 2 : When calcium oxide reacted vigorously with water to form calcium hydroxide.

$$\underset{\text{Calcium oxide}}{CaO(s)} + \underset{\text{Water}}{H_2O(s)} \rightarrow \underset{\text{Calcium hydroxide.}}{Ca(OH)_2(s)} \quad \dots (19)$$

> **This reaction is known as combustion reaction. In this reaction heat will be liberated. These types of reactions are known as exothermic reactions. All combustion reactions are exothermic reactions.**

> **Do You Know?**
>
> Calcium oxide is known as quick lime, calcium hydroxide is known as slaked lime. This slaked lime is used to white wash to the houses.

2. **Chemical decomposition :** When a chemical compound is decomposes into 2 or more compounds/substances, these types of reactions are known as chemical decomposition.

Activity - 2

Calcium carbonate is get heated it decomposes to give calcium oxide and carbon dioxide.

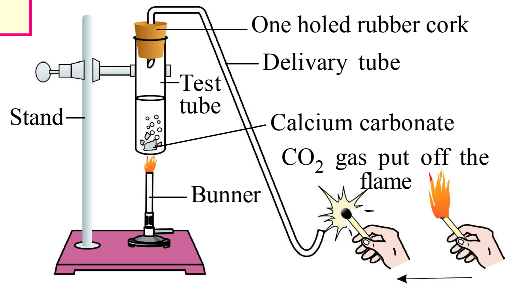


Fig - 3 : Heating of $CaCO_3$

$$\underset{\text{Calcium carbonate}}{CaCO_3(s)} \rightarrow \underset{\text{Calcium oxide}}{CaO(s)} + \underset{\text{Carbon dioxide}}{CO_2(g)} \quad \dots (20)$$

Eg. 2 : Potassium permanganate is get heated it decomposes to give calcium oxide and carbon dioxide.

$$\underset{\text{Potassium permanganate}}{2KMnO_4(s)} \rightarrow \underset{\text{Potassium Magnate}}{K_2MnO_4(s)} + \underset{\text{Manganese dioxide}}{MnO_2} + \underset{\text{Oxygen}}{O_2(g)} \quad \dots. (21)$$

Eg.3 : Lead nitrate is get heated it decomposes to lead oxide, nitrogen dioxide and oxygen.

$$\underset{\text{Lead Nitrate}}{Pb(NO_3)_2(s)} \rightarrow \underset{\text{Lead oxide}}{PbO(s)} + \underset{\text{Nitrogen dioxide}}{4NO_2(g)} + \underset{\text{Oxygen}}{O_2(g)} \quad \dots (22)$$

This decomposition reaction occurs in presence of sunlight and such reactions are called **photochemical reactions**.

Activity - 3 :

Take a Volta meter and pour water in it.

Place the two test tubes as shown in the figure. Connect the electrode to the battery and observe. After some time you can notices air babuls in two test tubes by liberating oxygen in one test tube and hydrogen in another. Water is decomposed to hydrogen and oxygen. In this reaction we used electricity.

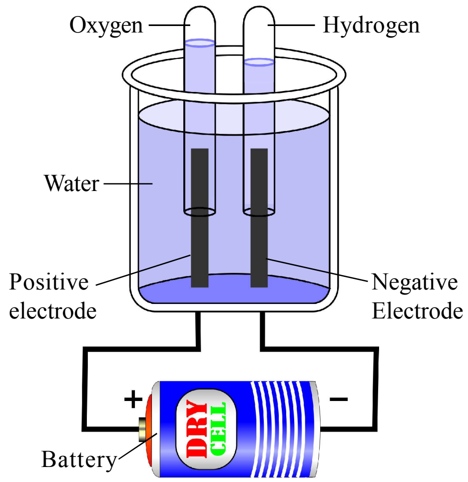


Fig - 4 : Electrolysis of water

This decomposition reaction occurs in presence of electricity and such reactions are called **electro chemical reactions**.

Note : Volta meter is vessel contains two electrodes and used to the electrolysis process.

3. **Chemical Displacement :** In displacement reaction one element displaces another element from its compound and takes its place there in.

Acitivity - 4:

Take a some znic granules in a conical flask and add 2 ml of dilute hydrochloric acid and tie a balloon to the flask mouth and observe.

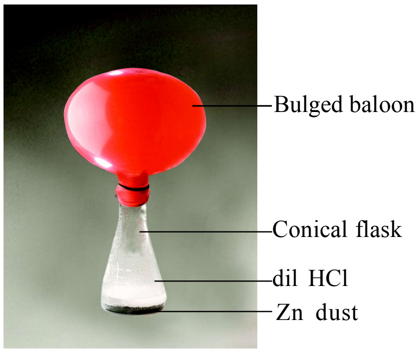


Fig 5 : Metal reacts with acid

What do you observe?

You can see the gas bubbles coming out from the solution and the balloon bulges out as shown in the figure. Zinc pieces react with dilute hydrochloric acid and liberate hydrogen gas as shown below.

$$Zn(s) + 2HCl\ (aq) \rightarrow ZnCl_2(aq) + H_2(g) \qquad .... (23)$$

In the above reaction the element zinc has displaced hydrogen fromhydrochloric acid. This is displacement reaction.

Activity - 5:

Let us take 1 gram of copper sulphate beaker and add water to it. Observe the colour. What is the colour of the solution? You can notice the colour of the solution is blue.

Now add zinc metal to the copper sulphate and observe. After some time you can notice that the colour of the solution will turns in to colour less and formed zinc sulphate. Here zinc displaces the copper in copper sulphate.

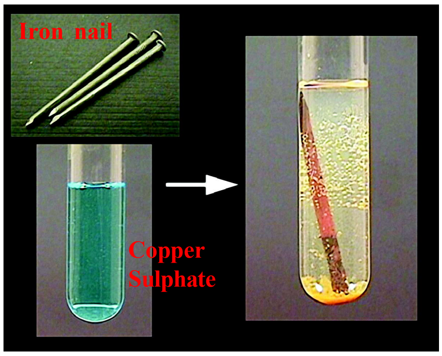


Fig - 6

$$\underset{\text{Zinc}}{Zn(s)} + \underset{\text{Copper sulphate}}{CuSO_4(aq)} \rightarrow \underset{\text{Zinc sulphate}}{ZnSO_4(aq)} + \underset{\text{Copper}}{Cu(s)} \qquad ... (24)$$

In this reaction iron displaced from copper sulphate and forms iron sulphate and copper is coated on the nail.

$$\underset{\text{Copper sulphate}}{CuSO_4(aq)} + \underset{\text{Iron}}{Fe(s)} \rightarrow \underset{\text{Iron sulphate}}{FeSO_4(aq)} + \underset{\text{Copper}}{Cu(s)} \qquad ... (25)$$

4. **Chemical double Displacement :** In double displacement reaction two compounds react by an exchange of ions to form new compounds.

Activity.7:

The reaction between lead nitrate and potassium reaction best example for double displacement.

- Take 2 test tubes.

- Take 5 ml of potassium iodide solution in one test tube.
- Take 5 ml of lead nitrate in another test tube.
- Mix the lead nitrate solution with potassium iodide solution.
- What happened?
- What do you notice?

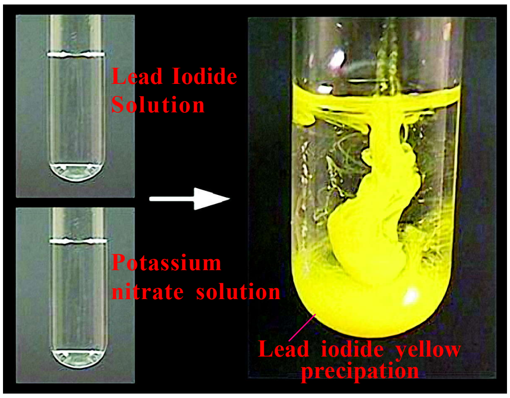


Fig - 7 Double desplacement reaction

- Yellow colour precipitation (lead iodide) and potassium nitrate formed. Both compounds react by exchange ions and formed new compounds.

Potassium nitrate

$Pb(NO_3)_2(aq)$	+	$2KI(aq)$	$\rightarrow$	$2KNO_3(s)$ + $PbI_2(s)$ ... (26)
Lead iodide		Potassium iodide		Lead nitrate

Eg. - 1: Sodium hydroxide reacts with hydrochloric acid to form sodium chloride and water.

$$NaOH\ (aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) \quad \text{... (27)}$$

Check your Progress

1. Observe the following equations. What type reaction is they represented?

(i) $4P + 5O_2 \rightarrow 2P_2O_5$

(ii) $2K + Cl_2 \rightarrow 2KCl$

(iii) $H_2S + Cl_2 \rightarrow 2HCl + S$

14.5 Oxidation and Reduction

Addition of oxygen to an atom or a group of atoms or removal of hydrogen is known as oxidation. In other terms lose of electrons are also oxidation. All combustion reactions are oxidation reactions. In the previous topic we discussed sulphur, carbon and sodium react with oxygen to give oxide. These types of reaction are oxidation reactions.

Oxidation-Addition of Oxygen

Eg. - 1: When carbon reacts with oxygen and forms carbon dioxide. Here carbon oxidised to carbon dioxide.

$C(s)$	+ $O_2(g)$	$\rightarrow$	$CO_2(g)$	... (28)
Carbon dioxide	Oxygen		carbon	

Eg. - 2: When Magnesium reacts with oxygen and forms Magnesium oxide. Here magnesium oxidised to Magnesium oxide.

$2Mg(s)$	+	$O_2(g)$	$\rightarrow$	$2MgO(s)$	... (29)
Carbon dioxide		Oxygen		carbon	

Oxidation-Removal of hydrogen:

Eg. - 1: Reaction between chlorine and hydrogen sulphide ,hydrogen sulphide is oxidesed to sulphur to loss of hydrogen.

$$\underset{\text{Hydrogen sulphide}}{H_2S} + \underset{\text{Chlorine}}{Cl_2} \rightarrow \underset{\text{Hydrogen chloride}}{2HCl} + \underset{\text{Sulphur}}{S} \quad ...(30)$$

Reduction -Addition of Hydrogen:

Eg. - 1: Passing Hydrogen gas over heated copper oxide to get black copper metal. In this reaction copper oxide is reduced to copper metal. This is a reduction reaction.

$$\underset{\text{Copper oxide}}{CuO} + \underset{\text{Hydrogen}}{H_2} \rightarrow \underset{\text{Copper}}{Cu} + \underset{\text{Water}}{H_2O} \quad ...(31)$$

Eg. - 2: When nitrogen reacts with hydrogen under specific conditions, ammonia is formed – since hydrogen is added to nitrogen, here nitrogen is reduced.

$$\underset{\text{Ammonia}}{N_2} + \underset{\text{Nitrogen}}{H_2} \rightarrow \underset{\text{Hydrogen}}{2NH_3} \quad ...(32)$$

14.6 Redox reactions

Generally oxidation and reduction occur in the same reaction. If one reactant gets oxidized, the other gets reduced. Such reactions are called oxidation-reduction reactions or redox reactions.In the CuO, H_2 reaction CuO is reduced and H_2 is oxidized.

Some other examples of redox reactions are:

(i) $2\ Fe_2O_3(s) + 3C(s) \rightarrow 4\ Fe(s) + 3CO_2\ (g)$ ... (33)

(ii) $2\ PbO\ (3) + C(s) \rightarrow 2Pb(s) + CO_2\ (g)$ ... (34)

Effects of oxidation reactions in daily life

You may notice rusting of iron articles which are open to air and moister. When you travelling in a bus in winter. You hold a aluminium/iron rod in the bus. You can notice some black colour attached to your hand.

- Why iron get rust?
- Are only iron articles getting rust?

Corrosion

This is due to the metals react with oxygen and oxidised to give its oxide. It causes the damage of metal. This is known as Corrosion of metal. Corrosion is the process in which metals are eaten up gradually y the action of air, moisture or a chemical on their surface. Most common form of corrosion is rusting of iron.

Let us write the chemical equation for the rusting of the iron articles. Iron metal is oxidised by the oxygen of air in the presence of moisture (water) to form hydrated iron oxidised called rust.

$$\underset{\text{Iron}}{Fe} + \underset{\text{Oxide}}{O_2} \rightarrow \underset{\text{Iron oxide}}{Fe_2O_3} \quad ...(35)$$

Prevention of Corrosion of metals

- Corrosion can be prevented or at least minimized by shielding the metal surface from oxygen and moisture.
- It can be prevented by painting, oiling, greasing, galvanizing, chrome plating or making alloys.
- Galvanizing is a method of protecting iron from rusting by coating them a thin layer of Zinc.
- Alloying is also a very good method of improving properties of metal.

Rancidity.

- Rancidity is an oxidation reaction. How can we prevent the spoiling of food?
- The spoilage of food can be prevented by adding preservatives like Vitamin C and Vitamin E.
- Usually substances which prevent oxidation (Antioxidants) are added to food containing fats and oil. Keeping food in air tight containers helps to slow down oxidation process. Manufacturers of potato chips flush bags of chips with nitrogen gas to prevent the chips from getting oxidized.

Fig. 8

Fig. 9

Prevention of Corrosion Prevention of Corrosion

- By adding anti-oxidants to food containing oils.
- Fat containing food item Chips , kur curay, packets will be filled with nitrogen gas.
- Keeping food items in air tight container.
- It can be restarted by storing foods away from light.

Check your Progress

- Give some examples that you observed redox reaction in day to day life.
- What happens if do not prevent rusting of iron articles?

Key Points

- ❖ We cannot get primary substance in this reaction. This is a permanent change. This type of change is known as Chemical change.
- ❖ The symbolic representation of chemical reaction in terms of chemical formula is called Chemical Equation.
- ❖ Unbalanced chemical equation is known as skeleton equation.
- ❖ All the chemical equations must be balanced, because atoms are neither created nor destroyed in chemical reactions.
- ❖ A chemical equation in which the number of atoms of different elements on the reactant side (left side) are same as those on product side (right side) is called a balanced reaction.

- A balanced chemical equation tells us about the mass of all substances involved in a chemical reaction.
- This reaction is known as combustion reactions. In this reaction heat will be liberated. These types of reactions are known as exothermic reactions. All combustion reactions are exothermic reactions.
- In this reaction heat will be Absorbed. These types of reactions are known as endothermic reactions. Most of the chemical decomposition reactions are endothermic reactions.
- Addition of oxygen to an atom or a group of atoms or removal of hydrogen is known as oxidation. In other terms lose of electrons are also oxidation. All combustion reactions are oxidation reactions.
- This is due to the metals react with oxygen and oxidised to give its oxide. It causes the damage of metal. This is known as Corrosion of metal.
- It can be prevented by painting, oiling, greasing, galvanizing, chrome plating or making alloys.
- Galvanizing is a method of protecting iron from rusting by coating them a thin layer of Zinc.
- Alloying is also a very good method of improving properties of metal.
- Rancidity is an oxidation reaction.
- The spoilage of food can be prevented by adding preservatives like Vitamin C and Vitamin E.

Practice for Learning Outcomes

1. Write the chemical reaction for the following reaction :
   "Iron reacted with hydrochloric acid and forms Iron chloride and liberates hydrogen gas"
2. Explain chemical combination reaction with an example?
3. Write the balanced chemical double displacement reaction.
4. What information does a chemical reaction give?
5. Why do we balance the chemical reaction?
6. How can we prevent rusting?

Multiple choice Questions

7. Which of the following is a Skeleton Equation ( )

   A) $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ B) $2Mg + O_2 \rightarrow 2MgO$

   C) $2Na + Cl_2 \rightarrow 2NaCl$ D) $NH_3 + Cl_2 \rightarrow NH_4Cl$

8. Which of the following is odd one

   A) $C(s) + O_2(g) \rightarrow CO_2(g)$ B) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$

   C) $S(s) + O_2(g) \rightarrow SO_2(s)$ D) $H_2S + Cl_2 \rightarrow 2HCl + S\downarrow$

9. The spoilage of food can be prevented by ( )

   A) Adding preservatives like Vitamin C B) Adding preservatives like Vitamin E.

   C) Keeping food in air tight containers helps to slow down oxidation process.

   D) Food packets are Filled with oxygen

10. Acids reacts with metals and liberate ( )

    A) Oxygen B) Carbon dioxide C) Hydrogen D) Nitrogen

Chapter 15

Atomic Structure

Introduction

Atoms are the smallest particles of the matter. We have learnt in previous class that, matter is formed by the molecules and atoms .Before we discuss about atom and molecules, we should know about the Law of conservation of mass which states that "Matter is neither created nor destroyed during a chemical reaction" which means a given chemical substance always contains the same elements combined in a fixed proportion by mass. It is also stated in Law of constant proportions. In this, the relative proportion of elements in a compound is independent of the source or method of preparation.

- What will be the structure of atom?

The atom has structure and contains smaller constituents like electrons ,protons and neutrons which are called sub-atomic particles. In this chapter we will discuss different atomic models proposed by John Dalton, J.J.Thomson, Rutherford and Bhor's model of atom. We will learn about how these sub-atoms particles are arranged in the atoms. The study of the electronic configuration explains the properties, nature of chemical bond of the elements.

Learning Outcomes

After completing this lesson you will be able to:

- Explain the Dalton's atomic theory.
- Explain J.J.Thomson's atomic model and Rutherford's model of atom.
- Explain the Rutherford's model of atom and itsdrawbacks.
- Explain the Bhor's model ofatom.
- Explain the various rules for filling of electrons and distributions of electrons in different shells.
- Explain valancy and correlate to the electronic configuration of an atom with its valency.

15.1 Daltons atomic theory

John Dalton, an English scientist put forward his atomic theory in 1808, Daltons atomic theory was based on the law of conservation of mass and law of definite Proportions. In order to describe the structure of atom Daltonput forward atomic theory, called Daltons atomic theory.

Main postulates of Daltons atomic theory.

1. Matter is made up of very small indivisible particles called atoms.
2. We cannot creat and distroy atoms in a chemical reaction.
3. Atoms of the give element have identical mass and identical properties. Atoms of different elements different masses and different properties.
4. Compounds are formed when atoms of different elements combine in simple whole number ratio. That is chemical change is the union or seperation of atoms are in whole number.
5. When atoms of different elements combine in different whole number of ratios they form different compounds. Eg. Carbon and oxygen combine in 1 : 1 and 1 : 2 ratios respectively to give two different compounds as CO and CO_2.

Check your Progress

- Explain the postulate of Dalton's atomic model?
- What are the sub-atomatic particular present in an atom?

15.2 Electron

J.J. Thomson

Electrons are the negatively charged particles in the atom which were discovered by J.J. Thomson in 1897. The charge of the electron is 1.602×10^{-18}C and the mass is 9.1×10^{-31} kg or 0.00055 amu.

Properties of the electrons

1. Electrons travel in straight line
2. They posses kinetic energy.
3. They are attracted towards positively charged particles when they are placed in electric field.
4. Electrons cause shadow of opaque objects placed in the path.
   - In what way the sub atomic particles are arranged in atom?

To explain this on the basis of experimentation and observations different models were proposed by the Scientist to understand the structure of an atom. We shall now, learn some of the important atomic model.

15.3 J.J. Thomson's Atomc Model

J.J.Thomson proposed atomic model in 1898. This model was commonly called plum pudding model, referring to the way the fruit pieces are distributed throughout a plum-pudding. According to this model:

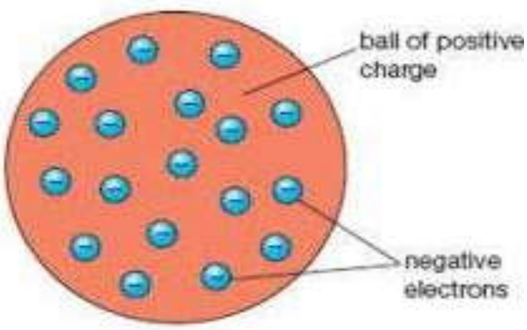


Fig. 1 Thomsons 'plum-pudding' model of the atom

1. An atom is considered as a solid sphere of uniform positive charge and electrons are embedded in it here and there to neturalise the total positive charge.
2. The total mass of the atom is considered to be uniformly distributed throughout the sphere.

3. The negative and the positive charges are supposed to balance out and the atom as a whole is electrically neutral.

Do you know

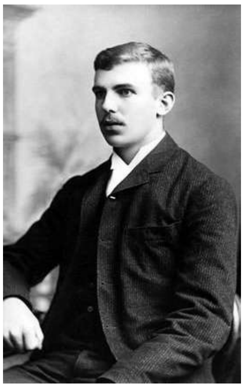
During the 1800s it became evident that electric charge had a natural unit, which could not be sub-divided any further, and name it "electron." When J.J. Thomson discovered the light particle which carried that charge, the name "electron" was applied to it.

Check your Progress

1. What is the charge of electron?
2. Explain the properties of the electrons?

15.4 Rutherfords's atomic model

The discovery of electrons energized the search for other particles in the atom. Rutherford carried out authentically by α-scattering experiment in 1911. The experiment arrangement consist of a radio active source (Polonium) that emits α-particles. A thin gold foil of about 10^4 atoms thickness and a screen coated with zinc sulphide behind the gold foil. When α-particles hit the foil, most of the alpha particles passed straight through the atoms without deflection. Some particles deflected in a small angle. Only few particles were deflected through large angles and a very small number of particles were reflected right back. By this experiment.



Rutherford

Rutherford proposed few important postulated. They are :

1. Majority portion of an atom empty.
2. All the positively charged particles in an atom form a small dense center, called "nucleus" of the atom. The electrons are not a part of nucleus.
3. **Nearly all the mass** of an atom resides in the nucleus.
4. The electrons revolve around nucleus in circular orbit.
5. The electrons revolve around the nucleus as planets revolve around the sun in the solar system. Hence, this model is also called **Rutherford's planetary atomic model.**

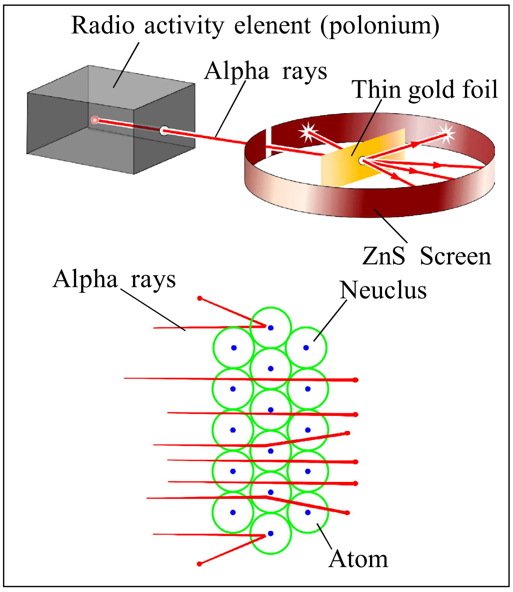


Fig - 2 : Rutherford alfa scattering

6. The size of nucleus is very very small as compared to the size of the atom.

- Do you find any defects in this model ?

Drawback of Rutherford's model of atom.

1. According to Rutherford's model of atom negatively charged electrons revolve in circular orbits around the positively charged nucleus.

   As per the Electromagnetic theory of Maxwell, if a charged particle revolves, it losses energy to accelerate around another charged particles. Then it continuously loses energy in the form of radiation. When electrons revolve around the nucleus would lose energy and finally fall into the nucleus. If it happens the atom should be highly unstable and hence the matter would not exist. we know that the atoms are quite stable.

D o You Know

Alpha particle, positively charged particle, identical to the nucleus of the helium-4 atom, spontaneously emitted by some radioactive substances, consisting of two protons and two neutrons bound together, thus having a mass of four units and a positive charge of two. Discovered and named as protons in 1899 by Ernest Rutherford.

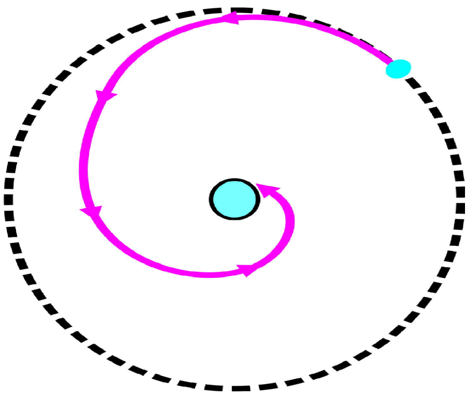


Fig - 3

Check your Progress

- What observation Rutherford did in his experiment?
- Explain the drawback of Rutherford's atomic model?

15.5 Neils Bhor's atomic model

- Why atoms are stable?
- How does the drawback of Rutherford's atomic model helped to extend the next level of the atomic model?

To overcome the drawbacks of Rutherford's atomic model of an atom Neils Bhor proposed atomic model of an atom in 1913. According to the Bhor's atomic model,

1. Electrons revolve around the nucleus of an atom in a fixed path called "orbit" of"shell".

2. Electrons in each shell have definite energies. These shells are also called energy levels. As long as the electrons revolve in a particular orbit, its energy remains constant. Therefore these orbits are called stationary orbits.

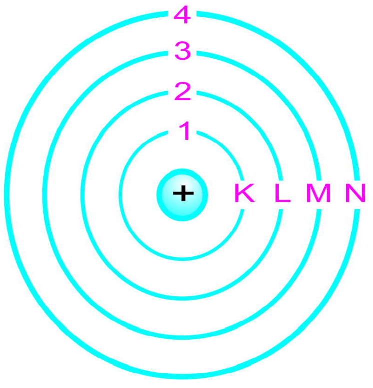


Fig - 4

3. These orbits or shells are represented by the letters K, L, M, N ………… or the numbers n = 1, 2, 3, 4,…….
4. Electron can change its shell or energy level by absorbing or releasing energy.
5. An electron at a lower energy state E_1 can go to a higher energy level E_2 by absorbing energy (consider here E_1, E_2, E_3, ... are energies of the orbits)

   $E_2 - E_1 = h\upsilon$

   (Where 'h' is Plank's constant and 'υ' is frequency of radiation)

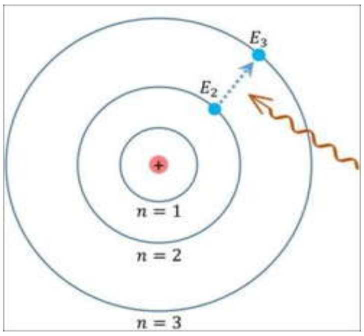


Fig - 5

Drawbacks of the Bhor's Atomic Model:

1. This model could be able to explain only hydrogen atomic model having single electron atom. But could not be able to explain atomic spectrum of atoms with more than one electron.
2. When hydrogen spectrum lines kept in high resolution spectroscopy, observed splitting into sub lines in groups. This is called "Zeemen effect". Bhor's model failed to explain "zeeman effect".

Check your Progress

- What happens when one electron jumps from lower energy level to higher energy level?
- n = 3, 4, 5 then write the principle shell names respectively?

15.6 Discovery of Neutrons

- Is any other sub atomic particle in atom? If so what is the charge of the particle and location of the particle?

In 1932, James Chadwick discovered another subatomic particle in atom which has no charge but mass nearly equal to that of a proton. It was named as neutron. Neutrons are present in the nuclei of all atoms, except protium. In general, a neutron is represented as ‘n’. The mass of an atom is the sum of the masses of protons and neutrons present in the nucleus. Mass contributed by electron to the atom is generally negligible. The discovery of neutron is lead to explain the drawn back of Bhor atomic model.

Characterstics of the fundamental subatomic particles

Particles	Symbol	Mass (in kgs)	Actual charge (in Coulombs)	Relativecharge
Electrons	e	$9.109\ 389 \times 10^{-31}$	$1.602\ 177 \times 10^{-19}$	-1
Protons	p	$1.672\ 623 \times 10^{-27}$	$1.602\ 177 \times 10^{-19}$	1
Neutorns	n	$1.674\ 928 \times 10^{-27}$	0	0

15.7 Distribution of Electrons in different Orbits and Electonic configuration

Electrons move around the nucleus of atom in various shells. Electrons in different shells have different energies. Each shell is represented by ‘n’ which is known as a shell number or energy level number. The shell closest to the nucleus (and has the lowest energy) is called the K- shell (n = 1), the shell farther away (and has higher energy than K-shell) is called the L-shell (n = 2), etc. Similarly other shells are denoted as (M, N,)

- How many electrons can be accommodated in each shell of an atom?
- Can a particular shells have just one electron?
- What is the criteria to deciding number of electrons in a shell?

After explaining the structure of atom with different atomic models, scientists started describing the distribution of electrons in different energy levels or shells of an atom. Bohr and Bury proposed the following rules for electron distribution in the shells.

Rule 1 : The maximum number of electrons present in a shell is given by the formula $2n^2$, where ‘n’ is the shell number or energy level number, which takes values 1, 2, 3…. The maximum number of electrons that can be accommodated in each shell is shown in the table

Value of n	Shell name	Maximum capicity
1	K-Shell	2
2	L-Shell	8
3	M-Shell	18
4	N-Shell	32

Rule 2 : Each energy level or electron shell is further divided into subshells. The maximum number of electrons in the outermost shell is 8.

Rule 3 : Electrons cannot be filled in a given shell unless the inner shells completely filled, i.e., shells are filled in stepwise manner.

Let us take an example of oxygen (Z = 8). As number of protons are equal to number of electrons. So, it contains eight electrons.

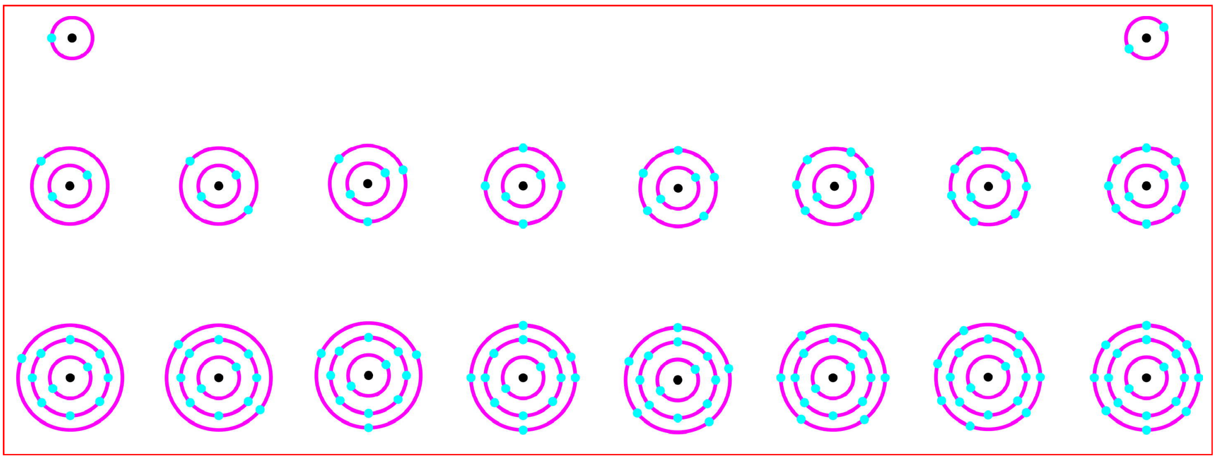
Step 1 : Maximum 2 electrons can be filled in k shell (n = 1) so 2 electrons filled in n = 1.

Step 2 : The other 6 electrons will be filled in the higher shell n = 2 or the L-shell

Step 3 : Then, the electronic configuration for oxygen atom is 2, 6.

Arrangement of electrons for the first eighteen elements is shown schematically in given figure

Bohr -Bury rule for distribution of electrons in an atom



Arrangement of electrons for the first eighteen elements

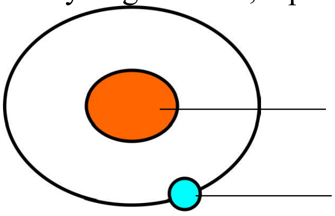
Atomic Number

"The number of protons present in the nucleus of the atom is called atomic number of the element". It is represented by letter "Z". all the atoms of the same element contains same number of protons. Protons are positive by charged particles. To neutralize the positive charge electrons are present and revolve around the nucleus. The number of electrons are equal to the number of protons.

Atomic number of an element (Z) = Number of protons present in its atom's nucleus.

= Number of electrons present in atom's nucleus.

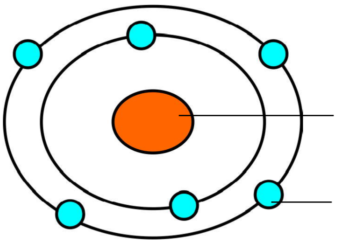
For example in Hydrogen atom , 1 proton is present in its nucleus.



Hydrogen

The atomic number of hydrogen is (Z) = 1

In carbon atom, 6 proton are present in its nucleus.



carbon atom

The atomic number of carbon is (Z) = 6

Activity-1

Observe the following table. In the table some elements are given .Fill up the blanks.

Table - 1

S.No	Name of the element	Number of protons present in its nucleus	Number of electrons present in its atom.
1	Sodium	11	
2	Zinc		30
3	Chlorine		17
4	Potassium	19	
5	Calcium		20
6	Nitrogen	7	

Atomic mass Number

In the atom protons are present in the nucleus.

- Are these any other fundamental particles present in the nucleus of the atom?
- What are they?

  In addition to protons, the nuclei of atoms also contain neutrons.

Protons and neutrons are present in nucleus and they are commonly known as nucleons. In some elements number of protons and neutrons are equal, but in some elements vary.

The sum of the numbers of protons and neutrons (nucleons) is known as **"Mass Number"** of the atom

Mass number is represented by the letter "A" of that element.

Mass number (A) = Number of protons (P) + Number of neutrons (N)

= Atomic number (Z) + Number of neutrons (N)

A = Z + N

Let us find the mass number of some elements

Eg.1 - Hydrogen.

Number of protons (P) or atomic number (Z) = 1

Number of neutrons (N) = 0

Mass number "A" = Z + N

Mass number of hydrogen = 1+0= 1

Do you know?

In hydrogen atom only one proton is present. There is no neutron in it.

Eg.2. Magnesium

Number of protons (P) or atomic number (Z) = 12

Number of neutrons (N) = 12

Mass number "A" = Z + N

Mass number of magnesium = 12+12 = 24

Activity-2

Observe the following table. In the table some elements are given .Fill up the blanks.

Table - 2

S.No	Name of the element	Number of protons present in its nucleus (P)	Number of electrons present in the atom (P)	Number of Nuetrons present in the atom (N)	Atomic number (Z)	Mass number (A)
1	Silicon	14		14		
2	Zinc			35	30	
3	Sulphur				16	32
4	Iron			26		54
5	Fluorine		8	9		
6	Sodium		11			23

By convention atomic number is written at the bottom of left corner of the symbol of the atom of a particular element and mass number is written at the top left corner. For example, symbol

$^{12}_{6}C$ indicates that there is a total of 12 particles (nucleons) in the nucleus of a carbon atom, 6 of which are protons. Thus, there must be 12-6 = 6 neutrons.

Similarly $^{16}_{8}O$ indicates 8 protons and 16 nucleons (8 protons + 8 neutrons). Since atom is electrically neutral, oxygen has 8 protons and 8 electrons in it. Further, atomic number (Z) differentiates the atom of one element from the atoms of the other elements.

An element may be defined as a substance where all the atoms have the same atomic number.

But the nuclei of all the atoms of a given element do not necessarily contain the same number of neutrons. For example, atoms of oxygen, found in nature, have the same number of protons which makes it different from other elements, but their neutrons (in nucleus) are different. This is the reason that the masses of atoms of the same element are different. For example, one type of oxygen atom $^{16}_{8}O$ contains 8 protons and 8 neutrons in one atom, second type i.e., $^{17}_{8}O$, 8 protons and 9 neutrons and the third type $^{18}_{8}O$ contains 8 protons and 10 neutrons. We represent these oxygen atoms as $^{16}_{8}O$, $^{17}_{8}O$, $^{18}_{8}O$ and respectively.

Atoms of an element that have the same atomic number (Z) but different mass number (A) are called isotopes.

Applications of isotopes

- The $^{235}_{92}U$ isotope of uranium is used as a fuel in nuclear reactors.
- The isotope of iodine is used in the treatment of goitre (thyroid).
- The isotope of cobalt is used in the treatment of cancer.

Check your Progress

- The Atomic number of chlorine is 17. Find the number of electrons present in chlorine atom?
- The mass number of an element X is 27, electrons present in that element is 13. Find number of protons, neutrons and atomic number of the of the element and also write the name of the element.

15.8 Activity - 1

Observe the following table and complete the empty boxes:

Name of element	Symbol	Atomic number	Number of protons	Number of neutrons	Number of electrons	Distribution of electrons				Valency
						K	L	M	N	
Hydrogen	H	1		-		1	-	-	-	
Helium	He	2	2	2		2	-	-	-	0
Lithium	Li		3	4		2	1	-	-	
Berilium	Be	4	4	5		2	2	-	-	2
Boran	B	5		6		2	3	-	-	
Carbon	C		6	6		2	4	-	-	
Nitrogen	N		7	7		2	5	-	-	
Oxygen	O		8	8		2	6	-	-	
Fluorine	F	9		10		2	7	-	-	
Neon	Ne	10		10		2	8	-	-	0
Sodium	Na	11		12		2	8	1	-	
Magnesium	Mg		12	12		2	8	2	-	
Aluminium	Al		13	14		2	8	3	-	
Silicon	Si		14	14		2	8	4	-	4
Phosphorus	P	15		16		2	8	5	-	5.3
Sulphur	S	16		16		2	8	6	-	2.6
Chlorine	Cl	17		18		2	8	7	-	1
Argon	Ar		18	22		2	8	8	-	0

Check your Progress

- Write any two bivalent elements?.
- Mention the zero valence elements?
- Draw the diagram showing the arrangement of electrons in the orbitals of sulphur and beryllium.
- What is the electronic configuration of chlorine (Cl)?

Key Points

❖ According to Dalton's atomic theory, the atom is considered to be the smallest indivisible constituent of all matter. This theory could explain the of conservation of mass, law of constant composition and law of multiple proportions. The atom is made up of even smaller particles called electrons, protons and neutrons.

❖ Sir J.J.Thomson discovered cathode rays. It showed that the rays were made up of a stream of negatively charged particles called electrons. The discovery of electrons meant that the atom is not indivisible as was believed by Dalton and others.

- According to Rutherford's atomic model an atom contains a dense and positively charged region called nucleus at its centre and the negatively charged electrons move around it.
- The Rutherford's model however failed as it could not explain the stability of the atom.
- According to Neils Bhor's atomic model electrons revolve around the nucleus of an atom in fixed path called "orbit" or "shells" Electrons in each shell have definite energies. These shall are also called energy levels. As long as the electrons revolving in the particular orbit, its energy remains constant. Therefore these orbits are called stationary orbits. These orbits or shells are represented by the letters K, L, M, N ………… or the numbers n = 1, 2, 3, 4,…….

  Electrons can change its shell or energy level by absorbing or releasing energy.
- In 1932. James Chadwick discovered an electrically neutral particle in atom and named it as **neutron.**
- The maximum number of electrons Present in a shell is given by the formula $2n^2$' where 'n' is the shell number or energy level number, which takes values 1, 2, 3…. The maximum number of electrons that can be accommodated in each shell is '8' the penultimate shell contains maximum of 18 element.

Practice for Learning Outcomes

1. Explain the main feature of the Dalton's atomic model ?
2. Mentions the characteristics of the sub-atomic particular in the atom.
3. Mention any two features the atomic model of J.J.Thonsom ?
4. Draw the diagram of J.J.Thomson's plum pudding model of an atom
5. Give any four postulate of Rutherford's atomic model of an atom ?
6. Mention the drawback of Rutherford's atomic model of an atom?
7. Draw the diagram of α-scattering experiment which leads the discovery of protons?
8. Explain the postulates and limitations of Neils Bhor atomic model ?
9. Explain the rules proposed by Bhor-Bury for electron distribution in an atom ?
10. What is the electronic configuration of oxygen and sodium?

Multiple Choice Questions

11. The discovery of electrons is made by ( )
    A) Goldstein B) Thomson C) Chadwick D) Stoney
12. How many electrons can be accommodated in M-Shell ( )
    A) 2 B) 8 C) 18 D) 32
13. The electronic configuration of Fluorine (F) ( )
    A) 2, 8, B) 2, 6 C) 2, 7 D) 2,8,1
14. What are the sub atomic particles present in the nucleus ( )
    A) electrons B) electrons and protons
    C) protons D) protons and neutrons

Periodic Classification of Elements

Chapter 16

Introduction

If you go to a grocery shop and ask any item, what the shopkeeper is doing? Is he searching the total shop for item or directly going to the item and bringing that?

If you go to a medical shop for any medicine where hundreds of medicines are there, is that person directly going to that medicine or searching for the medicine?

Similarly, if you go to a super market, how the items of the shop are arranged?

How it is possible to the shop person to bring the items by directly going to them? It is possible due to the arrangement of the items in a systematic manner. By that arrangement they are easily remembering the place of items. The arrangement is called classification.

From the above observations you understand that for any system involving several things, a particular order of arrangement of those things is essential. Even in chemistry, from the earliest times, scientists have been trying to classify the available elements in to a limited number of groups on the basis of their properties.

Learning Outcomes

After completing this lesson you will be able to:

- Describe briefly about the classification of elements
- State the Modern periodic law
- Explain the modern classification of elements
- Explain the characteristics of long form of periodic table
- Explain the variation of atomic size, metallic nature, non-metallic nature, ionization energy, electron affinity across the period and group of the periodic table.

16.1 Classification of elements

16.1.1 Need for the classification of elements:

In the beginning of 18^{th} century, only a few elements were known. So, it was quite easy to study and remember the properties of those elements and then compounds formed by those elements.

By the middle of 19^{th} century, more elements had been discovered. And also, the compounds formed by those elements increased enormously. So, it became more difficult to study and remember their properties.

By now, including synthetic elements, there are more than 118 elements. As the number of elements increased, it became difficult to keep in memory the properties of individual elements and their compounds.

The elements are classified in metals and non-metals. For example sodium, potassium, etc. are metals and sulphur, chlorine are non-metals. But this classification had so many limitations. Aluminium has some metallic properties and some non-metallic properties. Elements of this type are considered as metalloids or semi metals. So, there was a need to classify them in still better ways. Hence, chemists started to frame ways to group the elements and compounds on the basis of their physical and chemical properties.

Dobereiner's Triads

In 1829 a German chemist J.W. Dobereiner, based on the atomic weight arranged the elements into groups of three elements each. They are called 'triads'. This is known as 'Dobereiner law of triads'.

J.W. Dobereiner
(1780-1849)

According to this law, "when three elements with similar properties are arranged in order of increasing atomic weights, the atomic weight of the middle element was nearly equal to the arithmetic mean of the atomic weights of other two elements". Few elements only can be arranged into triads.

Examples of Dobereiner triads:

1. Lithium (A=7), Sodium (A=23), Potassium (A=39)

   Atomic weight of sodium = (23+39) / 2 = 23 U.

   It is equal to sodium atomic weight.

2. Chlorine (A = 35.5), Bromine (A = 80), Iodine (A = 127)

   Atomic weight of bromine = (35.5 + 127) / 2 = 162.5/2 = 81.25 U.

   It is approximately equal to bromine atomic weight.

Newlands' Law of Octaves:

In 1864, an English chemist John Alexander Newlands arranged the elements in the increasing order of their atomic weights and observed that every eighth element had the properties similar to the first element.

Though there are several drawbacks in the classification this law recognized the periodicity of properties for the first time.

The law of octaves states that when elements are arranged in the ascending order of their atomic weights they fall into a pattern in which their properties repeat at regular intervals. Every eighth element starting from a given element resembles in its properties to that of the given element. Elements with similar chemical properties are to be present along a horizontal row.

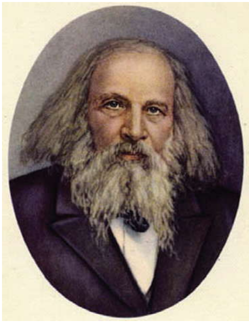
Arrangement of some elements with their atomic masses according to the Law of Octaves.

Element	Li	Be	**B**	C	N	F	Na	Mg	Al	Si	P	S	Cl	K	Ca
Atomic weight	7	9	11	12	14	19	23	24	27	28	31	32	35.5	39	40

According to this law every eighth element Li, Na and K are having same properties.

Mendeleev's Classification

In 1869 a Russian scientist D'mitri Mendeleev proposed a law based on his observations on classification of elements which is known as Mendeleev's periodic law. It states that, **"The chemical and physical properties of elements are a periodic function of their atomic weights (or atomic masses)".**



D. Mendeleev (1834-1907)

Main Features of Mendeleev's Periodic Table

The following are the main features of this periodic table :

1. The elements are arranged in **rows** and **columns** in the periodic table.
2. The horizontal rows are called periods. There are six periods in the periodic table.
3. These are numbered from 1 to 6 (Arabic numerals). Each one of the 4th, 5thand 6th periods have two series of elements.
4. Properties of elements in a given period show regular gradation (*i.e.* increase or decrease) from left to right.
5. The vertical columns present in it are called **groups**. There are eight groups numbered from **I** to **VIII** (Roman numerals).
6. Groups I to VII are further divided into A and B **subgroups**. However, group VIII contains three elements in each of the three periods.
7. All the elements present in a particular group are chemically similar in nature.
8. They also show a regular gradation in their physical and chemical properties from top to bottom.

Limitations of Mendeleev's periodic table

1. **Anomalous pair of elements:** Certain elements of highest atomic weights precede those with lower atomic weights.

   For example, *tellurium* (atomic weight 127.6) precedes *iodine* (atomic weight 126.9).

2. **Dissimilar elements placed together:** elements with dissimilar properties were placed in same group as sub-group A and sub-group B.

   For example, alkali metal like Li, Na, K etc., of IA group have little resemblance with coinage metals like Cu, Ag, Au of IB group. *Cl* is of VII A group and 'Mn' is of VII B, but chlorine is a non metal, where as manganese is a metal.

The attempts made to accommodate the newly discovered elements in the periodic table and to overcome the limitations of the Mendeleev's periodic table. These attempts led to the formation of Modern periodic table (also called as Long form of periodic table). Let us know about it.

Check your Progress

- Who proposed the law of triads?
- Explain the role of Mendeleev in the classification of elements.
- What is periodicity? State the Mendeleev's periodic law.

16.2 Modern periodic law

In 1913, an English Physicist Henry Mosley found that, in the classification of elements, the atomic number is the most fundamental property not the atomic weight.

Atomic number(Z) of an element is the number of protons in the nucleus of its atom or the number of electrons present in the atom of that element.

After knowing the atomic numbers of elements, it was recognized that a better way of arranging the elements in the periodic table is according to the increasing atomic number. This arrangement eliminated the problem of anomalous series. For example, though tellurium (Te) has more atomic weight than iodine (I), it has atomic number less by one unit compared to iodine. This atomic number concept forced the periodic law to be changed.

Modern periodic Law:

"It states that, the chemical and physical properties of elements are periodic functions of their atomic numbers".

Based on the modern periodic law, the modern periodic table is proposed. It is the extension of the original Mendeleev's periodic table known as short form of the table and this modern table is called the long form of the periodic table. Atomic number of an element (Z) indicates not only the positive charges i.e., the protons in the nucleus of the atom of the element but also the number of electrons in the neutral atom of that element.

The physical and chemical properties of atoms of the elements depend not on the number of protons but on the number of electrons and their arrangements (electronic configurations) in atoms. Therefore, the modern periodic law may be stated as "The physical and chemical properties of elements are the periodic functions of the electronic configurations of their atoms."

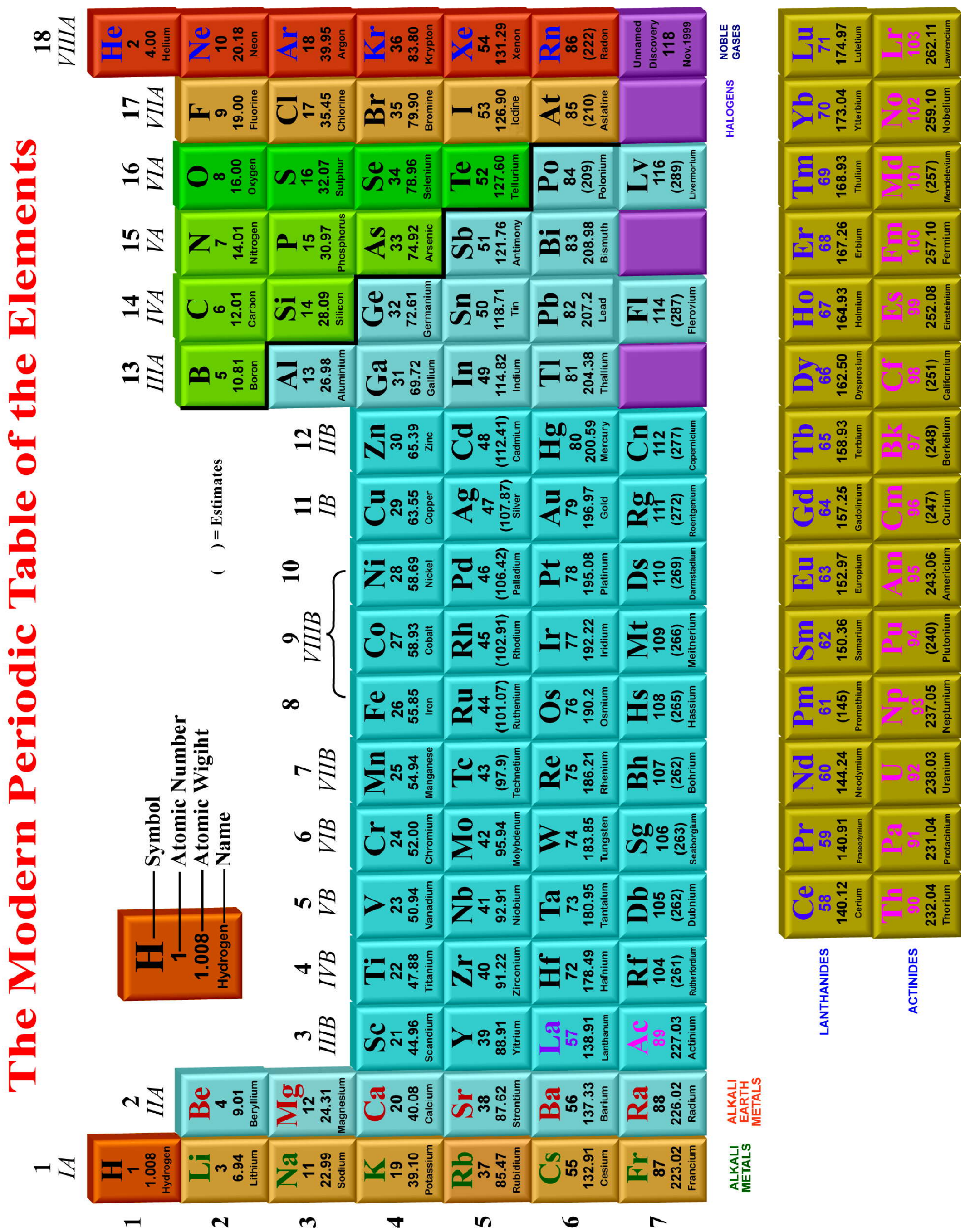
16.3 Modern Periodic Table

The periodic table of elements prepared by using the modern periodic law is known as 'Modern periodic table'. The presently accepted periodic table is called 'Long form of periodic table'.

16.3.1 Features of Long form of Periodic Table

The long form of periodic table is based on atomic number, which is also the number of electrons. The elements in the periodic table arranged on the basis of electronic configuration.

As already we discussed, periodic table contains rows and columns. The rows are called periods and columns are called groups or family.



Groups:

There are 18 columns in long form of periodic table. That means there are 18 groups in the periodic table. They are given Hindu-Arabic numbers from 1 to 18.

Observe the group 2 elements in the following table.

Group – 2 Elements	
Element	**Electronic Configuration**
Be	2, 2
Mg	2, 8, 2
Ca	2, 8, 8, 2
Sr	2, 8, 8, 18, 2

After observing the above table, we can say that

- The electronic configuration of all the elements in the group is similar.
- The number of valence electrons of all elements of the group is same.
- As we move from top to bottom in the group the number of orbits increasing.

Based on the special features of elements names are given to some groups. For Ex. The name 'Alkali metals' to Group 1 elements, 'Alkaline earth metals' to Group 2 and 'Halogens' to Group 17 elements.

Periods:

There are 7 rows in long form of periodic table. That means there are 7 periods. They are given Hindu-Arabic numbers from 1 to 7.

Observe the 2nd period elements in the following table.

2nd period elements								
Element	Li	Be	B	C	N	O	F	Ne
AtomicNumber	3	4	5	6	7	8	9	10
ElectronicConfiguration	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8

After observing the above table, we can say that

- The elements in a period have consecutive atomic numbers.
- A new orbit starts in the first element of the period and that orbit fills as we go to the end of the period. (Here the second orbit is starting in Li and it filled in Ne, the last element of the period).
- In every element of the period, the number of the orbits is equal to the period number. (Every element of the second period has two orbits).

When we observe the periodic table

- There are **two elements** in the first period. It is very short period.
- There are **eight elements** in second and third period each. These are short periods.
- There are **eighteen elements** in fourth and fifth period each. These are long periods.
- Sixth and seventh periods are very long periods. But sixth period has 32 elements and seventh period is incomplete.

16.3.2 Types of Elements:

1. **Noble Gases:** In long form of periodic table, the right last group (group 18) elements are called Noble gases. These are He, Ne, Ar, Kr, Xe and Rn.

   The outer most orbit of 'He' have 2 electrons and the remaining Noble gases outermost orbit contains 8 electrons.
   These are inert. The valency of these gases is zero.

2. **Representative or Main group elements :** In the long form of periodic table, the left side groups 1,2 and right-side groups 13 to 17 elements are called Representative or Main group elements. These elements have outer most orbits, which are not completely filled. They have less than 8 electronsin the valency shell.

3. **Transition elements :** These elements are present in the middle of the long form of periodic table, from group 3 to group 12. Among the representative elements and noble gases the newly joining electron will enters into the outer most orbit. But in these transition elements, that electron will join the incomplete last but one orbit. So, in the transition elements, there are two incomplete orbits, the outermost and the penultimate.

   The reason for naming these elements as Transition elements is, they show a transition from most electro positive to more electro negative character among the elements.

   Transition elements

4. **Inner Transition elements :** These are arranged in two rows at the bottom of the periodic table. All these elements should be as a part of the Transition elements in side the long form of periodic table only. (The first-row Inner transition elements should be in 6^{th} period under 3^{rd} group all at one place and second row elements should be in 7^{th} period under 3^{rd} group all at one place).

   But for our convenience we show them as two separate rows at the bottom of the periodic table. These are also called lanthanoids and actinoids.In these Inner transition elements, the last three outer most orbits are incomplete.

Lanthanoids: The elements from 58^{th} element **'Ce'** to 71^{st} element **'Lu'** are called lanthanoids. These are first row elements of the inner transition elements.

Actinoids: The elements from 90^{th} element **'Th'** to 103^{rd} element **'Lr'** are called actinoids. These are second row elements of the inner transition elements.

16.3.3 Metallic nature of the elements:

As per the metallic nature of the elements of the periodic table, we can divide them as follows.

Metals: These are present on the left side of the periodic table. The elements present in group 1 and group 2 are strong metals.

Group 1 elements are Alkali metals. They are Li, Na, K, Rb, Cs and Fr.

Group 2 elements are Alkaline Earth metals. They are Be, Mg, Ca, Sr, Ba and Ra.

Non-metals: These are present on the right side of the periodic table. The elements present in group 16 and group 17 are strong non-metals.

Group 16 elements are Chalcogens. They are O, S, Se, Te and Po.

Group 17 elements are Halogens. They are F, Cl, Br, I and At.

Metalloids: These elements show mixed properties of both metals and non-metals. They are present along the diagonal line starting from 13^{th} group Boron to 16^{th} group Polonium.

Check your Progress

- What is the difference between the Mendeleev and Modern periodic law?
- Write about the groups and periods of the Modern periodic table.
- Mention the types of elements of the periodic table and explain them.
- According to metallic nature, the elements are how many types? What are they?

16.4 Periodic trends in properties

When we discussed about periodic law, we come across periodicity. Periodicity means one property repeats itself in certain intervals. Let us see the periodicity in the periodic table by taking some properties.

16.4.1 Atomic size:

Among the properties of the elements, the atomic size is very important. The other properties are based on this.

Atomic radius of an element is not possible to measure in its isolated state. This is because it is not possible to determine the location of the electron that surrounds the nucleus.

"Atomic size of an element is the distance between the centre of the nucleus and the outermost shell of it atom". It is measured in pico meters(pm).

$$1 \text{ pm} = 10^{-12} \text{ m}$$

Variation in a period: You learnt that, in all elements of a period same number of orbits will present and as we move from left to right the atomic number increases consecutively.

Due to this, the positive charge on the nuclei of the elements gradually increases. Due to this as we move from left to right the electrons will be attracted by the nucleus with a greater force and they move some what near to the nucleus.

By having same number of orbits and the electrons are attracted by nucleus strongly, the atomic size decreases gradually as we move from left to right in the period of the periodic table.

The atomic radii of the elements of 2^{nd} period are given below. (in pico metres)

Element	Li	Be	B	C	N	O	F
Atomic number	3	4	5	6	7	8	9
Atomic size or radius (pm)	152	111	88	77	74	66	64
Atomic Size							

Variation in a group : We know that as we move from top to bottom of a group, one new orbit is being added to every element. As a result, the distance from nucleus to outer most orbit is increasing. So, the atomic size is gradually increasing from top to bottom of a group of the periodic table.

The atomic radii of the elements of 1^{st} group are given below. (in pico metres)

Element	**Atomic number**	**Atomic size or radius**
Li	3	152
Na	11	186
K	19	231
Rb	37	244
Cs	55	262

Here, the discussed variations are applicable to every period and every group.

16.4.2 Ionization Energy

In any certain situation, if we want to remove one electron from the atom, we require energy.

The energy required to remove an electron from the outer most orbit or shell of a neutral gaseous atom of an element is called **ionization energy**.

Ionization energy is measured in **kJ/mol.**

Variation in a period: As we move from left to right in a period, the atomic size or radius decreases. So, it requires more energy to remove electron, due to strong attraction of nucleus over electron. So, the Ionization energy increases from left to right in a period of the periodic table.

The Ionization energy of second period elements are given below. (in KJ/mol)

Element	Li	Be	B	C	N	O	F	Ne
Ionization Energy	520.2	899.5	800.6	1086.5	1402.3	1313.9	1681	2080.7

Variation in a group: As we go from top to bottom in a group, the atomic size is increasing. So, it requires less energy to remove electron, due to decrease in the attraction between the nucleus and outer most electrons. So, the ionization energy decreases from top to bottom in a group of the periodic table.

The ionization energy of second group elements are given below. (in KJ/mol)

Element	Ionization energy
Be	899.5
Mg	737.7
Ca	589.8
Sr	549.5

16.4.3 Electron affinity

The energy liberated when an electron is added to neutral gaseous atom of an element is defined as Electron Affinity of the element.

Variation in a period: As we go from left to right in a period, due to decrease in the atomic size, the electron affinity increases from left to right in every period.

Variation in a group: As we go from top to bottom in a group the atomic size increase. So, the electron affinity decreases from top to bottom in every group.

16.4.4 Electronegativity

The electronegativity of an element is defined as the relative tendency of its atom to attract electrons towards itself when it is bonded to another atom.

In the elements of the periodic table, the most electronegative element is 'F' and the least electronegative element is 'Cs'.

Variation in a period: As we go from left to right in a period, the atomic size is decreasing. So due to more attraction of nucleus the tendency of the atom to attract electrons increases. So, as we move from left to right in a period electronegativity increases.

Variation in a group: As we go from top to bottom in a group, the atomic size is increasing. So, the tendency of the atom to attract the electrons decreases. So, as we move from top to bottom in a group electronegativity decreases.

16.4.5 Metallic and Non-metallic character

The tendency of element to lose electrons to form cation is called metallic (electropositive) character.

The tendency of element to accept electrons to form anion is called non-metallic (electronegative) character.

Variation in a period: As we go from left to right in a period, the metallic character decreases and the non-metallic character increases.

Metallic character of 3rd period elements shown below.

Element	Na	Mg	Al	Si	P	S	Cl
Nature	Metal	Metal	Metal	Metalloid	Non-Metal	Non-Metal	Non-Metal

Variation in a group: As we go from top to bottom in a group, the metallic character increases and non-metallic character decreases.

Metallic character of group 14 elements shown below.

Element	Nature
C	Non-Metal
Si	Metalloid
Ge	Metalloid
Sn	Metal
Pb	Metal

Key Points

- First, the classification of elements was based on atomic weight (atomic mass).
- Based on atomic weight Dobereiner formed triads (group pf three elements).
- Newlands arranged the elements in ascending order of the atomic weights of the elements and observed periodicity for the first time.
- In 1869 D'mitri Mendeleev formulated a table of elements by proposing a periodic law. That table is called Mendeleev's periodic table.
- Mendeleev's periodic table of elements having rows and columns, which are called as periods and groups respectively.
- Mosley proposed that atomic number is most fundamental property, not the atomic weight and changed the periodic law. That law is called modern periodic law.
- Based on the modern periodic law, the modern periodic table is formed. Now the accepted table is called as long form of periodic table.
- Long form of periodic table is having 7 period (1to7) and 18 groups (1 to 18).
- The properties of elements like atomic size, ionization energy, electronegativity, electron affinity etc. are showing the periodicity over the period and group in the periodic table.
- Atomic size decreases across the period from left to right and increases in a group from top to bottom.
- Ionization energy increases in a period and decreases in a group.
- Electronegativity increases in a period and decreases in a group.
- Electron affinity increases in a period and decreases in a group.
- In a period from left to right metallic nature decreases and non-metallic nature increases.
- In a group from top to bottom metallic nature increases and non-metallic nature decreases.

Practice for Learning Outcomes

1. State modern periodic law.
2. Mention the names of the Noble gases.
3. How many orbits are incomplete in Actinoids?
4. Which period is the very short period in the periodic table? How many elements are present in that period?
5. How the ionization energy is changing in a group?
6. Based on the metallic nature, how many types of elements are there in the periodic table? What are they?
7. Write about Mendeleev's classification briefly.
8. Explain with reason, how the atomic size is changing in a period.
9. Explain the types of elements of the periodic table.
10. Write about the variation of metallic nature of the elements in the periods and groups of the periodic table.

Multiple Choice Questions

11. First periodic table is based on
    (A) Atomic size B) Atomic weight
    (C) Atomic number (D) Metal nature
12. The 'law of octaves' was given by
    (A) Mendeleev (B) Newlands (C) Lother Meyer (D) Doberiener
13. The element with atomic number 16 belongs to the period
    (A) 2 (B) 3 (C) 4 (D) 5
14. Among the third period elements, the strong metal is
    (A) P (B) Na (C) Al (D) Cl
15. The atomic radius is measured in the units of
    (A) cm (B) mm (C) pm (D) nm
16. Who proposed that, atomic number is the fundamental property rather than atomic weight
    (A) Mendeleev (B) Newlands (C) Mosley (D) Doberiener
17. The number of orbits present in an element of a period is equal to
    (A) number of the group to which it belongs to
    (B) number of the period to which it belongs to
    (C) sum of the number of the period and group to which it belongs to
    (D) we can not say by using the period or group number

Chapter 17

Chemical Bonding

Introduction

We see various substances around us which are either elements or compounds. You also know that atoms of the same or different elements may combine. When atoms of the same elements combine, we get molecules of the elements. But we get compounds when atoms of different elements combine.

- Have you ever thought why atoms combine at all?
- You know about the elements and the atoms present in them.
- We require oxygen gas to live.
- Is it in the form of atoms?
- When we feel thirsty we drink water. Is the water an element?
- In the photosynthesis process, the trees absorb carbon di oxide. Is it an element?
- If the water and carbon di oxide are not the elements, then what are they?
- They are called compounds. What are the basic units of compound? The basic units of compound are the molecules.
- The molecules of those compounds are formed from the atoms of elements. How do the atoms of the elements combine? How the atoms of different elements combine to give the molecules of compounds?

We will first explain what a chemical bond is and then discuss various types of chemical bonds which join the atoms together to give various types of substances. The discussion would also highlight how these bonds are formed. The properties of substances depend on the nature of bonds present between their atoms.

Learning Outcomes

After completing this lesson you will be able to:

- Understand and explain the reason for bonding of the atoms.
- Understand and explain the formation of chemical bond.
- Understand the different types of chemical bonds.
- Explain the types of chemical bonds
- Explain the properties of the compounds formed by different types of the chemical bonds.

17.1 Chemical Bonding

It was believed that electrostatic forces were the cause of attraction between atoms in a molecule. When two atoms come sufficiently close together, the electrons of each atom experience the attractive force of the nucleus of the other atom. But the electrons which are negatively charged repel each other, and the positively charged nuclei also repel each other. The strength of attraction or repulsion will decide bond formation. If attraction is more than the repulsion then atoms combine. If repulsion is more than attraction then the atoms do not combine. The nucleus and the electrons in the inner shell remain unaffected when atoms come close together. But the electrons in the outermost shell (valence shell) of atoms get affected. Electrons in valence shell (valence electrons) are responsible for the formation of bonds between atoms.

Why Do Atoms Combine?

When we observe the periodic table, the 18^{th} groups elements are called Noble Gases. They are inert. They did not react with other elements to form compounds i.e. they were non -reactive. In the initial stages they were also called inert gases due to their non-reactive nature. Thus it was, thought that these noble gases lacked reactivity because of their specific electronic arrangements which were quite stable. When we write the electronic configurations of the noble gases we find that except helium all of them have 8 electrons in their outermost shell.

Electronic configuration of Noble gases

Table - 1

Atomic number	Name of the element	Symbol	Electronic configuration	Number of electrons in outermost shell
2	Helium	He	2	2
10	Neon	Ne	2, 8	8
18	Argon	Ar	2, 8, 8	8

Activity-1

Observe the modern periodic table. Write other three noble gases name and fill the table.

Table - 2

Atomic number	Name of the element	Symbol	Electronic configuration	Number of electrons in outermost shell

- Have you noticed anything from the electronic configuration?
- What is your observation?

17.1.1 Octet Configuration

You might have noticed that except helium all other elements have 8 electrons in its outer most orbital. So they are most stable elements in the periodic table. It was also observed that other atoms such as hydrogen, sodium, chlorine etc. which do not have 8 electrons in their outermost shell undergo chemical reactions. They can stabilize by combining with each other and attain the above configurations of noble gases i.e. 8 electrons in their outermost shells. Thus, atoms tend to attain a configuration in which they have 8 electrons in their outermost shells. This is the basic cause of chemical bonding. This attainment of eight electrons for stable structure is called the **octet rule**. The octet rule explains the chemical bonding in many compounds.

17.1.2 Lewis dot structures (or) Lewis symbols.

The arrangement of electrons in different shells of atoms (electronic configuration) of 18th group elements given in the table-1.The valence electrons in the atom of an element are depicted in a short form by *Lewis symbol* or *electron dot structure*. We represent the nucleus and inner shell electrons of the atom by the symbol of the element and electrons in the outer shell by dots or cross marks. Let us see how?

Lewis dot structure of **neon** and **oxygen** atoms are written.

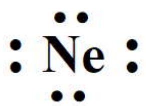
Neon.

Neon symbol is ‘Ne’.

Its atomic number is 10.10 electrons present in its orbitals. Its electronic configuration is 2,8

First write the symbol of element ***Neon***. **‘Ne’**

Place the 8 valence electrons around the symbol : Put two dots at a time on each of the four sides of the symbol of the element till all are used up. So, we get,



Oxygen.

Oxygen symbol is ‘O’.

Its atomic number is 8.8 electrons present in its orbitals. Its electronic configuration is 2,6

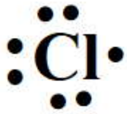
First write the symbol of element ***oxygen***. **‘O’**

Place the 6 valence electrons around the symbol. Put two dots at a time on each of the four sides of the symbol of the element till all are used up. So, we get,

Activity - 2

Observe the following table and write the Lewis dot structure for the remaining inert gases and other elements given in the table.

Table - 3

Atomic number	Name of the element	Symbol	Electronic configuration	Number of valency electrons	Lewis dot structure
36	Krypton	Kr	2,8,18,8	**8**	
54	Xenon	Xe	2,8,18,18,8		
7	Nitrogen	N	2,5	**5**	
11	Sodium	Na	2,8,1	**1**	
17	Chlorine	Cl	2,8,7	**7**	
19	Potasium	L	2,8,8,1		

After observing the Lewis dot structures of some above elements. We can say the following information.

Element	No. of electrons present in the valence orbit	No. of electrons required for octet configuration
Na	1	7
Cl	7	1
N	5	3
O	6	2

To get octet configuration, atoms of different elements require different number of electrons. Now the question is how they get that configuration and stability. Let us discuss.

17.1.3 Electronic theory of valence by Lewis and Kossel

Many scientists attempted to explain the formation of chemical bond between the atoms in terms of electrons. In 1916, a satisfactory explanation was given by Lewis and Kossel independently. They explained that the stability of noble gases is due to octet configuration in the outer most shells of their atoms. So, atoms of remaining elements also try to obtain octet electronic configuration in the valance shell to get stability. In the above table, the atoms of the elements will get octet configuration when they gain or lose electrons. But is it possible to gain 5,6 or 7 electrons? No, it is not possible to gain many electrons for the atoms.

Let us understand this with the following illustrations.

Group IA elements (Li to Cs) try to lose one valence shell electron from their atoms to form corresponding uni-positive ions which get octet in their outer shells.

Example : ${}_{11}Na \rightarrow 2, 8, 1;$ ${}_{11}Na^{+} \rightarrow 2, 8$

Group IIA elements (Mg to Ba) try to lose two valence electrons from their atoms during chemical changes and form di– positive ions with the octet in the outer shells.

Example : ${}_{12}Mg \rightarrow 2, 8, 2;$ ${}_{12}Mg^{2+} \rightarrow 2, 8$

Group IIIA elements try to lose three valence electrons from their atoms and form corresponding tri positive ions with octet in the outer shells.

Example : ${}_{13}Al \rightarrow 2, 8, 3;$ ${}_{13}Al^{3+} \rightarrow 2, 8$

Group VIA elements try to gain two electrons into the valence shells of their atoms during the chemical changes and form corresponding di negative anions which get octet in their outer shells.

Example : ${}_{8}O \rightarrow 2, 6;$ ${}_{8}O^{2-} \rightarrow 2, 8$

Group VIIA elements try to gain one electron into the valence shells of their atoms during the chemical changes and form corresponding uni– anions which get octet in their outer shells.

Example : ${}_{9}F \rightarrow 2, 7;$ ${}_{9}F^{-} \rightarrow 2, 8$

Group VIIIA elements, the noble gases do not try to lose or gain electrons.

Example: ${}_{10}Ne \rightarrow 2, 8;$ No electron gain or loss from the neon atom

What have you observed from the above conclusions about the main groups?

· Why do atoms of elements try to combine and form molecules?

Noble gases of VIII A (18th group) possess eight electrons in the valence shells of their atoms. Helium is an exception. Its atom has only two electrons, but its only shell is completely filled. Noble gases with eight electrons in the valence shell in their atoms are highly stable and rarely participate in chemical changes. Therefore it is concluded that any species (atom or ion) with eight electrons in the valence shell is stable.

- Is it accidental that IA to VIIA main group elements during chemical reactions get eight electrons in the outermost shells of their ions, similar to noble gas atoms?

No. It cannot be simply accidental. Eight electrons in the outermost shell definitely gives stability to the ion or atom. Based on the above observations a statement known as " The Octet Rule" is framed.

Octet rule:

"The atoms of elements tend to undergo chemical changes that help to leave their atoms with eight outer-shell electrons."

Lewis depicted the atom in terms of a positively charged kernel (Kernel is the nucleus and all other electrons in the atom except the outer most shell electrons) and the outershell that could accommodate a maximum of eight electrons.

Chemically active elements do not have an octet of electrons in the valence shell of their atoms. Their reactivity arises from their tendency to achieve the octet, by forming bonds either with atoms of their own type or with atoms of other elements.

The force of attraction between any two atoms or a group of atoms that results a stable entity is called a *'chemical bond'*. There are many types of chemical bonds, but here we discuss only about *ionic bond* and *covalent bond*.

Check your Progress

- Atoms of which elements are having the octet configuration?
- To attain octet configuration, what the atoms are doing?
- Who proposed the electronic theory of valence?

17.2 Types of Chemical bonds.

There are different types of chemical bonds. But here we discuss only two types ionic bond and covalent bond.

17.2.1 Ionic bond

Kossel proposed the formation of ionic bond (which is also called as electrostatic bond) based on the following facts.

(i) Ionic bond is formed between the atoms of two dissimilar elements.

(ii) In order to obtain stability i.e. octet in the outer most shells atoms of some elements lose electrons and form stable positive ions. (generally, metals) and some atoms gain electrons and form stable negative ion. (generally, non-metals). The electron lost by one atom will be gained by the other atom.

(iii) These two oppositely charged ions experience electrostatic forces and get attracted to each other.

(iv) Due to the electrostatic force those ions are form the chemical bond known as electron static bond.

(v) Here the bond is formed between the oppositely charged ions. So, the bond is called 'ionic bond'.

(vi) The bond formed by the transfer of electrons from one atom to another is called ionic bond.

(viii) The electrostatic force between the atoms (ions) is strong.

Example : Formation of NaCl molecule.

Sodium atom loses one electron to get octet configuration and forms Na^+ (cation) and get its nearest inert gas **'Ne'** electronic configuration.

$$_{11}Na \rightarrow {}_{11}Na^+ + e^-$$

$$2, 8, 1 \qquad\qquad 2, 8$$

Chlorine atom gains one electron to get octet configuration and form Cl^- (anion) and get its nearest inert gas **'Ar'** electronic configuration.

$$_{17}Cl + e^- \rightarrow Cl^-$$

$$2,8,7 \qquad\qquad 2,8,8$$

Transfer of electrons between 'Na' and 'Cl' atoms, results in the formation of 'Na^+' and 'Cl^-' ions. These oppositely charged ions get attracted towards each other due to electrostatic forces and form the compound sodium chloride ($NaCl$).

$$Na^+(g) + Cl^-(g) \rightarrow Na^+Cl^- (s) \text{ or } NaCl$$

17.2.1.1 Ionic compounds and their properties.

The compounds formed due to ionic bond are called ionic compounds (NaCl, $MgCl_2$ etc). The properties of these compounds are as follows.

(i) Ionic compounds are solids at room temperature.

(ii) They are soluble in polar solvents like water.

(iii) They are insoluble in non-polar solvents.

(iv) Ionic compounds are good conductors of electricity.

17.2.2 Covalent bond.

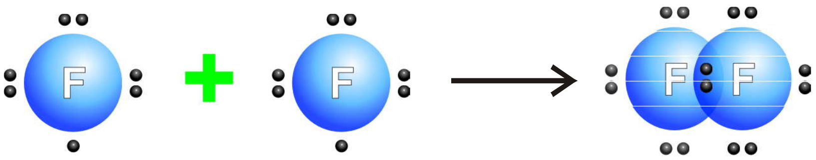
In 1916 G.N. Lewis proposed that the atoms of some elements aquire the octet configuration without transferring of electrons between them. They share the valence electrons with one or more atoms. The sharing of electrons between the atoms leading to the formation of a chemical bond is called as 'covalent bond'.

Here the atoms may be similar or dissimilar. The shared electrons belong to both the atoms.

- *The chemical bond formed between two atoms by contributing one electron each to form a pair and the mutual sharing of that pair of valence orbit electrons so that both of them attain octet in their valence orbit is called 'covalent bond'.*
- Sometimes, two or three pairs of electrons are also shared by the atoms. If two electron pairs are shared between the two atoms it is called di covalent bond or simply double bond (eg. O=O) and if three pairs are shared it is called triple covalent bond or triple bond (eg; N≡N)

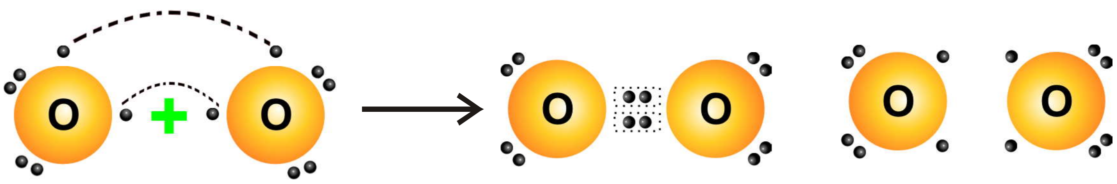
Example: Formation of 'F_2' molecule.

- Fluorine electronic configuration is 2, 7. Fluorine atom has 7 electrons in the outer orbit.
- It requires one electron for the octet configuration.
- Each Fluorine atom contributes one electron and two fluorine atoms form a pair of electrons.
- That electron pair is mutually shared by both the atoms.
- The pair of electrons shared by the atoms is called as bonded pair of electrons.
- After sharing electron pair each fluorine atom has octet configuration and get stability.
- The resulting entity is called fluorine molecule..
- Here are pair of electrons are shared. So it is single bond.



Formation of O_2 molecule

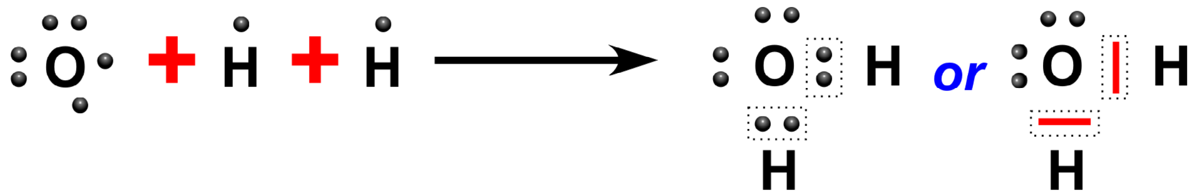
- The electronic configuration of O_8 is 2, 6.
- Oxygen atom has six electrons in its valence shell.
- T requires two more electrons to get octet in its valence shell.
- Therefore oxygen atoms come close and each oxygen atom contributes two electrons for bonding.
- Thus, there exist two covalent bonds between two oxygen atoms in O_2 molecule as there are two pairs of electrons shared between them.
- We can say that a double bond is formed between two oxygen atoms in O_2 molecule.
- Observe the following figures. Both the oxygen atoms have octet in the valence shell.



Water (H_2O) molecule

- In water molecule (H_2O), there are two O – H single covalents bonds.
- Electron configuration of O_8 is 2,6 and H_1 is 1.
- Oxygen atom needs '2' electrons to attain octet in its valence shell.
- Therefore it shares '2' electron with two hydrogen atoms to form

Water (H_2O) molecule.



17.2.3 Covalent compounds and their properties.

The compounds formed by the covalent bond are called covalent compounds (F_2, O_2 etc). The properties of these compounds are as follows.

(i) Covalent compounds are generally liquids or gases at room temperature.

(ii) They are soluble in non-polar solvents.

(iii) They are insoluble in polar solvents.

(iv) Covalent compounds are poor conductors of electricity.

Key Points

- ❖ Some of the elements contain atoms and some of the elements are containing molecules.
- ❖ The Noble gases which stable are have atoms with 8 electrons in their outermost orbit. This is octet configuration.
- ❖ The atoms of other elements also try to get stability by attaining the octet configuration.
- ❖ To attain the octet configuration some atoms are electrons, some atoms gain electrons and some atoms share electrons between them.
- ❖ Due to transfer of electron/s from one atom to another ionic bond is formed.
- ❖ The ionic bond is between the oppositely charged ions. There is electrostatic force between the oppositely charged ions.
- ❖ The force attraction between the atoms in ionic bond is strong and in the covalent bond is weak.
- ❖ Due to sharing of electrons between the atoms the covalent bond is formed.
- ❖ Ionic compounds are solids and good conductors of electricity.
- ❖ Covalent compounds are poor conductors of electricity.

Practice for Learning Outcomes

1. What is octet configuration?
2. How a cation will be formed?
3. Give example for covalent bond.

4. Explain the formation of ionic bond.
5. Write the properties of covalent compounds.
6. What is the reason for the formation of a chemical bond?
7. Explain the formation of ionic bond with example. Mention the properties of ionic compounds.
8. Write about the covalent bond. Write the properties of covalent compounds.
9. What is octet configuration? How the atoms are attaining the octet configuration.

Multiple Choice Questions

1. Among the following the atom with octet configuration

   A) O B) N C) Ne D) Na

2. Example for ionic bond

   A) NO B) CO_2 C) NaCl D) SO_2

3. Covalent bond is formed by

   A) losing electrons B) gaining electrons

   C) sharing of electrons D) ions

4. Ionic bond is first explained by

   A) Lewis B) Kossel C) Rutherford D) Chadwick

Chapter 18

Acids, Bases & Salts

Introduction

From generations, our elders have been using tamarind or lemon juice to give shiny look to the copper vessels and never store pickles in metal containers like brass and copper. Common salt and sugar has often been used as an effective preservative. How did our ancestors know that tamarind, lemon, vinegar, sugar etc. work effectively?

You have noticed that persons suffering from a problem of acidity take antacid tonic or chewing tablets.

Now a days, bleaching powder, baking soda etc. are commonly used in our homes. You must have used various cleaners to open drains and pipes and window pane cleaners for sparkling glass. How do these chemicals work?

Learning Outcomes

After completing this lesson you will be able to:

- Define the terms acid, base, salt and indicator
- Give examples to acids, bases, salts from household materials
- Suggest suitable indicators to test acids and bases and describe the properties
- Define pH
- Correlate the concentration of hydrogen ions and pH with neutral, acidic and basic nature of aqueous solutions
- Recognize the importance of pH in everyday life
- Define salts based on properties and describe their methods of preparation
- Manufacture and use of baking soda, washing soda, plaster of Paris and bleaching powder
- Understand corrosive nature of certain substances and learn to take appropriate measures.

This was common collective wisdom which was passed from generation to generation. Most of these substances given in examples can be classified as acids, bases and salts.

In this chapter, we shall categorize these substances, and study their characteristic properties. We will also be learning about pH, which measures acidity of various substances and its importance in our life.

18.1 Acids and Bases

For thousands of years, people have known that vinegar, lemon juice, Amla, tamarind and many other food items taste sour. However, only a few hundred years ago it was proposed that these things taste sour because they contain 'acids'. The term acid comes from Latin term 'accre' which means sour.

It was first used in the seventeenth century by Robert Boyle to label substances as acids and bases based on certain properties. He is succeeded in defining acids and bases, but could not explain their behavior on the basis of their chemical structure.

This was accomplised by Swedish Scientist Svante Arheius in the late nineteenth century. He proposed that on dissolving in mainly the properties of they form. Governed by this, he identified the ions furnished by acids and bases responsible for their characteristic behaviour and gaue their definitions

Some of the characteristics:

Acids	● Taste sour
	● Corrosive to metals
	● Change blue litmus into red
	● Become less acidic on mixing with bases
Bases	● Taste bitter
	● Feel slippery or soapy
	● Change red litmus into blue
	● Become less basic on mixing with acids
	● Do you know how we the identify acids and bases?

18.2 Indicators

You might have seen that the spot of turmeric or gravy on cloth becomes red when soap is applied on it. What do you think has happened? Turmeric has acted as an indicator of base present in soap. There are many substances that show one colour in an acidic medium and another colour in a basic medium.

Do you know?

Litmus is a natural dye extracted from certain lichens, plant belongs to the division of Thallophyta and colour is purple in neutral solutions. Coloured petals of some flowers such as Hydrangea , Petunia and Geranium are also used as indicator.

There are many natural materials like litmus, extract of red garbage, turmeric solution and extracts of coloured petals of some flowers contain dye molecule and synthetic materials like methyl orange and phenolphthalein are used for identifying nature of substance. Such are called acid-base indicators.

Litmus is a natural dye found in certain lichens. It was the earliest indicator to be used. It shows red colour in acidic solutions and blue colour in basic solutions. Phenolphthalein and methyl orange are some other indicators.

The colours of these indicators in acidic, neutral and basic solutions are given below in table:

Indicator	**Colour in acidic**	**Colour in neutral**	**Colour in basic**
Litmus red	-	Purple	Blue
Litmus blue	Red	Purple	-
Phenolphthalein	Colourless	Colourless	Pink
Methyl orange	Red	Orange	Yellow

Activity - 1

Collect the following samples from the science laboratory; hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3),acetic acid (CH_3COOH), sodium hydroxide (NaOH), calcium hydroxide [$Ca(OH)_2$], magnesium hydroxide [$Mg(OH)_2$], ammonium hydroxide (NH_4OH) and potassium hydroxide (KOH), prepare dilute solutions of the respective substances. Take four watch glasses and put one drop of the first solution in each one of them and test the solution as follows.

(a) Dip the blue litmus paper in the first watch glass.

(b) Dip the red litmus paper in the second watch glass.

(c) Add a drop of methyl orange to the third watch glass, and

(d) Add a drop of phenolphthalein to the fourth watch glass.

Observe the respective colour changes and note down in Table-1. Do the same with all the above dilute solutions.

Table-1

Sample solution	**Red litmus**	**Blue litmus**	**Phenolphthalein**	**Methyl orange**
HCl				
H_2SO_4				
HNO_3				
CH_3COOH				
NaOH				
KOH				
$Mg(OH)_2$				
NH_4OH				
$Ca(OH)_2$				

18.3 Reaction of Acids with Metals

Lab Activity

Aim : To study the reaction of acids with metals.

Objective : Experiment to study the reaction of diluted Sulphuric acid (H_2SO_4) with zinc (Zn).

Required material : A test tube, zinc(Zn) granules, diluted sulphuric(H_2SO_4), stand, match box and a test tube holder.

Procedure : Drop few zinc(Zn) granules in a test tube and add dil. sulphuric acid (H_2SO_4) carefully along the sides of the test tube. Set the apparatus as shown in the Fig. Bring a burning match stick near the mouth of the test tube. The gas burns with a 'pop' sound when a burning match stick is brought near the mouth of the test tube.

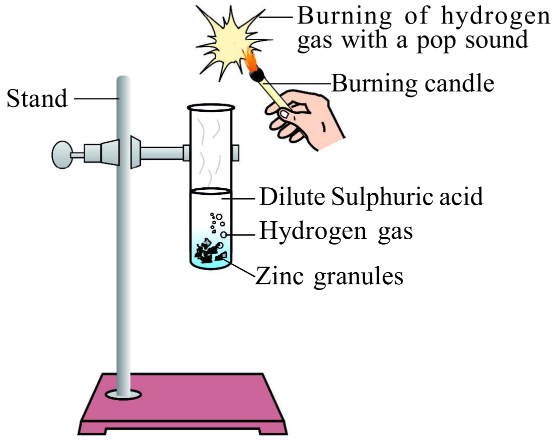


Fig - 1 : Reaction of acids with metals

Observation

When dilute sulphuric acid(H_2SO_4) is added to zinc(Zn) granules, hydrogen(H_2) gas is formed. The gas bubbles rise through the solution, and the burning match stick is brought near the mouth of the test tube the gas in the test tube burns with a 'pop' sound. This confirms that the gas evolved is hydrogen (H_2) gas.

Finding/Conclusion

From this experiment it can be said that dilute sulphuric acid (H_2SO_4)reacts with zinc(Zn) to produce hydrogen (H_2)gas.

A similar reaction is observed when we use other metals like iron.

In general, it can be said that in such reactions metal displaces hydrogen(H_2) from acids and hydrogen (H_2)gas is released. The metal combines with the remaining part of the acid and forms a compound called a salt, thus,

$$\text{Acid} + \text{Metal} \rightarrow \text{Salt} + \text{Hydrogen gas}$$

the reaction between zinc(Zn) and dil. sulphuric acid (H_2SO_4)can be written as:

$$\underset{\text{zinc metal}}{Zn} + \underset{\text{dil sulphuric acid}}{H_2SO_4} \rightarrow \underset{\text{zinc sulphate salt}}{ZnSO_4} + \underset{\text{hydrogen gas}}{H_2(\uparrow)}$$

Repeat activity with another acid,

Zn	+	HCl	$\rightarrow$	ZnCl	+	H_2 ($\uparrow$)
zinc metal		dil hydrochloric acid		zinc chloride salt		hydrogen gas

From the above activity you can infer that hydrogen(H_2) gas is evolved when acid react with metal.

18.4 Reaction of acids with metal carbonates and hydrogen carbonates

Activity - 2

Take the boiling tube and add about 0.5 g sodium carbonate (Na_2CO_3) to it and about 2 mL of freshly prepared lime water in another test tube. Add about 3 mL dilute hydrochloric(HCl) to the boiling tube containing sodium carbonate(Na_2CO_3) and immediately fix the cork filled with a delivery tube and set the apparatus as shown in the Fig. Dip the other end of the delivery tube in the lime water.

Repeat the activity with sodium hydrogen carbonate. observe the lime water carefully, both times.

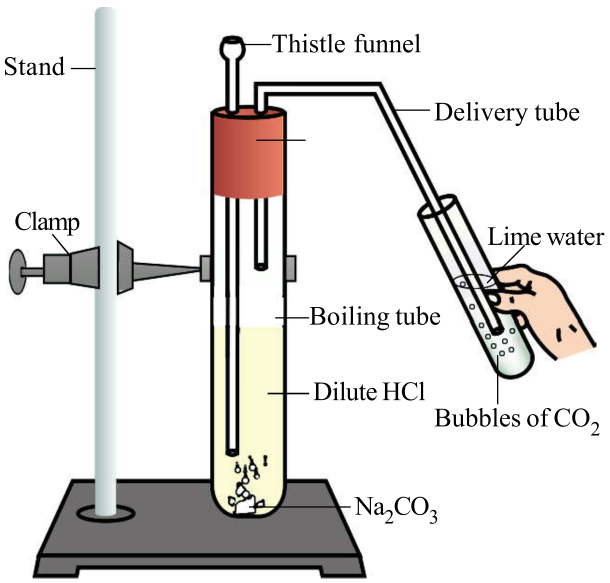


Fig - 2 : Reaction of acids with metal carbonates

Observation

When dilute hydrochloric(HCl) is added to sodium carbonate or sodium hydrogen carbonate, carbon dioxide gas is evolved. On passing carbon dioxide(CO_2) gas, lime water turns milky. On passing the excess of carbon dioxide(CO_2) gas, lime water becomes clear again.

Finding/conclusion

From the above activity it can be concluded that if sodium carbonate or sodium hydrogen carbonate react with dilute hydrochloric acid, carbon dioxide gas is evolved

$Na_2CO_3(s)$	+	2HCl(aq)	$\rightarrow$	2NaCl(aq)	+	$H_2O(l)$	+	$CO_2(g)\uparrow$
(sodium carbonate)		(dil. Hydrochloric)		(sodium chloride)		(water)		(carbon dioxide)

$NaHCO_3(s)$	+	HCl(aq)	$\rightarrow$	NaCl(aq)	+	$H_2O(l)$	+	$CO_2(g)\uparrow$
(sodium hydrogen carbonate)		(dil. Hydrochloric)		(sodium chloride)		(water)		(carbon dioxide)

On passing the evolved carbon dioxide(CO_2) gas through lime water, $Ca(OH)_2$, the later turns milky due to the formation of white precipitate of calcium carbonate($CaCO_3$)

$$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$$

(calcium hydroxide) (carbon dioxide) (calcium carbonate) (water)

Metal carbonate + Acid → Salt + Water + Carbon dioxide

Metal hydrogen carbonate + Acid → Salt + Water + Carbon dioxide

18.5 Reaction of acids with bases

Activity - 3

Take about 2 mL solution of sodium hydroxide (NaOH) in a test tube and add a drop of phenolphthalein indicator to it and observe the colour. With the help of a dropper add diluted hydro chloric (HCl) drop wise and stir the solution constantly till the colour disappears.

Now add a few drops of sodium hydroxide (NaOH) solution. The colour of the solution is restored.

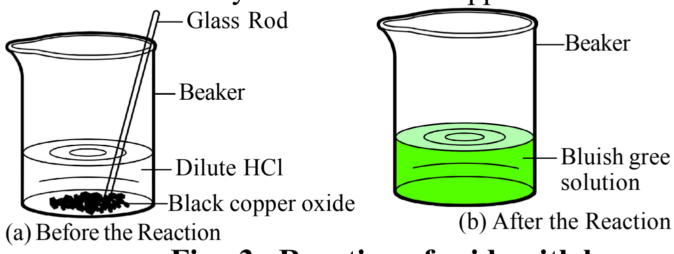


Fig - 3 : Reaction of acids with bases

When a drop of phenolphthalein is added to a solution of sodium hydroxide(NaOH) the solution becomes pink in colour. On adding hydrochloric(HCl), the colour of the solution fades due to the reaction between hydrochloric(HCl) and sodium hydroxide(NaOH).

When whole of sodium hydroxide(NaOH) has reacted with hydrochloric (HCl), the solution becomes colourless.

On adding sodium hydroxide (NaOH), the solution becomes pink again.

Finding/conclusion

From this activity, we can see that when dilute hydrochloric (HCl) is added to sodium hydroxide (NaOH) solution, the two react with each other. When sufficient hydrochloric (HCl) is added, the basic properties of sodium hydroxide (NaOH) and acidic properties of hydrochloric (HCl) disappear. The process is therefore called neutralization. It results in the formation of salt and water. The reaction between hydrochloric acid (HCl) and sodium hydroxide (NaOH) forms sodium chloride (NaCl) and water (H_2O).

$$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$$

(hydrochloric) (sodium hydroxide) (sodium chloride) (Water)

18.6 Corrosive Nature

The ability of acids to attack various substances like metals, metal oxides and hydroxides is referred to as their corrosive nature.

It may be noted here that the term ‘corrosion’ is used with reference to metals and refers to various deterioration processes (oxidation) they undergo due to their exposure to environment. Acids are corrosive in nature as they can attack variety of substances.

Check your Progress

- Write a chemical reaction for neutralization process?
- Give required material for hydrogen liberation in an chemical reaction?
- An acid reacts with a substance X with liberation of a gas which burns with a 'pop' sound when a burning match stick is brought near it. What is the nature of X? (a) CaO (b) SO_2

17.7 pH scale

The pH scale ranges from 0 to 14 on this scale. pH 7 is considered neutral, below 7 acidic and above 7 basic. Farther from 7, more acidic towards zero and towards 14 basic the solution.

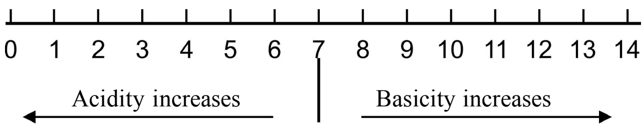


Fig - 4 : The pH scale

pH of some common substances

Common acids	pH	Common bases	pH
HCl (4%)	0	Blood plasma	7.4
Stomach acid	1	Egg white	8
Lemon juice	2	Sea water	8
Vinegar	3	Baking soda	9
Oranges	3.5	Antacids	10
Soda	4	Milk of magnesia	10.6
Grapes	4	Ammonia water	11
Sour milk	4.5	Lime water	12
Fresh milk	5	Drain cleaner	13
Egg yolks	5.6	Caustic soda 4% (NaOH)	14
Human saliva	6.8		
Pure water	7		

Determination of pH

pH of a solution can be determined by using proper indicator or with the help of a pH meter. The latter is a device which gives accurate value of pH. We shall discuss here the use of indicators for finding out the pH of a solution.

Universal Indicator/pH paper

- It is a mixture of a several indicators and used to know the strength of acid or base.
- It shows a specific colour at a given pH.
- A colour guides is provided with the bottle of the indicator or the strips of paper impregnated with it which are called pH paper strips.

- The test solution is tested with a drop of the universal indicator, or a drop of the test solution is put on pH paper.
- The colour of the solution on the pH paper is compared with the colour chart/guard and pH is read from it.
- The pH values thus obtained are only approximate values.

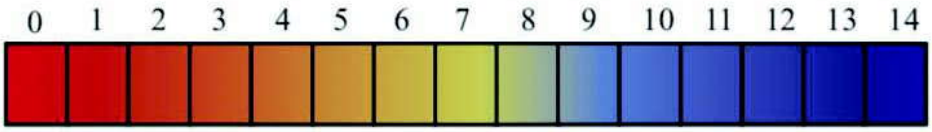


Fig - 5 : pH paper – colour and range, variation

The pH of neutral solution is 7. Values less than 7 on the pH represent an acidic solution. As the pH value increases from 7 to 14 represent a basic solution.

Importance of pH in everyday life

pH plays a very important role in our everyday life. Some such examples are described here.

1. **pH in humans and animals :** Most of the biochemical reactions taking place in our body are in a narrow pH range of 7.0 to 7.8. Even a small change in pH disturbs these processes.

2. **Acid Rain :** When the pH of rain water falls below 5.6, it is called acid rain. When acid rain flows into rivers, the pH of the river water also falls and it become acidic. As a result, the survival of aquatic life become difficult.

3. **pH in plants :** Plants have a healthy growth only when the soil has a specific pH range which should be neither highly alkaline nor highly acidic.

4. **In digestive system :** Our stomach produce hydrochloric acid which helps in digestion of food. When we eat spicy food, stomach produces too much of acid which causes 'acidity' i.e. irritation and sometimes pain too. To get rid of this we use 'antacids' which are bases like 'milk of magnesia' (suspension of magnesium hydroxide in water).

5. **Self defence of animals and plants :** Bee sting causes severe pain and burning sensation. It is due to the presence of methanoic acid in it. Use of a mild base like baking soda can provides relief from pain.

Some plants like 'nettle plant' have fine stinging hair which inject methanoic acid into the body of any animal or human being that comes in its contact. This causes severe pain and burning sensation. The leaves of dock plant that grows near the nettle plant when rubbed on the affected area provides relief.

6. **Tooth decay :** Tooth enamel is made of calcium phosphate, which is the hardest substance in our body and can withstand the effect of various food articles that we eat. If mouth is not washed properly after every meal, the food particles and sugar remaining in the mouth undergoes degradation due to the bacterial present in the mouth. This process produces acids and the pH goes below 5.5.

The acidic condition thus created corrode the tooth enamel and in the long run can result in tooth decay.

Check your Progress

- Why does tooth decay start when the pH of mouth is lower than 5.5?

18.8 Salts

Salts are ionic compounds made of cations and amims Hydroxyl ion (OH^-). Potassium sulphate (K_2SO_4), sodium sulphate (Na_2SO_4), calcium sulphate ($CaSO_4$), magnesium sulphate (Mg_2SO_4), copper sulphate ($CuSO_4$), sodium chloride (NaCl), sodium nitrate ($NaNO_3$), sodium carbonate (Na_2CO_3) and ammonium chloride (NH_4Cl). Salts having the same positive and negative radicals belong to the same family. sodium chloride (NaCl) and sodium sulphate (Na_2SO_4) belong to sodium salt family, sodium chloride (NaCl) and potassium chloride (KCl) belong to chloride family.

Some Commonly Used Salts

The common salt thus obtained is an important raw material for various materials of daily use , such as sodium hydroxide(NaOH), baking soda ($NaHCO_3$), washing soda ($Na_2CO_3.10H_2O$) , bleaching powder ($CaOCl_2$) and many more. Let us see how one substance is used for making all these different substances.

Sodium hydroxide(NaOH)

When electricity is passed through an aqueous solution of sodium chloride(brine solution) . it decomposes to form sodium hydroxide (NaOH) . the process is called chlor-alkali process because of the products formed chlor for chlorine and alkali for sodium hydroxide (NaOH).

Baking soda (sodium hydrogen carbonate, $NaHCO_3$)

You must have seen your mother using baking soda while cooking some 'dals'. If you ask her why does she use it, she would tell that it helps in cooking some items fasters which otherwise would take must longer time. Chemically baking soda is sodium hydrogen carbonate ($NaHCO_3$).

Baking soda - sodium hydrogen carbonate ($NaHCO_3$) uses

1. It acts as mild antiseptic.
2. For making baking powder, cakes and pastries are made flufly and soft by using baking powder.
3. In medicines , Being a mild and non-corrosive base, baking soda is used in medicines to neutralise the excessive acid in the stomach and provide relief. Mixed with solid edible acids such as citric or tartaric acid, it is used in effervescent drinks to cure indigestion.
4. Used in fire extinguisher as soda acid.

Washing soda (sodium carbonate decahydrate $Na_2CO_3.10H_2O$)

Washing soda is used for washing of clothes. It is mainly because of this chemical that the clothes washed by a washer man appear so white. Chemically, washing soda is sodium carbonate decahydrate ($Na_2CO_3.10H_2O$).

Uses of washing soda ($Na_2CO_3.10H_2O$)

1. It is used in the manufacture of caustic soda, glass, soap powders, borex and in paper industry.
2. As a cleansing agent for domestic purpose.

Plaster of Paris ($CaSO_4$ .1/2H_2O)

You must have seen some beautiful designs made on the ceiling and walls of rooms in many houses. These are made of plaster of paris, also called POP. Chemically, it is $2CaSO_4.H_2O$ or $CaSO_4.1/2\ H_2O$ (calcium sulphate hemi hydrate)

Uses of plaster of paris ($CaSO_4$ .1/2H_2O)

1. In making casts for manufacture of toys and statues.
2. In medicine for making plaster casts to hold fractured bones in place while they set. It is also used for making casts in dentistry.
3. For making the surface of walls and ceiling smooth.
4. For making decorative designs on ceilings, walls and pillars.
5. For making' chalk' for writing on blackboard.

Bleaching Powder ($CaOCl_2$)

Have you ever wondered at the whiteness of a new white cloth? How is it made so white? It is done by bleaching of the cloth at the time of its manufacture. Bleaching is a process of removing colour from a cloth to make it whiter. Bleaching powder has been used for this purpose since long. Chemically, it is calcium oxychloride, $CaOCl_2$ a salt with one cation and two anims Cl^- and OCl^- (hypochlorite)

Uses of bleaching powder ($CaOCl_2$)

1. In textile industry for bleaching of cotton and linen.
2. In paper industry for bleaching of wood pulp.
3. In making wool unshrinkable.
4. Used as disinfectant and germicide for sterilization of water.
5. Used as an oxidizing agent in chemical industry.

Check your Progress

- $CuSO_4$ was prepared by reacting an acid and a base. Identify the acid and the base that must have been used in this reaction.
- Define neutralization reaction with two examples.

Key Points

- ❖ Acids are the substances which taste sour, change blue litmus red, are corrosive to metals and furnish H+ ions in their aqueous solutions.
- ❖ Bases are the substances which taste bitter, change red litmus blue, feel slippery and furnish OH– ions in their aqueous solutions.
- ❖ Indicators are the substances that show one colour in an acidic medium and another colour in a basic medium. Litmus, phenolphthalein and methyl orange are commonly used indicators.
- ❖ Acids are presents in many unripe fruits, vinegar, lemon, sour milk etc., while bases are present in lime water, window pane cleaners, many drain cleaners etc.
- ❖ Aqueous solutions of acids and bases both conduct electricity as they dissociate on dissolving in water and liberate cations and anions which help in conducting electricity.
- ❖ Acids react with metal carbonates and metal hydrogen carbonates to produce salt, water and CO_2.
- ❖ Acids react with metal oxides to produce salt and water.
- ❖ Acids and bases react with each other to produce salt and water. Such reactions are called neutralization reactions.
- ❖ Water itself undergoes dissociation and furnishes H^+ and OH^- ions in equal numbers. This is called self dissociation of water. The extent of dissociation is very small.
- ❖ pH plays an important role in proper growth of plants and also for proper digestion in our bodies.

Practice for Learning Outcomes

1. Why do solutions of acids and bases conduct electricity?
2. Differentiate between strong and weak acids and give one example of each.
3. Which gas is evolved when an acid reacts with metal carbonates? Which other category of compounds would produce the same gas on reacting with acids?
4. What type of oxides react with acids? Give one examples of this type of oxide and write down the balanced equation for the reaction.
5. List three categories of substances that can react with a base. Give one example of each and write the chemical reaction involved in each case.
6. How does water help in dissociation of acids and bases? Explain.
7. Predict whether a given aqueous solution is acidic, basic or neutral if its pH is (a) 7.0, (b) 11.9 and (c) 3.2.
8. Give chemical formula of (i) baking soda and (ii) washing soda.
9. List any four uses of 'plaster of paris'.

Multiple Choice Questions

1. If a base dissolves in water by what name it is better known? ( )

   A) neutral B) acid C) base D) alkali

2. What colour would hydrochloric acid (pH = 1) turn universal indicator? ( )

   A) orange B) purple C) yellow D) red

Chapter
19

Metals, Non-Metals

Introduction

Look at and identify some of the materials around you.

Based on the proper lies, the elements present around us are grouped widely into metals and non metals. Can you say based on their properties, which material is metal and which is non metal? Is wood a metal? Is Iron a non-metal? Let us learn about these metals and non metals in this chapter.

Observe the figures

Jewellery **Anklet** **Axe** **Utensils**

Fig - 1

Try to name the metals from which the objects given in fig - 1. Add names of more metals that you know to the list. Your answers might be Gold, Silver, Aluminium, Iron, Copper, etc.,

- Did you add steel to the list of metals?
- Did you think that steel is a metal?

Let us learn the properties of metals so that you are able to answer these questions. Now observe carefully all the materials that you have listed above as metals.

- Do all these look alike?
- Do all of them shine?
- Are they hard or soft?
- Do they break easily?
- Can you group materials into two categories by looking at the properties?

We try to find two groups, then compare them in detail in this chapter.

Learning Outcomes

After completing this lesson you will be able to :

- Explain the terms metals and non metals.
- Can classify the metals and non metals.
- Differentiate between metals and non metals on the basis of their physical properties
- List out some of the common uses of metals and non metals.
- Explains the importance of recycling of metals
- Describe the reactions of metals with oxygen.
- Give examples to metals and non metals.
- Describe the reactions of non metals with oxygen.

19.1 Physical Properties of a metals

The easiest way to start grouping substances is by comparing their physical properties. Let us study them.

1. **State :** Metals are generally solids at room temperature. They have very high melting points and boiling points. Mercury and Gallium are exceptions as they are liquids at room temperature.

2. **Lustre :**

Activity – 1

Collect some pieces of iron, copper, aluminum, magnesium ribbon and silver (if possible). Clean & rub the surface of each sample with sand paper and note their appearance.

Do they shine?

Yes, their surfaces have a shining appearance.

Metals shine in their pure state. This shining property of the metals is called metallic Lustre. Gold is yellow and copper is reddish brown. Silver, magnesium, aluminum etc., are white.

3. **Hardness :**

Activity - 2

Carefully take out a piece of sodium (Na) and a piece of potassium (K) by a pair of tongs and dry them between the folds of a filter paper. (**Note:** always handle sodium metal with care). Cut each of them with a sharp knife. What do you observe? They can be cut with a knife, so they are soft metals.

Now try to cut using knife, metals pieces such as those of magnesium (Mg), lead (Pb), aluminium (Al), copper (Cu), iron (Fe), etc., and write your observations.

Metals are generally hard. Hardness of metals varies from one metal to another.

4. **Density :** Metals differ widely in their densities. Generally, they have high densities e.g. density of gold, mercury, silver and iron are 19.3, 13.6, 10.5 and 7.6 g/c.c. respectively. But some metals like sodium, potassium, calcium, aluminium and magnesium have low densities. Lithium (0.50 g/cc) is the lightest metal.

5. **Melting and boiling points :** Metals generally have high melting point and boiling point. *Sodium, potassium, mercury and gallium metals* are exceptions as they have low melting point and boiling point.

6. **Malleability :**

Activity - 3

- Take pieces of iron, zinc, lead and copper.
- Place any one metal on a block of iron and strike it four or five times with a hammer. What do you observe?
- Repeat this with other metals.
- Record the change in the shape of these metals.

You will find that some metals can be beaten into thin sheets. The ability of metals to be beaten into thin sheets is called malleability. Gold and silver are the most malleable metals.

7. **Ductility :**

Consider some metals such as iron, copper, aluminium, lead, etc.

- Which of the above metals are also available in the form of wires?

The ability of metals to be drawn into thin wires is called ductility. Gold is the most ductile metal. You will be surprised to know that a wire of about 2 km length can be drawn from one gram of gold.

It is because of their malleability and ductility that metals can be given different shapes according to our needs.

8. **Tensile Strength :**

The property due to which a substance can bear a lot of strain without breaking, is called tensile strength. Metals generally have high tensile strength. However, arsenic and antimony are exceptions to the property, that they have low tensile strength.

9. **Conductivity : (Electricity and Heat) :**

(a) Electricity : You might have seen an electrician using the screwdriver.

- What materials does it contain?
- Why does not a screwdriver used by electricians have metal handle?

Activity - 4

Arrange an electric circuit with a battery and bulb. Close the circuit using an iron nail, as shown in figure - 2.

Observe whether the bulb glows or not. Repeat the same experiment using the other metals and record your observations in the table - 1.

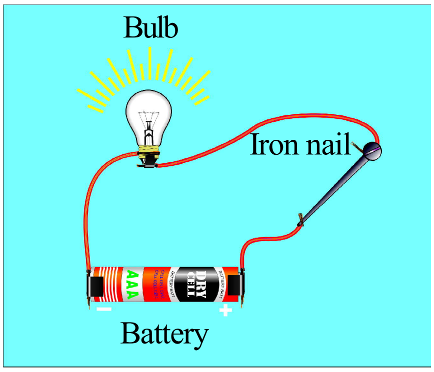


Fig - 2 : Electric circuit

Table -1

Material	Does the bulb glow? (Yes/No)
Iron	
Zinc	
Copper	
Sulphur	
Aluminium	
Carbon	
Magnesium	
Iodine	

- Do all the metals allow the bulb to glow?

Materials that allow electricity to pass through them and make the bulb to glow are called electric conductors. Metals like iron, copper and aluminium are good conductors of electricity. Property of materials to allow electric current to flow through them is called electric conductivity.

Talk to an electrician. Look at the handles of his tools.

- Are the handles of all tools made of the same material?

Note the precautions to be taken while working with such tools.

The handles of both electrical appliances and cooking utensils are not made of metals. Electrical appliances conduct electricity.

- What do cooking appliances conduct?

(b) Heat

Activity - 5

Observing conduction of heat by metals

Take an iron rod. Stick pins on it with the help of wax. Now fix the rod to a stand as shown in the fig-3. Heat one end of the rod with a spirit lamp and see how the pins fall off?

- Why did the pins fall from iron rod?
- Pin of which end fell first?
- What could be the reason for this?

You know that the pin fell because of the heat supplied to the iron rod makes the wax to melt at one end. The wax closer to the flame melted first. This activity clearly shows that heat moves from one end of the iron rod to the other. This property of a material is known as **conductivity of heat**. All metals conduct heat. All metals do not have equal conductivity. Cooking vessels made of Iron, copper and aluminum are preferred due to their high conductivity of heat. Property of materials to allow heat to flow through the materials is called heat conductivity.

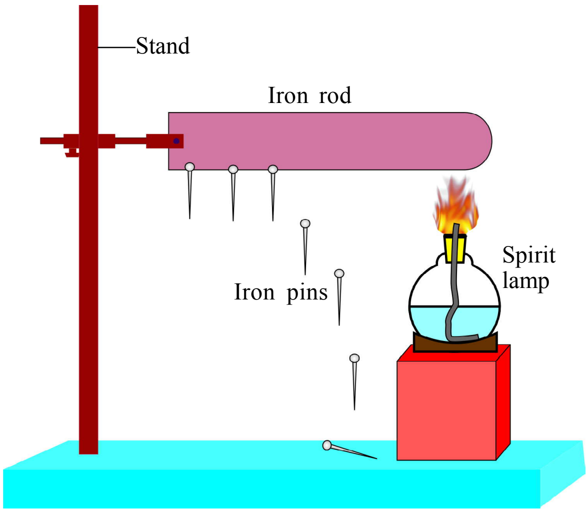


Fig - 3 : Conduction of heat by metals

10. Sonorous:

Sonu's mother was in kitchen. When she was carrying too many vessels, one vessel fell down. Sonu noticed that the vessel made a ringing sound when it hit the hard floor.

- Have you observed material used to make school bell or bells in temple?
- Why are wooden bells not used?
- Do all materials produce sound when they are dropped on hard surface? Drop a piece of coal on the floor and listen to the sound.
- Do you think coal is sonorous?

Activity - 6

Take the pieces of zinc, copper, aluminium, magnesium and tightly packed packets of sulphur, carbon and iodine. Drop them one by one, on a hard surface. Listen carefully to the sound produced and record your observations in table - 2.

Table -2

Material sample that Produce sound	Material Sample that do not Produce sound

- What similarity do you notice among materials which produce sound?

You may notice that some of the materials produce sound and some of them do not. Materials which produce ringing sound are called sonorous materials. Generally, most of the metals are sonorous. The materials other than metals are not sonorous. The property of a material to produce sound on falling on the hard surface is called sonorous.

Do this :

On the basis of all the activities carried out, fill the table - 3.

Table - 3

Material sample	Lustrous	Sonorous	Conducts heat	Conducts electricity	Malleable	Ductile
Iron						
Zinc						
Copper						
Sulphur						
Aluminium						
Carbon						
Magnesium						
Iodine						

We find that it is the metal which posses most of the properties such as luster, malleability, ductility, sonority, conduction of heat, conduction of electricity.

Check your Progress

- What is malleability?
- Give two examples for electric conductors.
- What is Sonorous?

19.2 Physical properties of non-metals

The physical properties of non-metals are just the opposite of physical properties of metals.

Non metals are generally, non-lustrous, non sonorous, do not conduct heat and electricity, non malleable and non ductile.

Table - 4

Comparative physical properties of metals and non-metals

Metals	Non-Metals
State : Metals are generally solids at room temperature. They have very high melting points and boiling points. Mercury and Gallium are exceptions as they are liquids at room temperature.	**State:** Non-Metals are generally brittle solids or liquids or gases. They change into vapour states at fairly low temperature. However, carbon, silicon and boron are exceptions to the property and change into vapours at very high temperature.
Lustre : When the metals are freshly cut, they have a brilliant shine over the cut surface. This metallic shine is called Lustre.	**Lustre :** Non-metals have no Lustre. However, iodine and graphite have luster.
Hardness: Metals are generally hard. However, metals like sodium, potassium are soft and can be cut with knife. Similarly, metals like gold and aluminium are not very hard.	**Hardness :** Non-metals are generally not hard. However, diamond (an allotrope of carbon) is hardest, naturally occurring substance.
Density: Metals generally have a high density. Sodium and potassium metals are exceptions, as their density is less than 1 gcm^{-3}	**Density :** Non-metals generally have low density. However diamond is almost as heavy as aluminium.
Melting point and Boiling point : Metals generally have high melting point and boiling point. Sodium, potassium, mercury and gallium metals are exceptions as they have low melting point and boiling point.	**Melting and Boiling point :** Non- metals have low melting point and boiling point. However, carbon, silicon and boron have high melting point and boiling point.
Malleability : The property of metals, due to which they can be beaten into sheets, is called malleability. Metals are generally malleable. However, metals like arsenic and antimony are exceptions to the rule.	**Malleability:** Non – metals are non-malleable. If hammered, they form powdery mass. Actually non-metals (if in solid state) are brittle in nature.
Ductility: The property by which a substance can be drawn into thin wires is called ductility. Metals are generally ductile. However, metals like zinc, arsenic and antimony are exception to the rule.	**Ductility :** Non-metals are not ductile. Carbon fibre is highly ductile.

Tensile Strength: The property due to which a substance can bear a lot of strain without breaking, is called tensile strength. Metals generally have high tensile strength. However, zinc, arsenic and antimony are exception to the rule.	**Tensile Strength:** Non-metals do not have tensile strength. However, carbon fibre is having tensile strength, which is an exception.
Conductivity : Metals are generally good conductors of heat and electricity. Silver is the best conductor. However, bismuth and tungsten are poor conductors.	**Conductivity :** Non-Metals are generally bad conductors of electricity. However, graphite and gas carbon are good conductors of electricity.
Sonorous : When metals are struck with some hard material, they produce ringing sound. Thus, metals are said to be sonorous.	**Sonorous :** Non-metals are non-sonorous, i.e., when struck with hammer they do not produce sound.

Check your Progress

- Name a non metal which is highly ductile.
- Give three examples for non metals.

19.3 Reaction of metals with oxygen

When metals are burnt in air, they react with the oxygen present in air to form metal oxides

$$\underset{\text{(from air)}}{\text{Metal + oxygen}} \longrightarrow \underset{\text{(Basic oxide)}}{\text{metal oxide}}$$

Thus, metals react with oxygen to form metal oxides. Metal oxides are basic in nature.

The vigour of reaction with oxygen depends on the chemical reactivity of metal. Some metals react with oxygen even at room temperature, some react on heating, whereas still others react only on strong heating.

Activity - 7

Aim :

To know the reaction of oxygen with metals.

Material required :

Magnesium, spirit lamp or bunsen burner, litmus papers, petridish.

Procedure :

Take a small strip of magnesium and note its appearance. Burn it. Note the appearance after burning.

Collect the ashes of magnesium in a petridish and add some distilled water to it. Test the solution with red and blue litmus papers.

$$\text{Magnesium (s) + oxygen (g)} \longrightarrow \text{magnesium oxide (s)}$$

The oxide of magnesium turns red litmus to blue. Metal oxides are basic in nature.

Fig. 4

19.4 Reaction of non metals with oxygen

Non metals react with oxygen to form acidic oxides or neutral oxides. Carbon forms an acidic oxide CO_2, Sulphur forms an acidic oxide SO_2, and hydrogen forms a neutral oxide H_2O. The acidic oxides of non metals turn blue litmus solution to red.

Activity - 8

Aim :

To know the reaction of oxygen with non-metals.

Material required :

Sulphur, spirit lamp or bunsen burner, litmus papers, deflagrating spoon, glass jar.

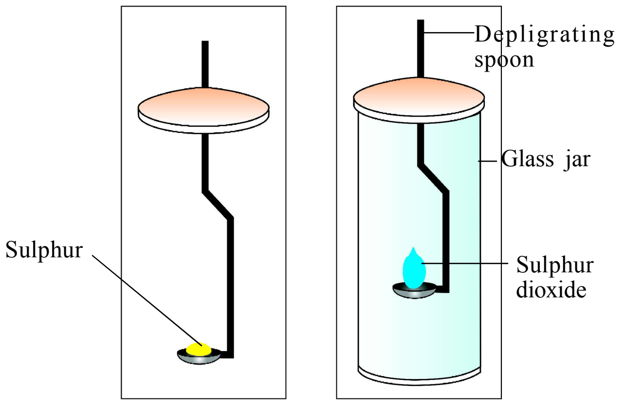


Fig - 5 : Collecting SO_2 gas

- Take a small quantity of powdered sulphur in a deflagrating spoon and heat it on a spirit lamp (be cautious, do not inhale fumes, they are harmful).
- As soon as sulphur starts burning, introduce the spoon into a glass jar / tumbler. Cover the tumbler with a lid to ensure that the gas produced does not escape.
- Remove the spoon after some time but try to keep the jar covered. Add a small quantity of water into the tumbler / jar and quickly replace the lid. Shake the tumbler well. Check the solution with red and blue litmus papers.

$$\text{Sulphur (s) + oxygen (g)} \longrightarrow \text{sulphur dioxide (s)}$$

The oxide of sulphur turns blue litmus to red. Non metal oxides are acidic.

You can also infer that non metals reacts with oxygen to give oxides which are acidic, while metals react with oxygen to give oxides which are basic in nature.

Check your Progress

- What type of oxides formed when non metals react with oxygen?
- What type of oxides formed when metals react with oxygen?

19.5 Uses of common metals

(a) Uses of Magnesium

Magnesium is a silver white metal and is put to following uses :

1. It is used in the preparation of alloys, such as duralumin and magnalium.
2. A mixture of powdered magnesium and potassium chlorate burns with a dazzling white flame on ignition. This mixture is used in preparing fireworks.
3. It is used as a fuse in the ignition mixture.

(b) Uses of Aluminium

1. Aluminium is cheap and resistant to corrosion. It is used for making cooking vessels, household fittings, etc.
2. Aluminium is a very good conductor of electricity and at the same time very light in weight. It is used for making electric transmission wires.
3. Aluminium, being extremely lightweight metal, is used for making lightweight alloys, which are highly tensile and are used for various of other purposes.
4. Aluminium foil is used in packing food stuffs, soap, cigarettes, photopgraphic films, tea leaves and medicines.
5. Aluminium powder mixed with linseed oil forms a silvery white paint. This paint is commonly used for painting iron poles, as it prevents rusting.

(c) Uses of Zinc

1. It is used for galvanizing iron. Galvanising is the process of coating iron sheets with zinc metal so as to protect them from rusting.
2. Zinc is extensively used for making containers of dry cells. These containers also act as negative pole of the dry cells.

Fig - 6 : Dry cells

3. Zinc is used in the preparation of alloys such as brass, bronze and german silver.

(d) Uses of Iron

1. Pure iron (wrought iron) is used for roofing, buckets, trunks, pipes and electromagnets.
2. Impure iron (cast iron) is used for making pipes, manhole covers and immovable parts of machinery.
3. Iron is converted into different kinds of steel. The steel is used for making rails, bridges, locomotives, ships, etc. Stainless steel is used for making utensils and surgical instruments.

(e) Uses of copper

Fig - 7 : Copper wire

Copper is a reddish metal. It is very good conductor of heat and electricity. It is highly malleable and ductile. It is put to the following uses:

1. It is used for making electric transmission wires, Coils in motors, electric generators.
2. It is used for making alloys such as brass and bronze and coins.
3. It is used for making radiators of automobiles, as it is a good conductor of heat.

19.6 Uses of common non-metals

(a) Uses of Hydrogen

Hydrogen is the lightest element. It is found in gaseous state. It is a colourless, odourless and tasteless gas which is put to the following uses :

1. It is used for hydrogenation of vegetable oils, i.e., converting edible vegetable oils into vanaspati ghee.
2. Hydrogen is an excellent reducing agent. It is employed in the extraction of metals like tungsten, molybdenum, copper, lead and tin.

(b) Uses of carbon

1. It makes up for 18% of the human body. Sugar, glucose, proteins etc., are carbon compounds.
2. Amorphous carbon is use to make inks and paints. It is also used in batteries.
3. Carbon in its diamond form is used in jewellery. Diamonds are also used for industrial purposes.
4. Carbon in the form of graphite is used in pencil lead, electrodes and dry lubricant.

Fig - 8 : Diamonds

(c) Uses of Nitrogen

1. It is used in preserving packaged food.
2. Liquid nitrogen is used in the preservation of biological specimens

(d) Uses of oxygen

1. It is used in the artificial respiration for high altitude climbing, deep sea diving, in submarines, in space ships, etc.
2. It is used to prepare mixture of 5% carbon dioxide and 95% oxygen. It stimulates natural breathing. It is given to the patients suffering from asthma.
3. The oxy-hydrogen flame or oxy-acetylene flame can easily melt most of the metals and hence is used for cutting or welding of the metals.
4. It is used in the manufacture of sulphuric acid, nitric acid, etc.

(e) Uses of phosphorus

Phosphorous is found in the form of red, yellow or white phosphorus. The yellow phosphorus is highly reactive as compared to red phosphorous. Following are the uses of phosphorous:

1. Red phosphorus and phosphorus trisulphide are used to make matchstiks, fireworks, fertilizers.
2. Zinc phosphide is used as rat poison.

(f) Uses of sulphur

Sulphur is a yellow solid non-metal, brittle in nature. It is put to the following uses :

(1) It is used in the manufacture of sulphuric acid.

(2) It is used in the preparation of sodium thiosulphate, which is extensively used in photography.

(3) It is used in the manufacture of sulphur dioxide gas, which is further used for bleaching silk, paper and sugarcane juice.

(4) It is the main constituent of some skin ointments.

19.7 Recycling of Metals

Metals are extracted from their ores which are found at few selected places on the Earth. In order to extract a particular metal from its ore a lot of energy and human resources are utilized. Furthermore, the ores of metals are non-renewable. It is estimated that if we continue extracting the metals from ores at the present rate, the ores will exhaust in 200 years. Thus, in order to protect the needs of future generations, we must conserve ores as far as possible.

One way of doing this is to recycle the metals, which have been converted in to different articles, but are no longer in use; i.e., the articles have been scrapped. These scrapped metal articles should be collected and then sent to big factories. These factories will melt the scrap and then recover the pure metals for reuse.

This will not only save the metal ores, but will produce metals at a fraction of cost compared to the metals obtained directly from the ores. It will also help in conserving energy of the coal or electric current to some extent.

Key Points

- The materials which show brightness on surface and reflect the light are called lustrous and which do not shine are non-lustrous material.
- The property of materials by which they can be beaten into thin sheets is called malleability.
- The property of drawing material to make fine wires is called ductility.
- The ability of material to produce a particular sound when it is dropped on the hard surface is termed as sonorous.
- Metals often possess all the properties like lustrous, hard, malleable, ductile, good conductors of heat and electricity and sonorous.
- Non metals have properties opposite to that of metals. They are non-lustrous, brittle, neither malleable nor ductile, poor conductors of heat and electricity.
- Some metals react oxygen present in air in different manner with different rates and in different conditions.
- Gold and platinum are the metals which do not react with air.
- Oxides of metals are usually basic in nature.
- Oxides of non metals are usually acidic in nature.

Practice for Learning Outcomes

1. Name one metal and one non metal which exists in liquid state at room temperature.
2. Name one metal which has a low melting point.
3. Name the metal which is the poorest conductors of heat.
4. Which property of copper and aluminium makes them suitable for
   A) Making cooking utensils and boilers?
   B) Making electric wires?
5. Which metal foil is used for packing some of the tablets.
6. What is meant by saying that the metals are malleable and ductile? Explain with examples?

7. What type of oxides are formed when non – metals react with oxygen? Explain with an example?
8. How the property malleability of metals is utilized in our daily life?
9. Which metals are used in making jewellary? Why?

Multiple Choice Questions

1. The property due to which a metal can be beaten into sheets is called

   A) ductility B) tenacity C) malleability D) density

2. A non-metal which is a good conductor of heat and electricity, is

   A) phosphorus B) silicon C) graphite D) sulphur

3. The oxide of sodium is of

   A) acidic nature B) neutral nature
   C) amphoteric nature D) basic nature

4. The sulphur dioxide gas formed by burning sulphur in oxygen is

   A) an amphoteric oxide B) an acidic oxide
   C) a basic oxide D) a neutral oxide

5. Generally metals are obtained in the state of

   A) Liquid B) Solid C) Gaseous D) Plasma

6. Generally non metallic oxides are by nature

   A) Basic B) Acidic C) Neutral D) Dual

CHAPTER

1

Ecosystems Around us

The environment includes both living and non-living components as well as their interactions. In order to survive in the environment all organisms must grow and reproduce. For this organisms must get matter and energy from the environment. Their life is controlled by the environment and in turn they influence the environment.

* Do organisms live in isolation? Why? Why not?
* Which conditions helps the camel lives in deserts, and penguins lives in cold conditions?
* What will happens to the herbivores and carnivores? If plants vanish from the earth.

The living organisms such as producers, consumers and decomposers forms food chain and web by their food relations. They are present in all ecosystems. Living organisms has adaptations to adjust themselves to diverse and distinct changes to their surroundings. Biosphere includes organisms living in an area and their surroundings.

Let us discuss about the biotic, abiotic factors and their interactions in detail to study about the biosphere.

LEARNING OUTCOMES

The learner...

- ☆ Explains about Habitat, Ecosystem and Biosphere.
- ☆ Establishes relationship between Biotic and Abiotic components of an Ecosystem.
- ☆ Appreciates the role of decomposers in recycling of nutrients.
- ☆ Draws the Diagrams of food chain and food web.
- ☆ Prepares flow charts of the flow of energy in the Ecosystem.
- ☆ Gives reason for the formation of different type of Ecosystems.
- ☆ Appreciates the living organisms for their struggle for existance by having adaptations.

Earth's subsystems: Lithosphere, Hydrosphere, Biosphere and Atmosphere

1.1 Ecosystem

1.1.1 Habitat and Ecosystem

* What do we mean when we say habitat?

* What do we call as an ecosystem?

We resides in house. House is our habitat, as well as pond is habitat for fishes, tree is habitat for crow and desert is habitat for camel. **Does forest, river and oceans are also habitats, which contains many plants and animals?**

Habitat: A Habitat is the type of natural environment and suitable place for organisms to live. Habitat provides food, shelter, protection and conditions for reproduction of an organism.

Ecosystem: The living community together with the physical environment forms an interacting system called the Ecosystem. An ecosystem can be natural or artificial, temporary or permanent. Large grassland or a forest, a pond, a village, an aquarium can all be regarded as ecosystems.

The word ecosystem was first used in 1935 by A.G. Tansley (a British Botanist and Ecologist) to describe a basic unit of nature. Tansley coined the word as reduction of the term "Ecological system" to Ecosystem. Now we can say that habitat is a part of ecosystem.

* What are the components of a dynamic ecosystem?

1.1.2 Components of Ecosystem

The Hyderabad Biriyani (Pride of Telangana) which is fabled all over world for its amazing taste, is made of Basmathi Rice, vegetables, meat products, oil and different spices. The raw materials that you will require to make this luscious biriyani comes from different plants and animals. Similarly, the utensil that is used to make this biriyani can be made up of clay or metal. List out the components and fill the table which are involved in the preparation of Biryani.

Sl.No	Items	What it is made up of Source	Biotic/ Abiotic
1	oil	Ground nut plant	Biotic
2			
3			
4			

Now pause for a moment here and think, just to make one meal of biriyani you must require so many things around you, what about all the activities that you do in your daily life?

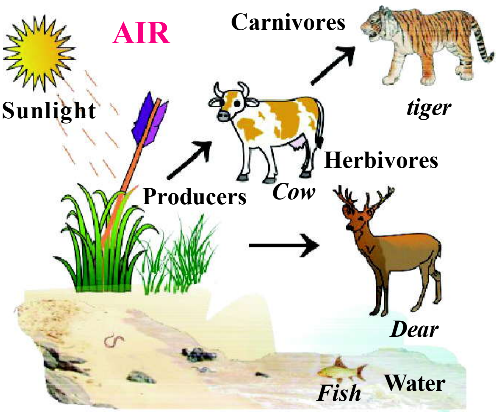
The interacting components of an ecosystem are divided in to Biotic and Abiotic factors.

Abiotic components are the non-living factors in the environment of an ecosystem. Ex: Air, Water, Temperature, Sunlight, Soil etc.

Biotic components are the living organisms in an ecosystem. Ex: plants, animals and micro-organisms

Activity

List out the components, and fill the table



Sl.No.	Abiotic components	Biotic components
1		
2		
3		
4		

1.1.3 Types of Ecosystems

Due to the occurrence and interactions of abiotic and biotic factors, different ecosystems develop in different ways. Ecosystems made by humans may be grouped as artificial ecosystems. What do we mean by natural ecosystems? Give to examples of natural ecosystems.

- Ecosystem
  - Natural ecosystem
    - Terrestrial ecosystem
      - Grassland ecosystem
      - Forest ecosystem
      - Desert ecosystem
    - Aquatic ecosystem
      - Fresh water ecosystem
      - Marine water ecosystem
  - Artificial ecosystem

Activity

Compare an artificial ecosystem like aquirum with forest (natural ecosystem).

CHECK YOUR PROGRESS.

- What kind of an ecosystem is an agricultural farm? What are the biotic and abiotic components present there.
- Write the differences between Habitat and Ecosystem?

Cropland, garden, Aequarium are some artificial Ecosystems.

1.2 Biomes

A part from habitat and ecosystem, we also use the term biome. The term was introduced to represent biotic communities in specific climatic areas. A.G. Tansley added climatic and soil aspects to it later, calling it an Ecosystem. Biome is larger than habitat. Any biome can comprise a variety of habitats. We may say a biome is a large community of plants and animals that live in the same place, that have common characteristics for the environment they exist in. To adjust themselves to diverse and distinct changes in Biomes organisms have to adapt different means for better survival. They are called adaptations. adaptation is a an evolutionery process.

Types of Biomes

Whittaker classified biomes into two groups, on the basis of abiotic factors: 1. Terrestrial Biomes 2. Aquatic Biomes

1.2.1 Terrestrial Biomes and Adaptations in Biotic components

Terrestrial biome is a large community of plants and animals that live on the land.

* What are the different adaptations that we observe in terrestrial biomes?

Adaptions of Xerophytic Plants


Xerophytes are desert plants, well adapted to high temperature and water shortages. They are adapted to store and conserve water. The adaptations that xerophytes may exhibit are:

- Deep widespread root system caters to maximum water uptake. In Opuntia leaves are modified into spines.
- Succulent, and fleshy leaves are found in Aloe veera.
- They have no or few leaves which fewer stomata to reduce water loss.
- Many desert trees and shrubs have thorns for protection from enemies.

Adaptations in desert animals:

- Most of the desert animals avoid being out in the sun during the day.
- Some animals live in burrows to escape the intense desert heat (Aestivation) and some animals come out during the night when the temperatures are low.
- Long legs, thick eyebrows, fat stored hump are some adaptions in Camel.
- Some animals have scaly skin, resistant to drying.
- The Side-Winder snake crawls sideways with only a small amount of its body pressed against the hot sand.

Adaptations to survive in extreme cold and scarcity of water:

- The animals which live in cold climates have very thick fur over the body to trap heat. They also have a layer of stored fat under the skin to give additional insulation.

- ❑ Some animals live in burrows to escape the winter (Hybernation).
- ❑ Penguins have a thick layer of densely packed feathers to reduce heat loss.

Aerial adaptations in animals:

Aerial animals include a small number of animals and birds. that are able to fly in the air. These animals come to the trees land or water for safety and shelter. Ex: Birds and Bats. The adaptations include.

- ❑ Streamlined body to steer through the air. Bones are hollow to make them light.
- ❑ Forelimbs are modified into wings and strong flight muscles to help them to fly.
- ❑ Bats have an extension of the skin between fingers of forelimb which help them to fly.

1.2.2 Aquatic Biomes and Adaptations in Biotic components

- ✻ What will happen if sunlight is absent in aquatic ecosystem?

Sunlight, of course, is necessary for photosynthesis, which brings energy into an ecosystem. So, the availability of that sunlight has a direct impact on the productivity and biodiversity of aquatic ecosystems.

- ✻ Do Aquatic living organisms have adaptations?

Aquatic adaptations in plants:

- ❑ Hydrophytes (Aquatic plants) have reduced root system.
- ❑ The stem may be long, slender and spongy, to prevent them from getting carried away by water current e.g. lotus
- ❑ Floating leaves have stomata only on their upper surface. The submerged plants such as Vallisnaria have no stomata in their ribbon shaped leaves.
- ❑ The broad upper surface of leaves are coated with wax which acts as water repellant, for example lotus, water lily.

  Floating plants such a as Pistia have balancing roots.

- ✻ Observe some aquatic plants in your surroundings and list out the adaptions found in them.

Aquatic adaptations in animals:

1. Smooth and streamlined body to move through the water.
2. Webbed feet in ducks, work like paddles for swimming.
3. Fishes have Flattened tail that serve as oar and Fins to swim.

CHECK YOUR PROGRESS.

- ✤ Mention the adaptations of living organisms found in Aquatic Biomes.
- ✤ Write the adaptations found in desert organisms?

1.3 Ecosystem functions

Pranavi said that, the sun is the main source of energy for all living things. Shyam said that plants are autotrophs; they prepare food for all living things.

❋ Do all organisms use the sunlight in the same manner?

All the organisms in an ecosystem derive energy from food to live. The sun is the main source of energy for all living things. Plants trap this energy through photosynthesis and prepare food for all living organisms. They are called as producers. Animals do not get energy directly from the sun. They are called as Consumers. Many organisms eat plants, and get thier energy. They are called as Herbirvores. Ex: Deer, Rabit, Elephant etc. Other animals that do not eat plants still indirectly depend on the energy of sunlight as they eat other animals. They are called as Carnivores. Ex: Fox, Tiger, Lion etc. Some animals eat both plants and animals. They are called as Omnivores. Ex: Human beings, Pigs, Crows, etc.

Some living organisms break down the dead and decay matter, other wastes and release simple inorganic molecules back to the envioronment. They are called as Decomposers or recyclers. Ex: Fungi etc. So energy from sunlight is transmitted to all living things.

1.3.1 Food Chain- Food web

❋ What does the arow mark indicates in a food chain?

The diagramatic representation of the feeding relationships from one organism to another is called food chain. They show how energy and matter move through ecosystems. Food chain includes producers and Consumers.

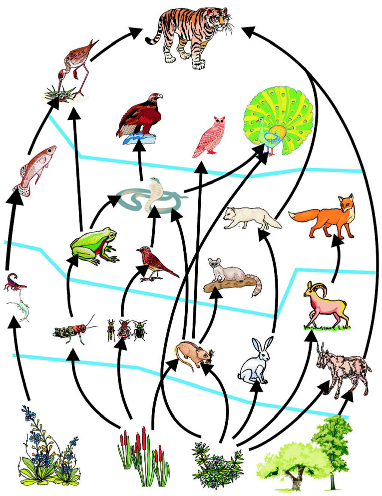
Let us take an example to understand this -

The Indian Bison is found in the Jannaram Wildlife Sanctuary in Adilabad district of Telangana. It feeds on grasses and other plants. The tiger, feeds on bison the relation can be shown as follows:

Grass Indian Bison Tiger

We represent the food and feeding relations in an ecosystem by a food chain. It helps us to represent the directin of flow of energy from an organism to the other.

In nature food chains are usually not simple and linear. They are often branched, because at every stage or trophic level consumers have several alternative forms of food to choose from. Most organisms consume-and are consumed by-more than one species.It includes many intersecting food chains and form a web called Food web. Decomposers are the final or last link in the food chain. Each and every living organism occupies a special postition with in the food web, called Niche.



Food web

Activity

Construct a food chian by observing an ecosystem in your surroundings.

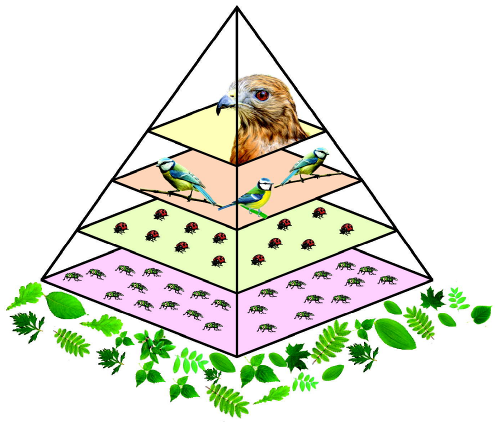
1.3.2 Ecological Pyramids

The graphical representation of the feeding level of an ecosystem in the shape of a pyramid is called "Ecological pyramid". It shows flow of energy from one organism to another. It was first introduced by a British ecologist Charles Elton. In the ecological pyramid the producers are represented at the base; and other successive trophic levels are represented one above the other with top carnivores at the tip.

There are three types of Ecological pyramids. Pyramid of number, Pyramid of biomass, Pyramid of energy.

Pyramid of numbers

The number of organisms in a food chain can be represented in a pyramid shape called as Pyramid of Numbers. At each trophic level in the food chain, from the first-order consumers to the large carnivores, there is normally an increase in size, but decrease in number, so the pyramid is upright.

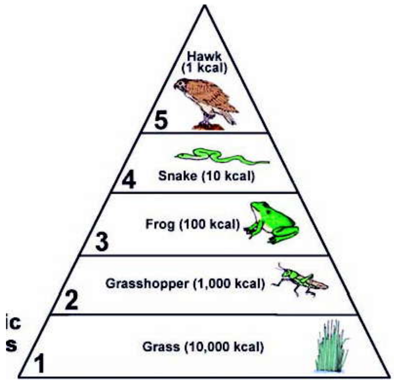


Pyramid of numbers

Pyramid of Biomass

Any type of plant or animal material that can be converted into energy is called biomass. The biomass of organisms in a food chain can be represented by a Pyramid of Biomass. In terrestrial ecosystems, the biomass progressively decreases from producers to top carnivores. So the pyramid of Biomass is upright.

Pyramid of Energy



Pyramid of Energy

Plants (producers) converts solar energy into chemical energy by the process of Photosynthesis. From the producers, the chemical energy passes to the consumers from one tropic level to the next through food. At each trophic level, organisms use most of the food energy that they assimilate into their bodies to fulfill their metabolic requirements.

Some energy is lost from a food chain mainly in the form of heat. Only about 10% energy reaches to the next trophic level Energy use diminishes from one trophic level to the other. Pyramid of energy is always upright.

* Are the Ecological pyramids always upright?

In an aquatic ecosystem, the biomass of microorganisms that are producers (phytoplanktons) is quite negligible as compared to that of the crustaceans and small herbivorous fish that feed on these producers. The biomass of large carnivorous fish feeding on small fishes is still greater. This makes the pyramid of biomass inverted.

CHECK YOUR PROGRESS.

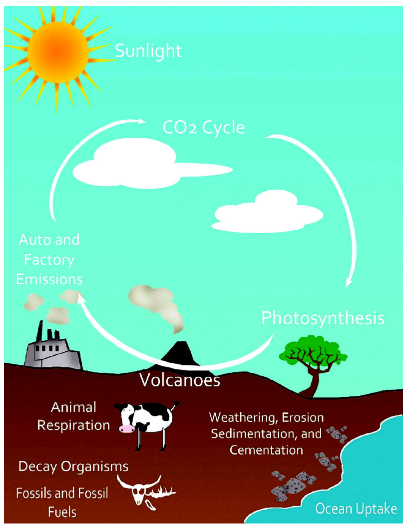
- Explain with exapmples, a fod chain and a food web.
- What are ecological pyramids?

1.4 Biogeochemical cycles

A constant interaction, between the biotic and abiotic components of the biosphere, makes it a dynamic, but stable system. These interactions consist of transfer of matter and energy between the different components of the biosphere. The cycling of matter may be represented by nutrient cycles. Though we may draw them separately for different elements, they are usually very much interconnected. As we know, matter may be elements, compounds and mixtures and thus, cycles may consists of all of them. Here are some examples that are just representative in nature.

1.4.1 Carbon Cycle

Carbon released in to the atmosphere by various methods such as burning fossil fuels, respiration of living organisms, from dead organisms and other organic materials decompose, volcanoes eruption, heating of limestone etc. Photosynthesis plays an important role in removing carbon from the atmosphere and place it back in to living organisms.



Carbon cycle

* What will happen, if Carbon is not recycled?

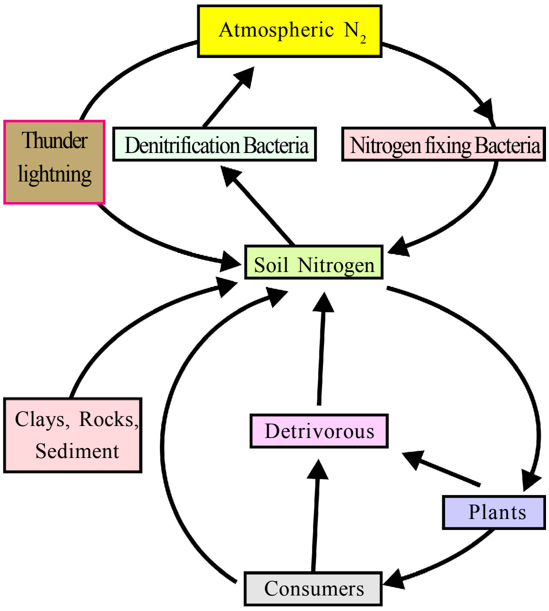
1.4.2 Nitrogen Cycle

The Earth's atmosphere contains 78% nitrogen, but plants and animals cannot use it in this form to make organic compounds for themselves. Nitrogen cycle has the following stages.

Nitrogen Fixation:

The process of changing atmospheric Nitrogen into nitrate and adding to the soil is called as Nitrogen fixation. We can see that nitrogen is an element while nitrate is a compound.

Nitrification: The Biological oxidation of ammonia to nitrite followed by the oxidation of nitrite to nitrate is called Nitrification. The transformation of ammonia to nitrite is usually the rate limiting step of nitrification. This is an important step in nitrogen cycle.



Nitrogen cycle

Assimilation: Nitrogen assimilation is the formation of organic nitrogen compounds like amino acids from inorganic nitrogen compounds present in the environment. Nitrogen compounds are taken up from soil by plants are used in the formation of plant proteins and as animals eat these plants, animal proteins are synthesized.

Ammonification: Production of Ammonia from Nitrates and other Nitrogenous compounds is called Ammonification. Ammonification also occurs when animals emit wastes, and the death of plants and animals. the nitrogen in the organic matter reenters the soil and water bodies where it is broken down by decomposer's.

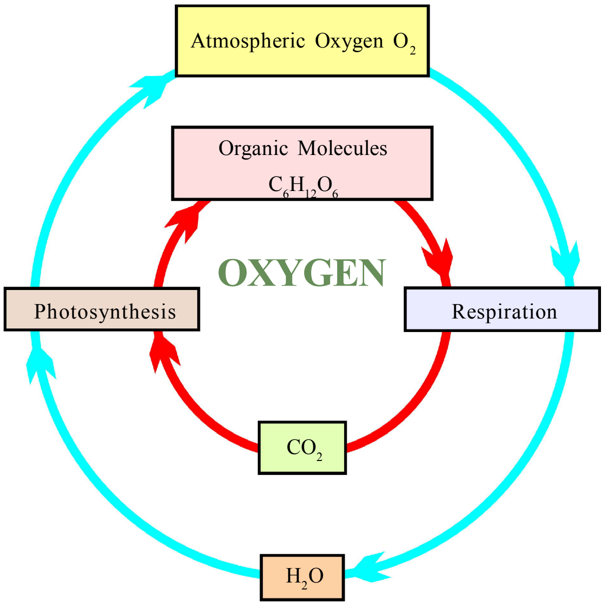
Denitrification: Solid nitrate is converted back to gaseous nitrogen through a process called Denitrification. It occurs primarily in wet soils where water makes it difficult for microorganisms to get oxygen. Denitrifying bacteria - will process nitrate to gain oxygen, leaving free nitrogen gas as a byproduct. Thus, the nitrogen is recycled and remains in a perfect balance.

1.4.3 Oxygen Cycle

Oxygen is an abundant element, next to Nitrogen, on our Earth. It is found in the elemental form in the atmosphere to the extent of nearly 21%. Oxygen is vital for life in many ways. It is also an essential component of most biological molecules like carbohydrates, proteins, nucleic acids and fats.

Living organisms utilized Oxygen in their respiration and releases Carbon di oxide. Dissolved oxygen supports aquatic life.

Oxygen from the atmosphere is used up mainly by the processes combustion, respiration and in the formation of oxides of elements like Nitrogen, Iron etc. Oxygen is returned to the atmosphere in only one major process, that is, Photosynthesis.



Oxygen cycle

Ozone

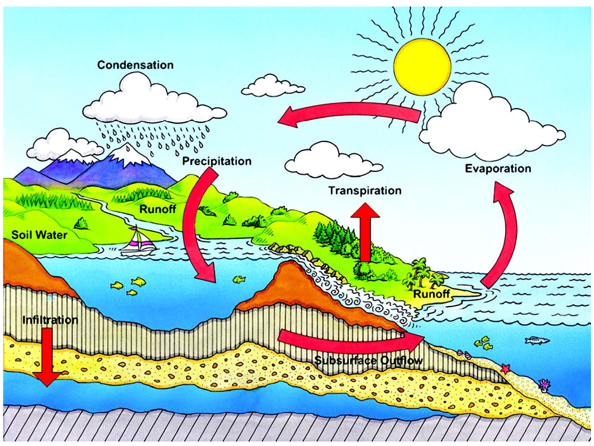
Ozone is a molecule containing three Oxygen atoms. It is blue in colour and has a strong odour. Oxygen having two atoms, colour and odour less. Ozone layer protects the living organisms by absorbing the harmful ultra violet radiation from the Sun.

1.4.4 Water Cycle

Water is the most essential, abundant substance in living things.

Earth's water is constantly in motion. The circulation of water into water vapour by evaporation, water vapour to clouds and clouds to rain by condensation is known as "water cycle"

Water changes to water vapor by three different processes, evaporation, sublimation and Transpiration.



Water cycle

1. **Evaporation** is the process by which water changes from a liquid to a gas or vapor.
2. **Sublimation:** occurs when ice and snow change directly to water vapor by the heat of the sun.
3. **Transpiration:** occurs when plants release water vapor through leaf pores called stomata.

The content of biodegradable substances in water is expressed by a special index called "biological oxygen demand" (BOD), representing the amount of oxygen needed by aerobic bacteria to decompose the waste.

CHECK YOUR PROGRESS.

- How, Oxygen enters in to the atmospheres?
- Explain about the Nitrogen cycle.

KEY POINTS

- An ecosystem is Structural and functional unit of nature.
- The living organisms in a habitat are classified into Autotrophs, Heterotrophs, parasites, Saprophytes and symbionts on the basis of their nutrition.
- Food chains and food webs are diagrams that represent feeding relationships of organisms in an ecosystem.
- Food chains and webs model how energy and matter move through ecosystems.
- Ecosystem requires constant inputs solar energy. Producers convert this solar energy into chemical energy. This energy is transmitted to the consumers through food. The energy flow in an ecosystem is unidirectional. The amount of energy is decreased from one trophic level to another along the food chain.
- The graphical representation of the feeding level of an ecosystem is in the shape of Pyramid called Ecological pyramid. It shows flow of energy from one organism to another.
- The cycles that involve the flow of nutrients on earth (elements essential for the living cell) from environment to organism and back through certain pathways are known as biogeochemical cycles.
- A Biome is large community of plants and animals of all ecosystems of an area.
- Adaptations are special features that allow a plant or an animal to live in a particular habitat.

PRACTICE FOR LEARNING OUTCOMES

1. Draw the diagrams of Number pyramid and Energy Pyramid.
2. Draw the diagram of any one food chain.
3. Why food chains form a food web?
4. Mention any two adaptations of polar/cold region organims.
5. Write 3 biotic and 3 abiotic factors
6. What is your role in Nitrogen cycle and Carbon cycle.
7. Why does the wax coating present on the leaves of floating plant.
8. Mention any two adaptations present in aerial animals.
9. Who is present at the base of the ecological pyramid. (   )

   A) producers   B) Herbivores   C) Carnivores   D) Decomposers

CHAPTER 2

Changes in Ecosystems

Natural changes usually become evident when they are sudden like calamities or disasters. Cleaning a forest area for agriculture purpose or for setting up factories are examples of large scale changes due to human activities.

* How do changes occur in ecosystems?
* What is the impact of human activities on changes in ecosystems?

Interrelationship between biotic and abiotic factors are studied in any ecosystem. Several ecosystems exist around us. They are constantly going either through gradual or sudden changes. Some changes are natural, whereas some are due to human activity.

* The COVID-19 pandemic has also caused change. Is it a natural one or caused by human activities? Give reasons for your answer.
* What will happen in the following situation?

There is a hundred year old tree in a forest. It serves as a habitat for a number of organisms. It provides food for some, shelter and protection for some and shade for some others.

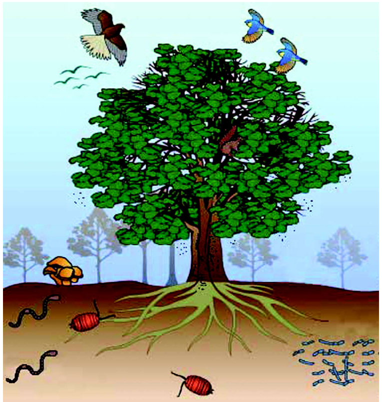
The tree collapsed in a strong storm:

* Put a tick mark on all options given here that you think are possible.

LEARNING OUTCOMES

The learner...

- ☆ Explains changes in the ecosystem.
- ☆ Categorises environmental problems into natural and manmade and cite examples.
- ☆ Gives reasons for changes in ecosystems due to climate change.
- ☆ Distinguishes between sudden and gradual changes.
- ☆ Explains about disasters with their management methods.
- ☆ Applies knowledge of different types of changes in adopting and managing them.



- ❑ All living organisms associated with the tree die.
- ❑ Some of the plants die while animals move out.
- ❑ Seeds or spores of plants grow again, some animals more out, some fail to dose.
- ❑ Animals living in the shade of the tree lose their habitat. More sunlight falls on the forest floor, which may lead to the formation of colonies of new organisms or death of some organisms.
- ✻ We are cutting down thousands of acres of forests for industries. What happens to the organisms living in that area?

2.1 Factors affecting changes in ecosystem

Here are somelines we come across over newspaper/ Telivision. These are some examples of changes to ecosystems.

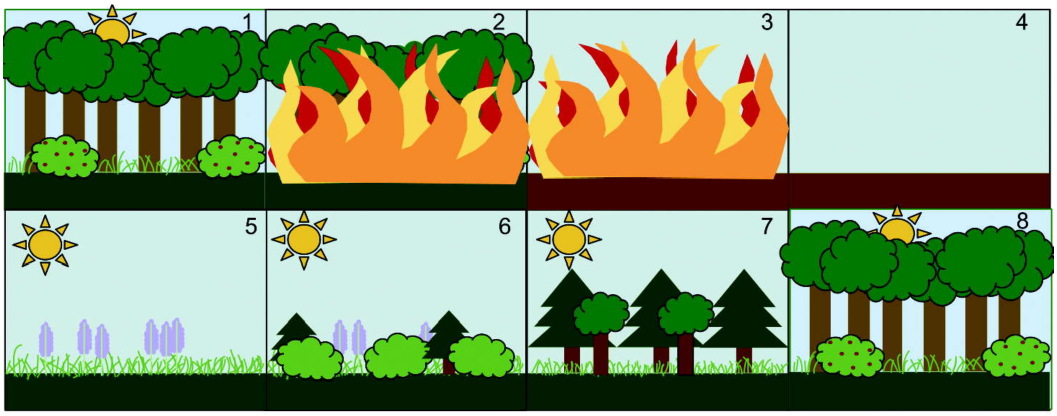
- ❑ Loss of property and life due to landslides.
- ❑ Eruption of volcanoes released lava, resulting in pollution.
- ❑ 16 people died in heat waves.
- ❑ Houses collapsed, hundreds died in the earthquake.
- ❑ Low lying areas submerged in water due to heavy rains.
- ❑ Ice melting in poles is resulting in rise in sea levels.
- ❑ Coastal area submerged due to the effect of tsunami.

- ✻ Do you think changes are only disruptive in nature?
- ✻ What impact do you think they could have on an ecosystem?

- ❑ Social Forestry Initiatives: Vanajeevi Ramaiah (Chetla Ramaiah) of Khammam district is well known for his contributions to extending tree cover by planting more than one crore saplings in and around Khammam district.
- ❑ Drought Prone and semi drought prone areas build the biggest reservior in the state: Rajanna Siricilla district had achieved this with good governance along with people's participation. The water table in the district raised by 6 meters in 3 years.
- ❑ Volcanic eruptions formed Galapagos Islands which are one of the most bio diverse areas on earth.

Here is an example of how forest five affects the ecosystem of a forest?

A forest fire started suddenly in a forest. It takes a lot of time to control and stop the forest fire. In the meantime, many herbs, shrubs, creepers, plants and trees are destroyed and reduced to ashes. Animals living in this ecosystem (squirrels, monkeys, birds and snakes etc.) falls under threat. Some of the animals die in the fire, other animals move to safer habitats. Other animals depending on these animals may die due to non availability of food. Some of the organisms also migrate to other areas.



On return of the favourable conditions. Those plants sprout first the seeds of which rely on a fire for sprouting. Grass starts growing in that area. Later herbs, shrubs and plants appear. It takes a lot of time for the growth of trees and return of animals. New organisms also come to that habitat. Forest usually grows back.

* The above forest ecosystem can't return to its original state. Do you a gree to this statement. Give reasons.

....

....

Activity-1

Observe any tree ecosystem in your surroundings. Birds, monkeys, squirrels, ants, snakes, spiders, caterpillars, house flies, bees, mosquitoes, moths, wasps are some organisms that you may find on a tree. Try to classify them based on where you find them.

1. Name of the ecosystem : ______________________
2. Place : ______________________
3. Organisms at the base of the tree : ______________________
4. Organisms on the trunk : ______________________
5. Organisms on, between the branches : ______________________
6. Organisms on the leaves : ______________________
7. Organisms on flowers : ______________________
8. Herbivorous animals : ______________________
9. Carnivorous animals : ______________________
10. List out all abiotic factors : ______________________

* Is there any threat to the ecosystem? Yes/No ______________________

  If yes, what? ______________________

  Suggest few remedial measures ______________________

Here is a list of several causes for changes in ecosystems classify them as natural man made and both by filling in the table:

Floods, cyclones, earthquakes, tsunamis, forest fires, landslides, heat and cold waves, volcanic eruptions, photochemical smog, droughts, vehicles, power stations, pandemics, deforestation, mining, more usage of fossil fuels, eutrophication, industrialization, urbanization, overpopulation, pollution, fossil burnings, nuclear power stations, chemical fertilisers, pesticides, chlorofloro carbons.

It is necessary to observe the effects of human activities on ecosystems. Let us observe the impact of human activities on ecosystems of our state.

2.2 Human Impact on Ecosystems

Case study of forest at Ramagundam:

60-70 years back Ramagundam had a dense forest with a rich heritage of wildlife. It was an abode for wild animals like tigers, leopards, deer, hyenas (kondrigallu), foxes, wild pigs (adavi pandi), bears, pythons, cobras, porcupines (mulla pandhi), owls, hares, monitor lizards (udumu) scorpions, geremandals (like the desert spider) etc.

After the establishment of thermal power station at Ramagundam (using coal to produce power) many other industries and human activities increased. This resulted in construction of many buildings, roads and stone quaries. Forest area was cleared and so several organisms started disappearing. While some others started inhabiting the area. People say peacocks have been sighted recently

Though an area near Mancherial (very close to Ramagundam) was once known as Tiger valley, it shows no signs of tigers now. Presently the forest ecosystem was totally transformed into an urban ecosystem a bunding in domesticated animals, humans, snakes, insects etc.

- What is the difference between the situation regarding types of animals present 70 years ago and now? Give reasons.
- Peacocks have an omnivorous diet. How can this be beneficial to their existence in Ramagundam.
- The Ramagundam forest is an example of changing ecosystem? Do you agree? Why/Why not?

The sad story of our Musi river

Hyderabad is located along the banks of Musi river. It is a tributary of the Krishna river flowing through Telangana. The river originates in Ananthagiri hills Vikarabad and flows into Krishna river at Vadapalli in Nalgonda district.

A report of 1908 states that the river had become flooded to such an extent that it inundated its banks causing the death of over 15000 people, rendering another 80,000 homeless. Heavy rains aggravated by cloudburst in the month of September had been the main cause for the floods.

The modern era of the development of the twin cities of Hyderabad and Secunderabad began soon after these floods in 1908. This necessitated planned, phased development. Sir Visvesvaraya, a Civil Engineer of repute in those days was requested by the Nizam's government for construction of flood protection and drainage system for the city. Sir Visvesvaraya proposed the construction of storage reservoirs of adequate capacity above the city, which proved effective in controlling future floods. There were several other engineers of his time who assisted him in successfully carrying out the plan like Mr. Ahmed Ali and Mr. C.T. Dalai.

Vishwesaraiya designed such a drainage system which if not clogged could help water flow into the river and down its basin. Sewage waste was redirected to a separate area in order to keep sewage from flowing into the river and clogging its outlets as well as causing depletion of water quality and siltation of the river basin. A sewage farm was built and pipes laid to carry the city's sewage there.This also helped in destroying mosquito breeding grounds and reduced incidence of diseases for which mosquitoes are vectors.

The first large reservoir came up as a dam was built in 1920 across the river, ten miles (16 km) upstream from the city called Osman Sagar. In 1927 another reservoir was built on Esi (a tributary of Musi) and named Himayat Sagar. These lakes prevented the flooding of the River Musi. They are major drinking water sources for Hyderabad city today.

Due to the increase in population, Musi river has become polluted adversely. Sewage is being dumped directly into the river. Water from it is being indiscriminately used over years. These have reduced it to a stinking slurry. The banks of the river have become a dumping site of waste. The water is worse than sewage water; its groundwater has become polluted as well by harmful chemicals from factories around it. The waters of Musi show traces of harmful chemicals. These chemicals enter the food chains and food webs affecting the health of livestock and crops in and around the area. Dissolved oxygen values of water has gone down and increased the biological oxygen demand.

The structure and nature of river Musi was changed completely. Drinking water became sewage water. Formation of silt has resulted in frequent floods. The water of the lake turned more alkaline in nature, turbid and low in Dissolved Oxygen (DO). So there is a need for high Biological Oxygen Demand (BOD), which affected aquatic organisms adversely.

Diseases like diarrhoea, typhoid, amoebiasis, arthritis, jaundice, skin allergies are common among the local inhabitants. Vector borne diseases like malaria, dengue have also increased.

Cyclonic rainfall in October 2020 had caused flash floods in the city of Hyderabad. Experts have attributed this to poor urban planning, a woeful drainage system and the pitiable condition of the Musi river. But along with all the perils, it has caused a rise in the volume of water in Musi, reviving it almost to its full potential.

- Write two causes for the floods of river Musi in 1908.
- Write 4 causes for the floods of Hyderabad in October 2020.
- In what ways could the flood of 2020 be avoided?
- What ways of management of natural calamity does the Musi river case teach us?
- Should sewage waste be dumped into a drinking water body?
- What does the meaning of cloudburst appear to you? Tick the option of your choice

  ❑ Sudden heavy rain   ❑ Slow steady rain

  ❑ Parting of clouds.   ❑ Bursting of clouds by separating them.
- Flash floods are rapid flooding of low lying areas. Why do you think Hyderabad experienced flash floods?
- How did flash floods help the Musi river condition?
- Write two beneficial and two adverse effects of human activity that impacted the Musi river.

Musi river, the Jeevanadi of Hyderabad is now transformed into a sewage water body on. How does a freshwater ecosystem change into a sewage water ecosystem? Also suggest how it may be revival.

The Musi River Reservoir Action Plan Project was undertaken to reduce the pollution levels in the river. Pollution control activities under the project are:

❑ Solid waste management

❑ Installation of sewage treatment plant

❑ Provision of low cost sanitary facilities

❑ Development of riverfront

❑ Efforts to develop public awareness

✻ State how the example of Musi river shows a changing ecosystem?

Industrial wastes are causing water pollution in many rivers and ponds in our state. Pollution gives rise to several major problems including a high incidence of diseases such as diarrhoea, skin allergies, malaria, dengue, food poisoning etc.

✻ What measures do you think should be taken to prevent pollution of water bodies.

✻ What changes do you think occured in the Musi river ecosystem?

Changes in ecosystems that affect it negatively have become a global concern over the last few decades. These changes include increase of some species, expansion of invasive species into new areas (Parthenium, COVID-19 virus), loss of habitats, intermingling of formerly nonoverlapping species etc.

The following changes are attributed due to human activities:(Impact on ecosystem). Do you think it is purely due to human impact? Why/Why not?

- ❑ Rising temperatures,
- ❑ Melting of ice at poles,
- ❑ Rising of sea levels,
- ❑ Air, water and soil pollution
- ❑ Increase in atmospheric levels of Carbon dioxide etc..

✻ The earth is getting warmer (global warming)? Why?

Ecosystems can vary from a small plant to a dense forest. The biosphere is the largest ecosystem present on earth. Terrestrial ecosystem and aquatic ecosystem are the main ecosystems of the biosphere. Climate change is happening on a global scale, but the ecological impacts are often local and vary from place to place.

Since the 1950s, drought and heat waves have appeared simultaneously with increasing frequency. Extremely dry and wet events within the monsoon period have increased. Ocean warming, sea level rise and ocean acidification may be caused as the result of these heat and cold waves.

Climate change has contributed to the expansion of drier climate zones, such as the expansion of deserts. Low lying islands and coastal communities are threatened through hazards posted by sea level rise. Some islands, coastal areas, and low lying areas are at risk of submerging. According to a study, the east coastal areas of India are in danger of being submerged in the coming 100 years. Economic damage, a consequence of climate change may be severe.

The following measures should be followed to control the changes in ecosystem.

1. Reducing greenhouse gas emissions.
2. Increasing the use of electric vehicles and public transport.
3. Rapid development of renewable energy.
4. Policies to reduce fossil fuel emissions, chlorofluorocarbons, aerosols etc.
5. Following soil conservation methods
6. Soil management on crop lands and grasslands.

7. Encouraging reforestation, forest preservation, water conservation.

* Mention some eco-friendly list of practices.

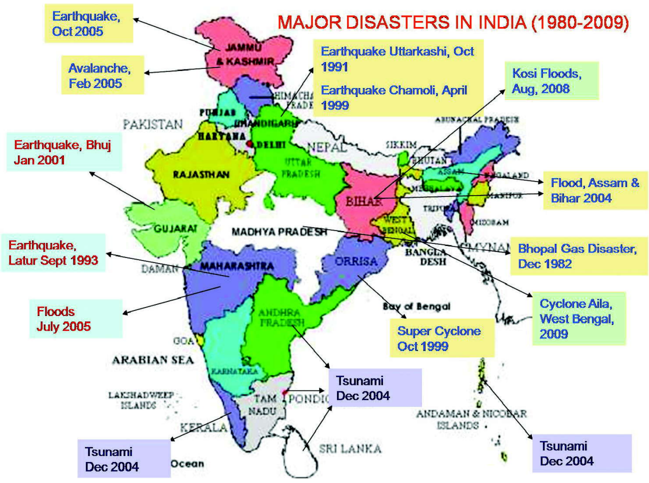
....

....

CHECK YOUR PROGRESS.

- How does an ecosystem change over fine? Is it always negative. Why/Why not?
- How do the changes in ecosystems show impact on living beings? Explain with an example.

2.3 India-Disasters



Observe the map and answer the following:

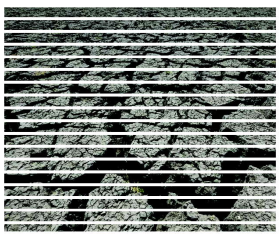
* Name the states where we had earth quakes after the year 2000.
* Name the states where we had floods. What must have been the cause of floods in those states?
* Make a list of all natural disasters mentioned in the map.
* Find out if some disasters have not been included in the map. Write a detailed account of such disasters.

Natural calamities are universal. Many disasters are a consequence of man-made activities, but some disasters are natural. This happens because of the weather or the natural conditions and some by human impact.

Major disasters in India

Here, a brief description of some disasters has been given.

India had faced the deadly disasters in its history. They are read the section and write in detail about any one of them in your own words.



1. **Great Bengal Famine, 1770:** West Bengal, Bihar, Odisha and Bangladesh were the affected areas and the number of deaths were around 1 crore. The reason was drought.

Nobel laureate, Indian economist, Amartya Sen describes this famine as a man made disaster. This was started in 1769 which continued for four years.

2. **Super Cyclone, Odisha, 1999:** Number of deaths were more than 15,000. This was the most dangerous tropical cyclone in the North Indian ocean. Its speed was 260 km per hour. It affected not only India but also Bangladesh, Myanmar and Thailand. Around 2.75 lakh houses were destroyed and 1. 67 million became homeless.

3. **Gujarat Earthquake, 2001:** Number of deaths were around 20,000, injured were 167000 and nearly 400000 became homeless. Suddenly an earthquake of 7.6 to 7.9 on the richter scale lasted for 120 seconds.

4. **The Indian Ocean Tsunami, 2004:** India and Andaman Nicobar Island, Lakshadweep Island, Indonesia, Srilanka etc. , were badly affected and the number of deaths were around 2.30 lakh people. Overall it affected around 12 countries. The magnitude of the tsunami was between 9.1 and 9.37 which was very high. As per the research it was the third largest earthquake in the world.

5. **Bihar Flood Disaster, 2007:** The Bihar flood disaster 2007 was described as the worst flood in the living memory of Bihar by the United Nations. It affected 19 districts in Bihar. Bihar flood had affected an estimated 10 million people in the entire state, about 29000 houses were destroyed, about 44,000 houses were damaged, 1 crore hectares of farmland damaged

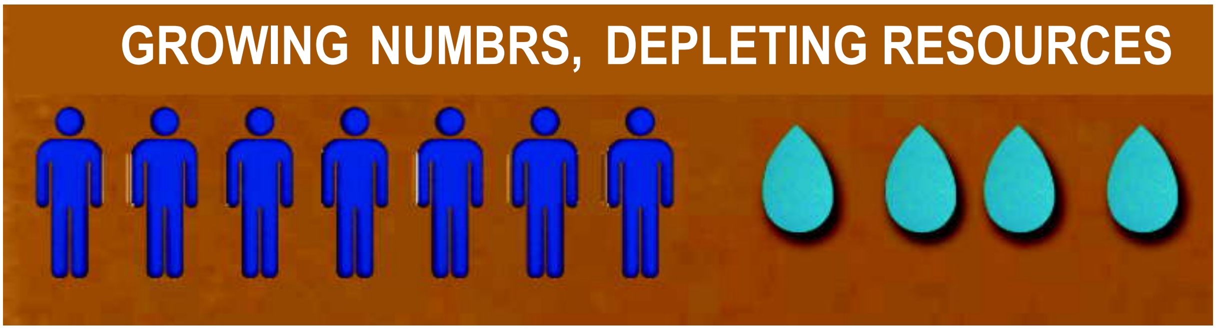
6. **Uttarakhand Flash Floods, 2013:** It affected 12 out of 13 districts of the state. - number of deaths are 5700. It was a sudden effect which was caused by heavy rainfall and massive landslides. This is the most disastrous flood in the history of India.

7. **Kashmir Flash Floods, 2014:** Number of deaths more than 550

No matter what disaster occurs, it brings a lot of changes in ecosystems that induces change in social and environmental situations. The disasters can be broadly divided into following categories.

1. **Hydrological related hazards:** Cyclones, floods, photochemical smog, hailstorm, droughts
2. **Technological hazards:** Industrial, chemical and nuclear disasters
3. **Geological hazards:** Earthquakes, tsunami, landslides
4. **Biological hazards:** Epidemics, pandemics, COVID-19, bird flu, plague in Gujarat

* Is India Disaster Prone? Which areas are disaster prone in our country? Let us know about the disaster prone areas in India.



2.4 Disaster Prone Regions of India

India is prone to disasters to a number of factors both natural and manmade; adverse climatic conditions, topographic features, environmental degradation, urbanisation, population growth, industrialisation, non scientific development practices etc.,

India is a disaster prone country and its region wise details are as follows

1. **Northern India:** It is confronted by landslides, avalanches, floods, droughts and earthquakes (area falls under seismic zone III to IV)
2. **Eastern India:** The area is prone to severe floods (due to Brahmaputra and Gangetic rivers), droughts, heavy wind, heat waves, hailstorms, cyclones and earthquakes.
3. **North eastern India:** It is affected by floods, landslides, wind damages and earthquakes (area falls and the seismic zone IV to V)
4. **Western India:** It is confronted with severe droughts, wind erosions, floods, cyclones and earthquakes (Gujarat, Bhuj)
5. **Southern India:** Southern India is prone to cyclones, sea erosions, tsunami and landslides
6. **Islands of Andaman Nicobar and Lakshadweep:** The area is prone to sea erosion, tsunami, sea level rise etc.

2.5 National Disaster Management Authority (NDMA)

Help Line Number: 011-26701728-1078

NDMA was established through the disaster management act enacted by the government of India on 23rd December 2005 and is responsible for framing policies, guidelines and best practices. It is headed by the prime minister of India and can have up to nine other members. NDMA coordinates with the State Disaster Management Authority (SDMA) to ensure a holistic and distributed approach to disaster management. It creates awareness among people by conducting mock drills etc. regarding disasters. Gives training at district and regional level, helps in reducing loss of life and property at the time of disasters.

In addition a Calamity Relief Fund (CRF) has been constituted in which union government and state governments contribute in the ratio of 3:1. So far CRF of 11th Finance Commission has been made eligible for disasters related with cyclone, drought, flood, earthquake, fire and hail storm, but in 12th Finance Commission CRF will also deal with landslides, avalanches, cloud bursts and pest attacks.

There is a need for increased awareness on the latest advances in ecosystem disaster risk reduction and climate change adaptation/ecosystem based adaptation. - United Nations Environment Policy (UNEP)

Ecosystem Disaster risk reduction- to achieve sustainable and resilient development.

Climate change adaptation/Ecosystem based adaptation - to help people adapt to the adverse effects of climate change by using biodiversity and ecosystem services.

Telangana State Disaster Management Authority.
040-23442944, 23442955

Disasters: Do's and Don'ts

- We should follow the information and warnings issued through T.V. , radio, newspapers. Don't spread rumours.
- Switch off electrical mains in your house.
- Keep ready the phone numbers of all emergency services like police, fire brigade and medical centres.
- Pack essentials for yourself and your family to last a few days including medicines, food, water, clothes etc.

Post disaster measures

- Do not drink contaminated water.
- Strictly avoid any loose and dangling wires.
- Don't go out to places where trees and buildings collapsed.
- Use and follow the advanced technology to follow the pre alerts.
- Cooperate and help your neighbours and friends.

In many areas man has changed the natural ecosystems to a great extent by damming rivers, draining marshes, re-claiming land from the sea, cutting down forests, plough-ing up land and growing crops, and by building towns, cities, canals and motorways. These changes have greatly altered the communities of plants and animals living there.

5th June of every year is observed as World Environment Day.

Ecosystems provide important services that can address several risk factors. Well managed ecosystems reduce vulnerability by providing food, water and resources and also saves biodiversity. If we save nature, it saves us.

CHECK YOUR PROGRESS.

- Explain the types of disasters
- Describe any two major disasters that occured in the past two decades in India
- What causes ice to melt at the poles?

KEY POINTS

- Ecosystems are constantly going through changes.
- Some changes in ecosystem are natural and some are due to human activity.
- Ecosystem changes affect the environment.
- Sometimes changes in the ecosystem lead to disasters.
- The National Disaster Management Authority was established for the management of disasters.

PRACTICE FOR LEARNING OUTCOMES

1. Write some slogans on climate change.
2. List out natural and manmade disasters.
3. What human activities could be reduced or curbed to save an ecosystem?
4. How does the changes in the ecosystem and climate changes affect human life?
5. How do you help people, If a disaster hits your area? What measures should be taken after the disaster?
6. What are the responsibilities of the National Disaster Management Authority?
7. The following is not a natural calamity ( )

   A) cyclones B) use of fertilizers C) floods D) Earthquakes
8. A pandemic ( )

   A) COVID-19 B) Typhoid C) Jaundice D) Heart problem
9. Global warming leads to ( )

   A) Land slides B) Melting of ice at poles C) Smog D) Depletion of fossil fuels
10. Matching

A.	Hydrosphere	( )	1.	Global warming
B.	Greenhouse gases	( )	2.	Pollution
C.	Geological hazards	( )	3.	Fresh water eco system
D.	Industrialisation	( )	4.	Earth quake

CHAPTER

3

Waste and its Management

Different types of wastes are generated by various activities in our day to day life. The things not useful for us can be useful for others. For example, old newspapers, used notebooks etc., are wastes for us, but they are raw materials for paper mills. Similarly, plastic and cardboards that we throw away are a source of earning for people who collect wastes. In India, nearly 62 million tonnes of waste is generated every year and by 2050, it is expected that nearly 3.4 billion tonnes will be generated.

The lack of understanding and awareness of wastes had disastrous effects on the environment. Resources will be depleted. Waste management should be done properly to protect our resources and environment. Cleanliness should be an integral part of our life. Waste management should be given importance in and out of our homes. Swachh Bharath - Swasthh Bharath should be our objective.

- What type of wastes are generated in our daily life?
- How can we reuse wastes?
- Why is proper management of wastes necessary?
- How are wastes disposed?

LEARNING OUTCOMES

The learner...

- ☆ Classifies the types of wastes.
- ☆ Identifies the sources of wastes.
- ☆ Identifies about the need for waste management.
- ☆ Explains waste disposal methods.
- ☆ Gives examples for success stories of waste management.
- ☆ Applies the knowledge of waste management in day to day life.

3.1 Wastes

* How much waste is generated in a day?
* What would happen if wastes generated accumulate at a place?

Activity-1

Take a medium sized bucket. Collect most of the wastes generated at home. This is the quantity of waste generated by your family, per day.

Prepare a list of waste materials generated in a day. Classify them as wet and dry wastes with the help of given examples.

Table-1

S.No.	Wet Wastes	Dry Wastes
1	Left over food	hair
2		
3		
4		
5		

* Can you imagine how much wastes generate in a day?

Weigh the wet wastes generated in a day. Divide this total weight by the number of persons living in your house. The result will be the per capita wet wastes produced in a day.

$$\text{Per capita wet wastes produced} = \frac{\text{Total weight of wet waste materials}}{\text{Number of persons in your house}}$$

❑ Multiply it by 30 = ... per month.

❑ Multiply it by 365 = ... per year.

You will be surprised to note this astonishing figure of the waste generated in a year.

Now, you may make an estimate of the amount of waste generated by all the people in your locality/ colony/village/city.

* Is our surroundings clean?
* What are the reasons for unclean surroundings?
* What are the different problems that would arise out of this?

Anything which is unwanted or useless is termed as waste. With the increasing population, waste generated is becoming unmanageable.

Observe the pictures.



Open dumps and heaps of garbage is the common sight. This unhygienic atmosphere leads to problems related to human health and environment, because untreated, uncovered waste is a breeding ground for flies, rats, mosquitoes and other insects which spread various diseases. The rainwater runoff from such sites contaminates nearby land and water. So it is necessary to plan for waste management.

We are generating tonnes of wastes in our daily activities. We throw wastes wherever empty places are found in villages, towns and cities. Some of the wastes rot and mix with the soil, but some others not.

Activity-2

Let us do the following activity and observe for one month to know more about this.

Take a pot or bucket. Fill half of it with soil. Keep wet and dry wastes in it. (Wastes should include vegetable peels, fruit peels, plastic, wood, paper etc.

Add some more soil and sprinkle water regularly. Tilt it and observe in 15 days intervals. Note your observations. Some of these wastes decomposed but some are not.

You may have observed that most of your house hold waste is composed of vegetable or fruit peels or any leftover food material.

* Why are some materials not decomposed?

These wastes can be divided into two types.

1. Biodegradable waste
2. Non biodegradable waste

Biodegradable waste: includes substances that can be degraded by microbes into harmless and non toxic substances.

Examples: vegetable peels, leaves, twigs, dung etc.

Nonbiodegradable waste: wastes cannot be easily degraded.

Example: aluminium cans, plastic, glass, batteries, e-waste, etc.

* What happens to non biodegradable wastes?

Usually we either throw away such house generated wastes or sell them. There are places other than our homes from where wastes are generated in large amounts daily. These are industrial areas, hospitals, commercial places, schools, colleges, and other government or private organizations

* What do you think the people who collect waste do with the waste they collect from our homes?

3. 2 Different types of wastes

While there are many different kinds of waste we can generally divide waste into 6 different categories. Recognising the different types of waste can help us decide how to treat or manage it.

1. **Dry/recyclable waste:** Consists mostly of man made products or materials that cannot be broken down or decomposed by natural organisms but can be recycled. Eg: glass, plastic, metal, paper, wood, leather, clothes
2. **Wet/biodegradable waste:** Refers to organic matter or waste from natural materials that can be broken down by microorganisms and fungi. Eg: fruit and vegetable peels, rotten fruits, left over food, fallen leaves, cut flowers
3. **Bio medical waste:** A kind of waste containing infectious materials coming from hospitals, clinics, testing centers etc. Eg: infectious waste includes discarded blood, used bandages and dressings, discarded gloves, masks, gowns, used needles and syringes, operation theater wastes etc.
4. **Electronic waste/E- waste:** Used electronics refurbishment, reuse, resale, recycling or disposal are considered as e_waste. It includes discarded electrical or electronic devices. . Electronic scrap components contain potentially harmful materials such as lead, cadmium, beryllium etc. affecting our health. Eg: sim cards, batteries, old televisions etc.
5. **Construction/demolition waste:** Consists of wastes produced during construction or demolition. Eg: old tiles, cement, broken bricks etc.
6. **Hazardous (chemical) waste:** Wastes that are a threat to public health or the environment. Eg: pesticides, acids, cleaning liquids, industrial wastes etc.

It is necessary to separate the wastes depending on their type. Ambikapur stood second in Swachh Survekshan, 2019. 51 Metric tonnes of wastes are generated daily at Ambikapur. It was successful in segregating wastes at domestic level (100%), collecting dry and wet wastes separately by e-rickshaws and following a three tier system (door to door collection, solid and liquid waste management, segregation of wastes) for waste management.

Ambikapur- waste collection by e-rickshaws

Separate colour dustbins should be used for dry wastes and wet wastes. The Government of Telangana had distributed two colours of dustbins to each house in all municipalities and corporations of the state. Awareness was created among people to use blue colour dust bin for dry waste and green colour dust bin for wet waste.

Wet waste should be used to prepare compost at school and house level. Dry wastes should be reused or recycled. If the above processes are not possible, dry wastes should be disposed properly

CHECK YOUR PROGRESS.

- Write the dry waste & wet waste generated at your home?
- What are the types of waste? Explain about them.

3.3 Waste Management

Waste management includes the activities and actions required to manage waste from its inception to its final disposal. This includes waste collection, transport, treatment, recycling and disposal of waste.

- What is waste management and disposal?
- How do you handle waste management?

Wastes can be solids, liquids or gases. Each type has different methods of disposal and management. Waste management is intended to reduce adverse effects of waste on environment. Proper management of waste is important for sustainability.

Waste sorting is the process by which waste is separated into different elements.

The following steps are followed in waste management.

1. Curbside collection: collection of waste by special vans or trucks at regular intervals
2. Vacuum collection: waste is transported from home /commercial premises by vacuum
3. Waste minimization
4. Waste segregation
5. Waste sorting
6. Mandatory recycling
7. Waste disposal

4 R's towards Waste Management

By using the 4 R's we can effectively contribute to reduce the waste, such that less amount of waste may go to landfills. Pollution of our environment and ground water resources can be reduced by implementing 4R's

The aim of Swachh Bharath programme initiated by Central Government is to achieve clean India by the year 2025.

1. R-Refuse : Avoid buying unnecessary materials, refusing the usage of waste generating materials Eg: Packaging material, plastic straws.
2. R-Reduce : Less usage of resources and reducing the amount of waste production at its source. eg:paper
3. R- Reuse : Reusing some materials without throwing away..
4. R- Recycle : The process of converting waste materials in to new materials and objects.

Our School_ Waste Management:

We have NGC(National Green Corps) eco clubs in our school. The students of class VIII were divided into five groups; 1. Biodiversity group, 2. Water management group, 3. Cleanliness group, 4. Energy management group, 5. Soil management group.

Awareness was created to the students and elders regarding plantation, proper usage of water, electricity, waste management, cleanliness etc. with the help of teachers.

Two dustbins were provided in each classroom. Awareness was created to use blue dustbin for dry waste, and green dustbin for wet waste. Wet wastes are converted into compost and used for plants in our school. We are sending dry wastes to recycling units without burning.

* What programmes are organized to protect the environment at your school/locality?
* What is the need for waste management?
* How can you preserve natural resources by following waste management?

3.4 Waste Disposal Methods

At present, the common methods adopted in waste disposal are as follows.

Mysore - Waste segregation

1. **Manual component separation:** Reusable articles are manually separated for recycling or resale, Eg: card boards, paper, news paper, glass etc.
2. **Compaction:** After separation, volume of wastes is mechanically reduced by compactors.
3. **Incineration:** The combustible wastes are subjected to incineration, It is used when suitable dumping land areas are not available. Incineration is a process of burning of waste after segregating

the recyclable material. The end product of the process is called ash which is then disposed of in landfills. Unfortunately incineration produces toxic gases which cause air pollution. Eg: rubber, wood, scrap, plastics

4. **Open dumping:** Some wastes are directly dumped in low lying areas of the earth or open areas in and out of the locality/village. Environmental problems arise from this method.

5. **Sanitary land filling:** It involves the disposal of municipal wastes on or in the upper layers of degraded areas.

6. **Pyrolysis:** It is a kind of destructive distillation in which the solid wastes are heated in a Pyrolysis reactor (650-1000 degrees C) in oxygen depleted environment.

7. **Composting:** Decomposition by microorganisms. They convert organic components of the municipal wastes into humus or compost and the process is known as composting, It is also called bio degradation.

8. **Bio remediation:** It is a process of wastewater treatment of human sewage and manufacturing industries.

9. **Recycling:** Waste materials are processed by some means and converted into a product, we call the process recycling. It helps in efficient management of wastes and also reduces the load on natural resources.

Some examples of Recycling are:

- Recycling of plastics and paper, converting municipal waste into manure converting rice husk into cardboard. Use of cattle dung for the production of biogas production of energy and electricity from biogas, energy and electricity.

Bio fertilizers are made by using aerobic and anaerobic processes from house hold wastes and municipal wastes/village wastes

(Railway has set up a bio gas plant in Mumbai Central to use organic waste to make fire for the railway kitchen.)

Waste disposal is a time taking major issue, as it has to be carried out with following objectives.

- Collecting solid wastes, transporting, and eco friendly disposal should be followed.
- Industrial wastes should be converted to less harmful substances by using biological, physical and chemical methods.

- It should not create any health hazard.
- It should not cause adverse environmental effects.
- It should involve opportunities for recycling of materials or waste utilisation.
- The process should be economical and eco friendly.

The Central government launched the Swachh Bharat Mission on 2nd October 2014.

Some objectives of the mission are given below:

- Elimination of open defecation
- Eradication of Manual Scavenging and usage of machines.
- Modern and Scientific Municipal Solid Waste Management
- To effect behavioural change regarding healthy sanitation practices
- Generate awareness about sanitation and its linkage with public health.

Waste is generated in an unmanageable way. The Swachh Bharat mission emphasizes on having a functional waste management system in each and every gram panchayath, town and city.

Swachh Survekshan is an annual survey of cleanliness, hygiene and sanitation in towns and cities across India. Indoor bagged first place in Swachh Survekshan survey for four consecutive years (2017, 2018, 2019 and 2020)

Let us know the practices followed by Indore to bag this award, 1115 metric tonnes of wastes generated daily in Indore (Madhya Pradesh). Creating awareness among public, decentralisation, development of infrastructure, 100% segregation of wastes at domestic level, seeking partnership of N.G.O's are some of the measures for cleanliness and waste management of Indore.

Let us know about how the waste management is going on in our state.

Success Stories

Village level- Ananthasagar

Ananthasagar of Chinnakodur Mandal, Medak district of Telangana is the proud recipient of Nirmal Gram Panchayat award. It was like any other village previously, a place where all used to defecate in open. Water borne diseases were very prominent. Let us know the steps taken by the gram panchayat to overcome this situation to bag the award.

The gram panchayat took a stand that if they find anybody henceforth going in open defecation would be charged with a penalty. In order to change the mindset of the community members, IEC activities were taken up. Traditional folk media, kala Jatara, door to door campaign, wall paintings, conducting parents meetings in school, rallies and other programs for generating awareness were carried out.

In order to sustain the program, school waste management also started to create awareness among students. The school sanitation committees for toilet complex, wash committees, environment and health committees were also formed in schools.

We shall also make our village/town /city clean. Prepare a plan to achieve this.

Division level-Rajendra Nagar

Rajendranagar is one of the most populous divisions in Hyderabad, generates a considerable amount of waste every day, ranging from 25 to 30 tonnes.

The waste management mechanism in the circle is such that despite the generation of so much waste, it does not pile up. The waste is segregated and dealt with on a daily basis. Nearly all the households in the circle segregate waste before handing it over to garbage collectors. The circle has a vermicompost plant and two dry waste collection centres

City level-Warangal:

Warangal city (Telangana) bagged Clean Cities Championship award, 2012. It is the first city in India to achieve 100% door to door municipal solid waste collection. Let us know the planning followed by Warangal to achieve this award.

houses → Collection of wastes → Waste collecting center → Seggregation of wastes

Collection of wastes: dry wastes, wet wastes

Seggregation of wastes: degradable wastes, recyclable wastes, wet wastes

degradable wastes → compost

recyclable wastes → recycling

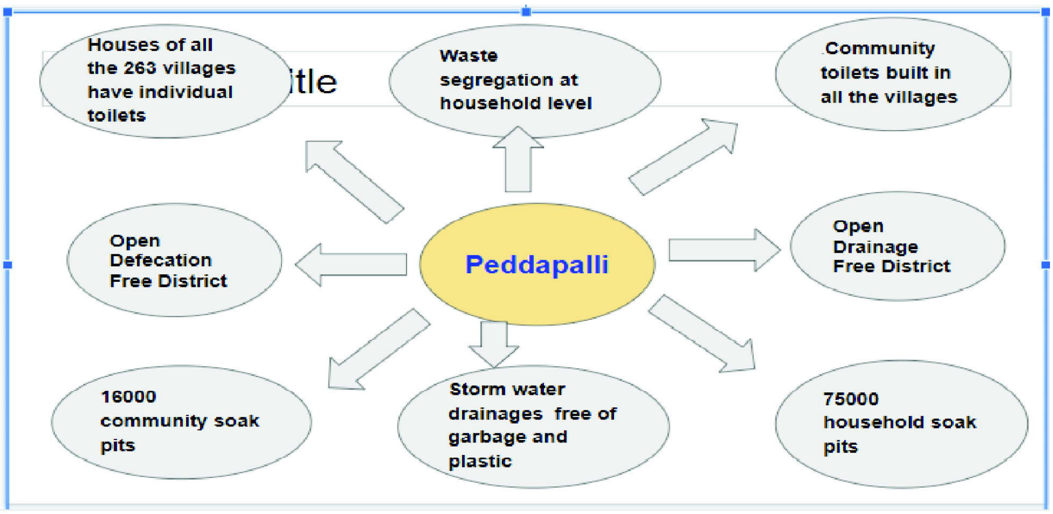
wet wastes → proper disposal

District level - Peddapalli

Peddapalli district of Telangana was bestowed the award of top district of Southern India and stood third in India - Swachh Survekshan, 2018. Continuing the spirit, Peddapalli has emerged as the 'Over all Best District' in the country in terms of sanitation and cleanliness. Swachh Survekshan. 2019. The district had won Swachh Sundar Shouchalay (neat and clean toilets) award with the construction and usage of 1.35 lakh individual sanitary latrines. (Open Defecation Free (ODF) district)

It is the first-ever district in India to be completely free of an open drainage system. Peddapalli has achieved this distinction of being designated as the cleanest district in the country by a combination of good governance initiatives, people's participation and prudent use of funds available.

Peddapalli: Novel ways of waste management:



In one year, IAS Officer turns a High-Risk Dengue Area Into India's Cleanest District. District collector, A.Sri Devasena was personally involved in the campaigns of swachh survekshan, involving Self Help Groups for the beautification of toilets, creating awareness among public, using cultural fests and media to educate people, involving NGOs etc to achieve this.

A community toilet in Peddapalli

CHECK YOUR PROGRESS.

- Write the importance of 4R's of waste management.
- Write about the objectives of Swachh Bharath programme.

3.5 Waste Management - Our Initiative

We have observed how waste can be managed in different ways after collection. If we could make an effort such that waste does not collect in large amounts, then it would be more helpful to address the problem of waste disposal.

* How can we reduce the production of wastes?

Let us make a list of such materials in our house, that we throw away by using them just once while we could have used such materials in their place that could be used over and over again.

Table 2

Sl.No.	Non reusable Materials	Reusable materials
1	Plastic glass	Steel glass
2		

You could take a meaningful initiative towards waste management.

Let us know how Individual/community/village/town/city level waste management can be done

Individual level:

- Use less and do not waste things.
- Find ways to reuse things
- Follow recycling of wastes
- Use cloth bags
- Conduct awareness programmes at schools/colonies
- Encourage all to participate in Swachh Bharath

Community level:

- Identify communal collection points for segregation and transfer
- Clean surroundings weekly once through clean-up drives (Swachh Bharath)
- Establish community based recycling centers
- Collect waste separately (dry/wet waste) (Separation of wastes should be based on the type of waste)

Village/Municipalities/City level:

- Adopt zero waste policy.
- Setup facilities for proper E-waste management.
- Install biogas units in villages/municipalities/cities that can generate energy and electricity. NEDCAP provide subsidies to establish bio gas plants under the central government guidelines.
- Establish a system for scientific disposal of municipal waste management.
- Develop strict policies for industrial waste management.

I am Shanthi, working as a waste collector. Collecting door to door wastes, sending them to the dumping site is our work. We are doing our best in keeping the surroundings clean and environmental protection. You should also follow the methods to reduce waste.

KEY POINTS

- Anything which is unwanted or useless is termed as waste.
- Categorizing wastes helps in its management.
- Those wastes that are degraded by living organisms are called biodegradable and those that aren't are called non- biodegradable.
- Most of the wastes generated at home are biodegradable.
- Waste reduction, disposal and management are essential.
- Manure produced by composting is very useful for agriculture
- We should use 4 R's for effective waste management.

PRACTICE FOR LEARNING OUTCOMES

1. Write your suggestions to make your village eco friendly.
2. Differentiate biodegradable wastes and non biodegradable wastes.
3. List and classify the wastes generated at home
4. Give some suggestions for wastes management in your locality.
5. How do you create awareness among people regarding plastics
6. What are the substances needed to prepare compost?
7. Which of the following method is used to sort out wastes?

   A) At source B) Compost C) At landfill D) All the above
8. Which substances can be decomposed easily using microorganisms? (   )

   A) Substances made of metal B) bio degradable substances

   C) e-waste D) plastic wastes
9. The following is an example for bio waste (   )

   A) Masks used for COVID-19 B) Radioactive waste

   C) Industrial waste D) Construction wastes
10. Matching

A)	plastic covers	( )	1.	hazardous/chemical waste
B)	damaged computer	( )	2.	dry/recyclable waste
C)	fruit peels	( )	3.	electronic waste/e-waste
D)	used needles and syringes	( )	4.	wet/biodegradable waste

CHAPTER

4 Biodiversity and Classification

Sunitha and Ramu went to their grandparents' village during the summer vacation. They were surprised to see the sparrows coming into their house. They asked their grandfather why sparrows are not seen in their house in the city. While going to the fields they observed several insects and birds. They saw insects like grasshoppers and lightning bugs for the first time. As they went around the village and the fields they observed many more organisms. Grandpa told them that he had observed 47 different organisms in his field. He said the number was less this year than the previous year and it is alarming. According to grandpa, all organisms have specific places where they live and reproduce, called as habitats. Sunitha added that a habitat provides food and shelter as well. So, grandpa remarked, sparrows may not be getting enough of food or shelter in the city.

- What would happen if only a few organisms stayed in a place?
- Should we preserve organisms in their natural habitat? Why/why not?
- What should be done to study all living things on earth and preserve them??
- How do we identify organisms?

LEARNING OUTCOMES

The learner...

- ☆ Explains biodiversity and importance of its conservation.
- ☆ Identifies the endemic, endangered and extinct species.
- ☆ Gives reason for extinction of species.
- ☆ Classifies organisms on the basis of their characters.
- ☆ Draws the flowchart of classification for plant and animal kingdom.
- ☆ Appreciates the work of scientists who tried classifying organisms.

4.1 What is biodiversity

No two living things on earth are alike.

While going to the fields, Sunitha and Ramu noted the names of some of the plants in their notebook with the help of grandpa. They also made sketches of some of them. They found 18 different organisms on their way to the paddy fields.

- ✳ How many types of animals are there in your surroundings?
- ✳ How many types of plants are present in your surroundings?
- ✳ Are there any organisms which are not visible with your unaided eye?
- ✳ How many different types of organisms do you think could be present on your body?

There are a large variety of organisms on our earth, from the single celled organisms which are invisible to unaided eye to the largest red wood trees and the biggest animals like Elephants and Whales. All organisms which live in a particular place are the biodiversity of that particular place. The biodiversity on our body includes around 10000 species. We may find some species in particular places only. At the same time there are differences between two organisms of the same species in the same place.

4.1.1 Diversity in Plants

In the paddy fields Sunitha and Ramu observed the workers removing plants other than the paddy. They asked their grandfather why the people were doing so? Grandpa told them that those were plants harmful for paddy production and are called weeds. The grandfather showed them that some weeds like Asters, Euphorbias and Amaranthuses were being dug out from the paddy fields and planted in pots. These pots would be carried away to another field where flowering and medicinal plants were being grown.

As the plants were being uprooted, grandpa asked the children to look for two aster plants that were same. Ramu went searching for them. Sunitha said she would look for two same paddy plants.

- ✳ What do you think, will Sunitha be able to do that? Why?
- ✳ Grow some mustard seeds/ avala ginjalu in a pot. Once the plants are around 5 to 6 inches in height, find out the similarities and differences in any two of them.
- ✳ Let the plants grow taller, try to find out two same leaves on the plant.
- ✳ Can you find two same leaves on a mango tree?

Grandpa told the children that no two plants on earth could be same. Also, it was not possible to find two same leaves on any plant. “But all ants are same”, said Sunitha. Ramu added, “the aphids on the leaves of rice plants were same”. Next day, grandpa gave them a handlens to find out if that was true.

4.1.2 Diversity in Animals

Grandpa told grandma “Today Laxmi didn't give milk properly”. Grandma asked “What about Gouri?”. Sunitha was surprised! All the cows in the dairy were white. How did grandpa and grandma make the difference? Grandpa asked them to take a closer look. See the ears, tails, eyes etc. more closely.


Observe animals in the pictures and make a list of all the characters that one may study to find out differences and similarities of such animals.

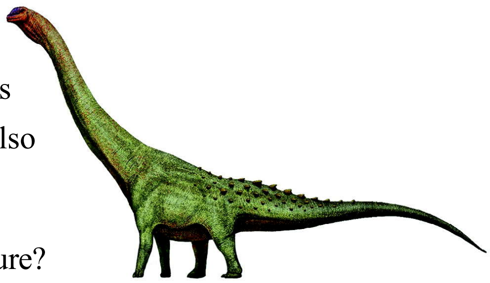
We see that biodiversity is about the differences in species and communities of them. Differences within species also add to biodiversity.

CHECK YOUR PROGRESS.

- Is it useful to have diverse organisms in an area? How?
- Write differences between any two organisms from your surroundings.
- What is biodiversity?
- By removing weeds from an agricultural field, do we affect the biodiversity of the area? How?

4.2.1 Extinct species

The most dangerous animal in the world is Man.



Man not only kills his fellow human beings using his intelligence for his survival, happiness and comfort, but also many other creatures all over the world.

* Have you ever seen the creatures present in this picture?
* Do we see anything similar? What are they?

These are called Dinosaurs. They once lived on earth. We do not see them anymore but organisms similar to them like the lizards, crocodiles etc. inhabit earth now. We do not know for certain how they became extinct. Some say that resources in their habitat had become less while others say that natural calamities had caused their extinction.

In the last 100 years around 500 species of animals disappeared from the earth. Due to human activities like pollution, deforestation, hunting or due to natural calamities like earthquakes, floods, volcanoes these species animals were extinct on earth.

Pink-headed duck

Northern Sumatran rhinoceros

4.2.2 Endangered species

Countries on the Indian subcontinent began banning diclofenac in 2006 and since then, vulture populations in the region seem to have increased.

'Diclofenac' is a drug that was used till 2006 in our country. Till then its use for treating diseases in cattle was most widespread and it would remain in the flesh of the animals even when they died. Vultures eating dead bodies having diclofenac residues, would die for certain. This lead to a drastic reduction in numbers of vultures to such an extent that, it was almost as if, they would go extinct. Fortunately, we found these vultures in Adilabad and Hyderabad of Telangana after the ban on the drug was imposed. An organisation SAVE (Saving Asiatic Vultures from Extinct) is putting good efforts to safeguard these asiatic vultures in Indian subcontinent. And slowly their number is increasing.

The white-rumped vulture

cycas

Fishing cat

Loris

These pictures are of organisms that are in danger of being extinct, in other words, these are called, endangered species.

WWF (World wildlife federation), IUCN**International Union for Conservation of Nature** together publish the data of endangered and extinct animals in a form of document called as the RED DATA BOOK.

4.2.3 Endemic species

Identify and write the names of the animals under their pictures.

All of us have heard the word 'pandemic' in connection to the corona virus disease. We know that it spread all over the world. As against a pandemic, 'endemic' relates to a specific area. We may thus say that Kangaroo populations are endemic to Australia as Asiatic lions are to India (Gir Forests). Purple frogs are endemic to the Western Ghats of India.

* How do species of organisms become endangered?
* Which organisms have more chances of becoming endangered, those that have a pandemic spread or those endemic to an area? Why?

CHECK YOUR PROGRESS.

- What are endangered species? Explain with examples.
- Write some endemic species of India.

4.3 Factors for biodiversity

The forest affected by wolf population.

In 1872 when 'Yellowstone National Park' was created in West America, it was mainly to support the prey population there. The predators affected deer population were controlled by rampant hunting. Numbers of gray wolves, bears and other declined rapidly. By the end of 1920, wolves had disappeared from the Yellow national park. After that, the number of deer (antelopes) increased drastically. These deers started eating the plants, even small bushes. And slowly the forest started vanishing. The wolves were recognized as endangered species and from 1995 they were introduced in the national park. They started hunting deers and slowly the forest was restored.

* Why were predators being removed from Yellow Stone National Park ?
* How was the biodiversity of the park affected as the population of wolves diminished?
* How was the biodiversity of the park restored?

The organisms in a place depend upon each other directly or indirectly. Every species in the world is unique and every species is important for Nature. We have to protect all species and biodiversity of nature.

COVID 19 pandemic has caused large scale destruction of human population. Do you think this can affect biodiversity? How?

Depletion of biodiversity may be caused by humans as for example pollution, hunting, deforestation, destroying habitats by converting them to areas for production of essential commodities. It may also be depleted by natural calamities like earthquakes, floods, tsunamis, volcanoes etc.

4.3.1 Conservation of biodiversity

Allow food chains and food webs in nature to continue without interruption.

Every creature in the world is unique and they depend upon each other. Humans for sake of their existence, destroy biodiversity. Biodiversity is changing due to deforestation, pollution, hunting. We have to protect biodiversity. We established national parks and sanctuaries for the conservation of biodiversity.

National park is a place for preserving organisms (both animals and plants) in their natural habitat. Poaching, hunting, cultivation, construction, mining is prohibited and collection of forest produce is restricted in these areas. Examples of natural parks are Jim Corbett National Park (Uttarakhand), Kasu Bhahmananda Reddy National Park (Telangana).

- Find out one national park each in the States around Telangana.
- Write the name of a National park that falls across two states.

Apart from national parks, there are wildlife sanctuaries as well that provide protection mainly to animals endemic of that area. Here also, animals are present in their natural habitats and capturing, killing and poaching of animals is strictly prohibited. Examples of wild life sanctuary are: Eturnagaram Wildlife Sanctuary (Telangana). Periyar Wildlife Sanctuary (Kerala).

CHECK YOUR PROGRESS.

- Every organism in the world is important. Why?
- What is the need of establishing the National Parks and Sanctuaries?

4.4 Classification

It is estimated that there are around 10 million species on the earth. We have so far been able to identify and name only about 1.5 million species. Organisms are present everywhere from very cold places to very hot regions and from the highest mountain peaks to deep under the oceans. We are trying to know about the organisms which are so small that we can't see with our unaided eyes to the largest of them like elephants, whales and redwood trees. To study these organisms, we have to organize them in a proper way.

Areas with high biodivesity have been identified as "Biodiversity Hotspots", recognizing the need to conserve them.

We look for different characters to organize the living organisms on earth into different groups that facilitate their study.

Thousands of years before in India, it is said that Sushruta and Parashara Maharshi studied the medicinal plants and classified them on the basis of characteristics of roots, flowers, leaf etc and the nature of medicines that were obtained.

Ancient records suggest that nearly 2000 years ago Aristotle, a Greek philosopher classified organisms into plants and animals for the first time. The basis of classification was movement. According to him animals were the group of organisms that could move from one place to the other while plants could not. A proper schema of classification beyond these two kingdoms was laid out around 300 years ago by Carl Linnaeus, a Swedish Naturalist. He observed different patterns in nature and described them with examples.

* We have studied earlier that most food chains begin with plants. Why is it so?
* What make plants distinct from animals?

4.4.1 Bi-nominal nomenclature

In 1730 AD in the village Prasanna Khamkar of Rajasthan, 363 Bishnois in the leadership of Amritha Devi sacrificed their lives to save Khejri trees. This Khejri tree was declared as the state tree of Rajasthan. The United Arab Emirates (UAE) also declared this Khejri tree as their National Tree and they called it as Ghaf.

Did you identify this tree ? This is the Khejri tree. Does it look like our Telangana state tree "Jammi Chettu"? Yes, this is our state tree "Jammi Chettu" which is called with different names in different places.

Telangana	Maharashtra	Rajasthan	Gujarath	Haryana	Panjab	UAE
Jammi	Shami	Khejri	Khijro	Janthi	Jaand	Gafa

It is difficult to identify the tree or animal with various names in the various regions. Thus, a standard protocol of nomenclature is required. One such protocol was introduced by Naturalist Carl Linnaeus nearly 300 years ago. According to him, each and every organism would have one scientific name of two words which could makes it easy to be identified universally. In this system of nomenclature the first name represents the Genus and second word represents the Species.

* But what is a genus or what do we mean by species?

4.2.3 The hierarchy of classification

The word Species has a broader meaning. A species is the basic unit of classification. It includes all organisms that are similar enough to interbreed or even individually reproduce. Organisms of the same species share maximum similarities among themselves. Let us take an example to see how Linnaeus made a classification schema.

Species-Genus-Family- Order- Class- Division/Phylum-Kingdom

Read the following text and complete the hierarchy of classification in the dogs. Household dogs come under species ***familiaris***. The wolf which shows similar characteristics to that of dogs is considered as the species ***lupus***. Linnaeus differentiated dogs to wolves on the basis of the presence of an upturned tail in them. Wolves and dogs have flesh tearing teeth called cannies and hence the genus Canus. Thus the scientific name of the dog is ***Canus familiaris*** and that of wolf is ***Canus lupus***. The similar characteristic, that is, having a long funnel -like mouth (muzzle) of Genus -**Canus** and Genus **Vulpes** (consisting of animals like foxes), relates to the family **Canidae**. And the similar characteristic of carnivorous habits / flesh eating habits of animals like cats, bears, tigers etc. of different families puts them under the same Order - Carnivora. The different orders showing similar characteristics of females producing milk for feeding (nursing) their young comes under one Class the**Mammalia**. All other animals, of different classes, having vertebrae come under Division - **Chordata** of Kingdom **Animalia.** The relation and similarities will be more in the organisms pertaining to the same species and when it comes to genus, family, order, class, division / phyla, kingdom the similar characteristics decreases. Classification is based on similar and different characteristics only.

Classification schemas keep changing as organisms keep evolving. It is tough to make one schema to fit all organisms as biodiversity diminishes/ increases on earth. Initially all organisms were classified into two kingdoms. But after new characteristics were found, it was observed that some characteristics of some organisms do not match either of the two kingdoms. In 1969 Whittaker proposed the classification of 5 kingdoms. Even this one fails to classify all organisms clearly.

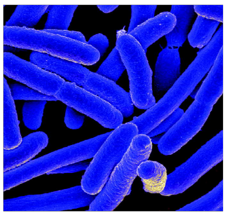
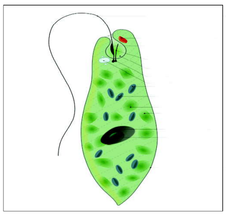
CHECK YOUR PROGRESS.

- Explain the classification of human beings based on the characteristics at different levels of classification.
- What is the need of classification of organisms?

Carolus Linnacus authored a book "Sistema Nature"

Organisms

Monera	Protista	Fungi	Plantae	Animalia
(Prokaryotic single cell) Eg: Bacteria	(Eukaryotic single cell) Eg: Ameoba	(Eukaryotic mostly multi cellular, saphophytes)	(Eukaryotic multi cellular, Auto tropic)	(Eukaryotic Multi cellular, Heterotropic)


Plant Kingdom (Plantae)

Non-floweating

Thallophyta
(No differentiation of roots, body etc)
Eg: Algae

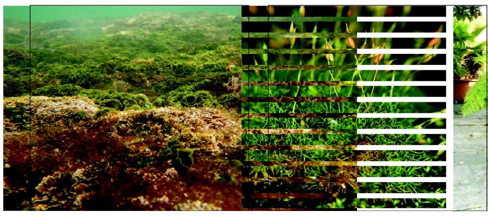
Bryophyta
(No true roots, leaves)
Eg:Mass

Pteridophyta
(True roots, spore bearing leaves)
Eg: Ferns

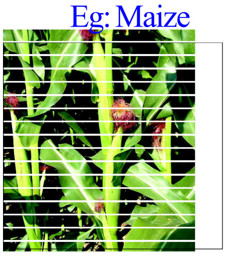
floweating

Gymnosperms
(No flowers, seeds naked and not enclosed in fruits)
Eg: Pine

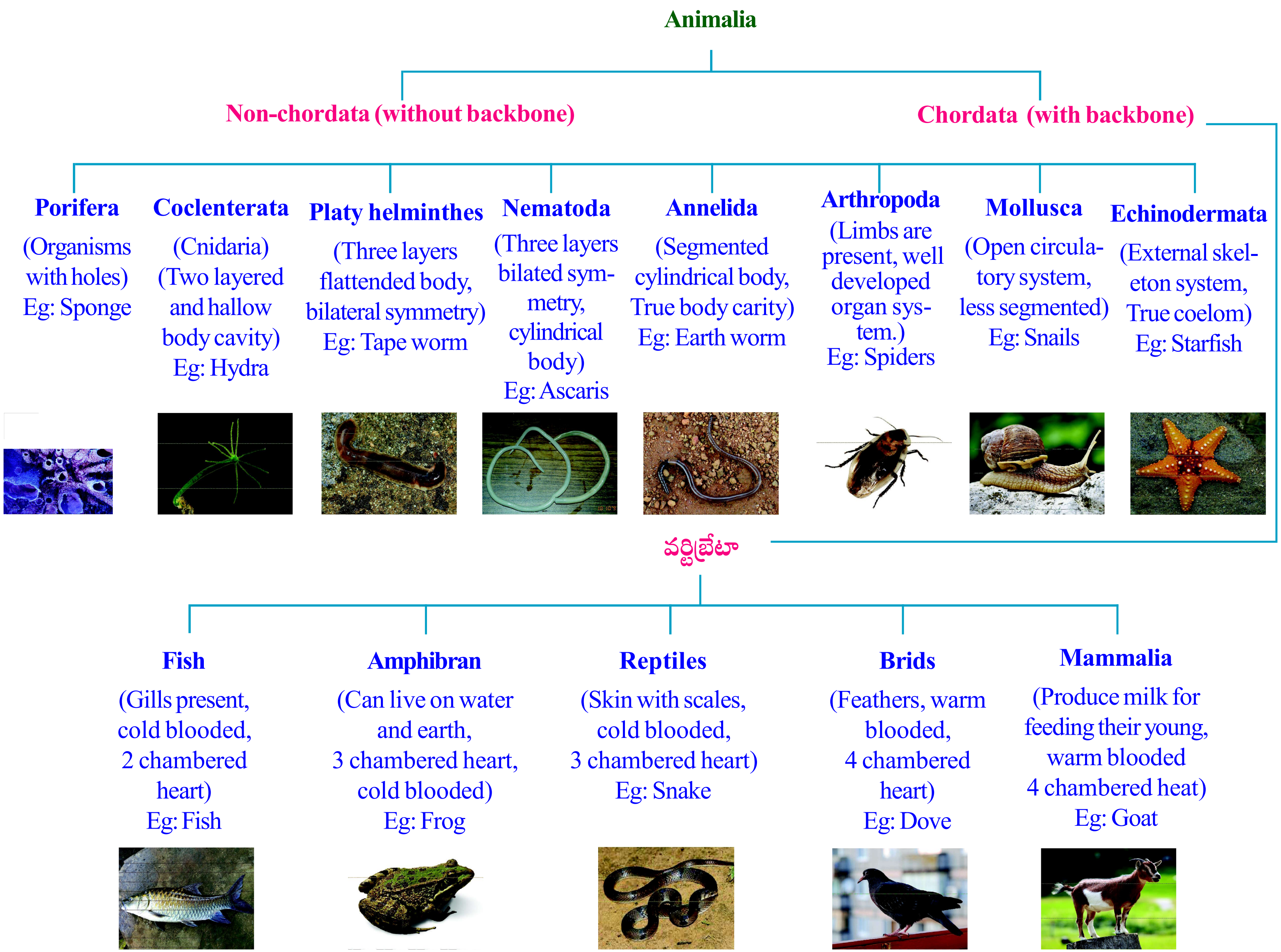
Angiosperms
(Flowering plants fruits bearing seeds)



Monocots
(Single cotyledon or embryonic leaf)
Eg: Maize



Dicots
(Two cotyledons or embryonic leaves)
Eg: Mango



The pit Bull is the most dangerous dog in the world. This dog is banned in most countries.

KEY POINTS

- In a particular place, the variety of plants, animals and other organisms live together. **The enormous variety of organisms is termed biodiversity**(bios means life and diversity means variety)
- There are differences between plants and also between animals. There is diversity in two animals of the same species. Means in the world any two organisms will not be exactly the same.
- Endemic species are those that are found in just one region and nowhere else in the world.
- We established National Parks and Sanctuaries for the conservation of biodiversity. National park is a place for preserving animals by providing natural habitat and prey.
- Each and every organism would have one scientific name of two words is called binomial nomenclature introduced by Carl Linnaeus.
- Classification is the systematic study of organisms present in nature.
- Whittaker classified all organisms into 5 kingdoms. They are 1. Monera 2. Protista 3. Fungi 4. Plantae 5. Animalia
- The animals which are capable of interbreeding and perpetuate or even individually reproduce come under species.

PRACTICE FOR LEARNING OUTCOMES

1. What is biodiversity ? And why should we conserve biodiversity?
2. What are the causes for changing biodiversity ?
3. Write the differences between extinct and endangered species?
4. What is Red Data Book ?
5. What is the purpose of making National Parks and Sanctuaries ?
6. Who introduced binomial nomenclature? Why ?
7. Who introduced 5 kingdom at classification

   A) Linneus   B) Wittaker   C) Aristatel   D) Parashara
8. First word in the binomial nomenclature.

   A) Kingdom   B) Genus   C) Family   D) Species
9. Vultures

   A) Endangered species   B) Extinct species   C) Endemic species   D) Forest organisms
10. Match the following

A)	Monera	( )	1.	Milk feeding
B)	Mammalia	( )	2.	True coelom, external skeleton
C)	Arthropoda	( )	3.	Prokaryotic, Unicellular
D)	Echinodermata	( )	4.	Jointed legs

CHAPTER

5

Ecosystem Services - Food Production

* What did ancient people eat?
* What was the first crop?

Before people began cultivating crops they would have spent their time wandering over a large area hunting animals and birds, fishing, gathering shellfish and collecting fruits, nuts, vegetables including tubers and grains in season. According to the information available so far, wheat is the first cereal crop to be cultivated by human. Later they also harvested vegetables such as onions, cabbages, beans, cucumbers and lettuce. They also reared several varieties of animals.

Agriculture is a composite term that includes all those activities which involve appropriate utilization of earth's resources for fulfillment of human needs of food, fodder, fibre, fuel, etc. Agriculture includes growing of crops, fruits, flowers and vegetables, on one hand, and animal husbandry and fisheries, on the other. We all depend on agriculture. Today agricultural research and sustainable farming has placed India among the top agricultural nations.

* So why are most farmers so poor in India?
* What are the methods to be followed to increase the productivity of land?
* How animal husbandary can meet food shortage?

In addition to all of these, in this lesson we will learn about the methods of food production and animal husbandry practices which are being carried out in our country.

LEARNING OUTCOMES

The learner...

- ☆ Discusses and elaborates present situation of crop production
- ☆ Classifies and compares Rainy season (Kharif), Yasangi crops (Rabi), short day and long day crops for optimizing production
- ☆ Explains processes leading to food production, factors affecting food production
- ☆ The value of animal husbandry, poultry and fisheries as income generating activities;
- ☆ Describes the link between production, storage and distribution.
- ☆ Applies food production related scientific concepts in daily life connecting science and society.

5.1 Increase crop production

* Can increasing area under cultivation help?

The only way to meet the food needs and rising demands of a growing population is to increase agricultural production. This requires soil testing and adoption of modern techniques in crop cultivation.

As cities expand, agricultural land is encroached upon, we need to curb this. Efforts towards turning barren or wastelands to agriculturally productive land can also help to increase production. Crop rotation and multiple cropping along with a regular work force involved in agriculture is necessary. We also need education that promotes knowledge of agricultural processes and practices.

* What can be done to increase the production in a piece of land?

Conduct a small survey in your locality (at least 20 households) to find out how many people own farms. Also find out if the farms' produce is enough to bear food and other needs of the whole family all through the year. Also find out the ways adopted to increase production.

Here is a table that you may use for your survey.

Name	No. of members	Area of Farm-land owned (if any)	Crops grown	What helps to increase productions?	Is agriculture the only occupation? Give a reason
S.Rao	8	4 acres	Gourd, brinjal, tomato, cucumber, fodder	Drip irrigation, good seed, green manure, fertilizer, pesticide, crop rotation, multiple cropping	No, not enough for need of all

5.1.1 Selection of high yielding varieties of crops

* What is a high yielding crop?

High yielding varieties of agricultural crops are usually characterized by a combination of higher crop yield per area, response to fertilizers, resistive to many diseases, early maturation etc.

Often seeds of hybrid varieties have such characters. Fertilizers and pesticides to increase crop yield. We have heard about green revolution in India that took place in the 1960s in mainly the wheat growing states of India. A high yielding wheat variety named Sharbati Sonora was used that raised production manifold. But it brought with it the perils of overuse of fertilizer and pesticides. Also raised questions on using high yielding varieties of crops. Soil in the areas that reported the high yield of wheat production by green revolution was damaged beyond repair. Soil being an important resource for farming needs to be tested at regular intervals.

5.1.2 Soil testing

* What is the importance of soil testing?

A soil test commonly refers to the analysis of a soil sample to determine nutrient content, its composition, and other characteristics such as the acidity or pH level. It is mainly done to optimize crop production, to protect the environment from contamination of excess fertilizers, pesticides etc. and also save money. It is useful to know which soil is suitable for which type of crop cultivation

5.1.3 Plant nutrients

Soil is a major source of nutrients needed by plants for growth.

* What are the most important plant nutrients? How do plants get nutrients?
* Why are nutrients important for plants?

For healthy growth, crops need nutrients. A total of 17 elements are needed by plants. Plants receive carbon and oxygen from air, oxygen and hydrogen from water (present mainly in soil) and the remaining 14 nutrient minerals are received from the soil. Out of the total number of essential nutrient elements, six are needed by plants in larger quantity. These are called **'macronutrients'.** They are - Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Sulphur. The remaining 8 nutrients are needed in smaller quantities. These are called **'micronutrients'**. These include Iron, Manganese, Boron, Zinc, Copper, Molybdenum, Chlorine and Nickel. Different varieties of crops would require different amount of nutrients and water. Need for both could vary on the basis of seasons as well.

5.1.4 Seasonal variation and crops

* What are the seasonal crops cultivated in India?

Based on seasons, crops grouped as; Rainy season crops (Kharif) and Yasangi Crops (winter season crops-Rabi). Rainy season (Kharif) crops are sown in June-July when early rains begin. They require lot of water and hot weather to grow. Rice, maize, jowar, bajra, tur, moong, urad, cotton, jute, groundnut, soybean, sugarcane, til (sesame), jute etc. crops are cultivated during this season. Wheat, barley, millets, tobacco, potato, peas, gram, mustard etc. crops are cultivated during winter season.

* Why certain flowers bloom only in certain seasons?
* Why do we get certain fruits in one particular season and not the others?

Irrigation of crops is usually done through various systems like canals, tubes, pumps, and sprayers. In our state one or two ponds are there in each village and crops are irrigated through these.

Photoperiodism is the phenomenon of physiological changes that occur controls flowering in plants. It is in response to relative length of day and night (i.e. photoperiod). The response of the plants to the photoperiod, flowers are intiated in plants. Hence we get certain fruits in a particular season only.

Depending upon the duration of photoperiod, the plants are classified into three categories.

1. Short day plants: These plants require a relatively short-day light period (usually 8-10 hours) and a continuous dark period of about 14-16 hours for subsequent flowering. E.g. Rice, coffee, soybean, tobacco and chrysanthemum.

2. Long day plants: These plants require longer day light period (usually 14-16 hours) for subsequent flowering. Eg. Wheat, radish, cabbage, sugar beet and spinach.

3. Day neutral plants: These plants flower irrespective of photoperiod. i.e. at any day length. Eg. Tomato, cotton, sunflower, cucumber, peas.

5.1.5 Methods to increase crop production

a) Crop rotation, b) Mixed farming/ multiple cropping, c) Organic farming.

* Why is crop rotation important?
* Can we grow a combination of crops to increase yield? How?
* Why is organic farming important?

Read the section here and see if you can answer these 3 questions.

a) Crop rotation: Growing of crops in a predetermined sequence, at a particular time of the year, is called crop rotation. An example is, growing rice at a time when the soil water content is highest in a year, followed by a crop like gram that will require less water and help in adding nutrients to the soil as removed by rice. Gram has nodules in its roots with nitrogen fixing bacteria that promotes replenishment of nitrogen in soil. Similarly, first those crops are grown which require more fertilizers. Subsequent to this, those crops are planted that require less fertilizer. For instance, first potatoes are grown then, Moong (pulses) crop is cultivated. Similarly, firstly the deep rooted crops are grown and then those with smaller roots. For example, cotton is planted first and then 'Methi' and jowar crop is cultivated after harvesting the pulse crops like moong or urad.

Benefits of crop rotation

- Maintains fertility of fields and affords soil nutrition due to abundance of nitrogen
- Prevents soil erosion
- Effective use of available resources
- Controls the insects and diseases which are affecting crops
- Regular income throughout the year. Production of crops is economical and crop productivity Increases.

b) Mixed cropping/ multi cropping: Mixed Cropping is the growing of two or more than two crops (2 - 4 crops) at the same time in the same field. For instance, mixed cropping of wheat with peas, wheat with Mustard, groundnut with sunflowers, jowar with safflower, jowar with red gram. During this process the crops are planted in separate rows as their maturation time and harvesting time are different. The biggest advantage of mixed cropping is that the farmer gets two crops simultaneously at one time or within a short interval of time from the same field. Mixed cropping also maintains soil fertility.

c) Organic farming: Organic farming is a method of cultivating crops by using naturally formed manures. It also ensures that natural environment is not affected in a negative way. It targets high quality crop yields.

5.1.6 Benefits of Organic manures and fertilizers

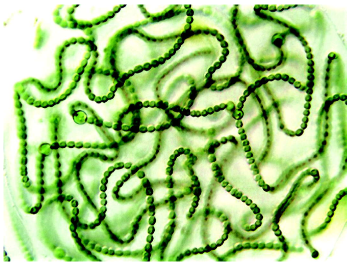
Vermi-compost

* What are the disadvantages (risks) of chemical fertilizers?
* What are the naturally occurring organic fertilizers?

a) Organic manures make the top soil more fertile and increases the crop yield. Depending on the type of soil and a kind of crop farmers' use different fertilizers and manures. Organic manures are natural materials (such as grass, the droppings/urine of birds/ animals or parts of organisms etc) that help in increasing soil fertility. When these are mixed with the soil, soil becomes porous, increasing the water storage capacity. Usually the nutrients in them are in small quantities. Now-a -day's emphasis is being laid on a sustainable use of organic manure as a major alternative to fertilizers. Some commonly used organic manures are; compost, vermi-compost, farm manure (decomposed plant and animal waste / debris), green manure etc.

- **Vermi-compost:** Vermi-compost is also calleds earthworm manure or vermiculture. Earthworms are termed "The True Friends of the farmers" or "The Natural ploughers". Earthworms feed on cow dung, dry leaves, grass, remnants of rice plants and plant refuse in the fields and they leave their excrements products in the form of vermin-composts. This is a complete natural, nutrients-rich and balanced kind of fertilizers.
- **Compost:** Compost is the manure created out of household wastes such as vegetables refuses, fodder, plants and animals debris which is decomposed in a ditch in the home backyard or compost pit.
- **Panchagavya** It is an organic product which can be used as manure. Panchagavya is a concoction of cow dung, cow urine, milk, curd and ghee. Along with the five constituents that come from the cow, it also contains jaggery, banana, and coconut water.

❑ **Biofertilizer** contains living micro-organisms. When it is applied to seeds, plant surfaces, or soil, it colonizes the rhizosphere of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Rhizobium, Azospirillum, Azotobactor and blue green algae are used biofertilizers *Rhizobium* inoculant is used for leguminous crops. *Azotobacter* can be used with crops like wheat, maize, mustard, cotton, potato and other vegetable crops.



Blue Green Alga (BGA) - CYANOBACTERIUM

b) Chemical Fertilizers contain one, two or three essential nutrients in large amounts. These fertilizers are prepared commercially in a factory from chemicals. Nitrogen, phosphates and Potassium (NPK) fertilizers are very important. Now-a-days potassium, urea, Super phosphate and ammonium phosphate and Curate of Potash fertilizers are widely used

CHECK YOUR PROGRESS.

- How different types of organic fertilizers prepared?
- What are the benefits of mixed cropping and crop rotation?
- How many types of crop plants are there based on photoperiodism? What are they?
- What are the macro and micro nutrients needed by plants for their growth?

5.2 Crop protection

Crop protection is the science and practice of managing plant diseases, weeds and other pests that damage agricultural crops.

5.2.1 Weeds

* Why weeds have to be removed?

Weed is an undesirable plant that grows along with crop plants. The weeds grow along with crops and compete with the main crop for sunlight, water and space, and also take away nutrients from the soil. Crop yielding is reduced due to decreased fertility of the soil. Hence, for better yield, weeds should be removed from the fields in the beginning itself. These can be removed by using the plough or harrow or can be removed manually.

Weedicides are the chemicals which are sprayed over field to get rid of weeds. They will not show any effect on crop plants. Two popularly used weedicides are 2,4-D (2, 4 dichlorophenoxy acetic acid- acts as a dicot weedicide) and Neem extract, spraying weedicides like Cemazine also removes the weeds.

5.2.2 Common plant diseases

* How do you identify the plant diseases? What are causative organisms of plant diseases?
* What are the signs and effects of plant diseases?

Most plant diseases around 85 percent are caused by fungi. And the remaining diseases are caused by pests, nematodes, bacteria and viruses.

Tikka Disease

- **Fungal disease:** Rust of wheat, smut of sorghum, tikka disease of groundnut, red rot of sugarcane, rice blast, late blight of potato, early blight of solanum, root rot disease, leaf spot diseases etc.
- **Bacterial diseases:** Citrus canker, grown gall, scab, rice bacterial blight, fire blight of apples etc.
- **Viral diseases:** Mosaic diseases of tobacco, tomato, cauliflower.
- **Insect pests:** Pest insects include surface feeders that damage foliage by chewing, piercing, or sucking. Some pest organisms spread diseases. Some examples of pests are mosquitoes, locusts, aphids. But not all insects are pests. Many kinds of insects are beneficial which eat other harmful insects and some other insects help in pollination.
- **Control of plant disease and pests:** There are certain plant diseases that cannot be treated so the prevention is better than cure. A variety of chemicals are available that have been designed to control plant diseases by inhibiting the growth of or by killing the disease-causing pathogens. Chemicals like pesticides, bactericides, fungicides, nematicides used to control pests, bacteria, fungi, and nematodes may be applied respectively to seeds, foliage, flowers, fruit, or soil.

5.2.3 Storage of grains

* Where are grains stored? Why is storage of grains important?
* What are the safe methods to store grains?

After harvesting, grains need to be stored safely. If there is lack of proper storage facilities, then the grain is vulnerable to attacks by insects, worms, fungi and various kinds of microbes. Following is a list of some techniques that have been developed to prevent the grains from deteriorating as well as maintaining their safe storage.

- **By drying:** Grains can be dried in the sun, or it can be dried by exposing it to hot air can be stored for along period.
- **Chemical treatment:** Prior to storage, there is sprinkling of insecticides and fungicides chemicals on the godowns and the storage vessels. Grains are also stored with neem leaves. It prevents insects from ovulating.
- The godowns, sacks, tanks or vessels used for storage of grain, should not have crack or holes in them. They should be clean. Cold storages are used commercially to store fruits and grain

CHECK YOUR PROGRESS.

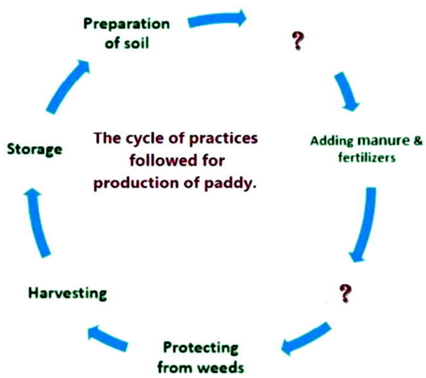
- What are weedicides? Give example.
- Name some prominent fungal diseases crops.
- What are the safe methods of storage of grains in rural areas?

5.3 Practices used in crop production

Case Study-1: Paddy cultivation steps

Paddy cultivation involves the following steps;

- **Preparation of Field:** Before growing crops proper ploughing of the soil is necessary. Ploughing loosens the soil and it helps in easy transportation of air and water.
- **Transplantation:** Picking up seedlings from the nursery beds and these seedlings are sown in the field in proper distances. This is called transplantation.
- **Field Maintenance (Applying manure, Irrigation, Weeding):** Applying manure and fertilizers at a specific time, watering crop plants in the field, removal of weeds from the field and controlling pests and diseases by spraying/ dusting pesticides are necessary steps to get maximum yield.
- **Harvesting:** Collecting grains from crop by cutting the matured rice plants is called harvesting. It is done either manually or by machines.
- **Threshing, Winnowing and Milling:** Threshing is done to separate the grains from rice twigs. Winnowing is to be done to blow-off/remove chaffs, dust and husk from the grains.
- **Storage of grains:** Grains are stored tins/ bags/ rooms/ cold storage units after drying them hot sunlight.



* Write the missing steps in the cycle of practices followed for production of paddy.

Case Study-2

Steps in Cotton Cultivation

Cotton is the most important fibre crop not only in India but all over the world. It provides raw material (cotton- fibre) for the textile industry. Its seeds are used in the vanaspathi (margarine) industry and can also be used in fodder for better milk production for dairy cattle. Cotton is a tropical and sub-tropical crop. It requires 210 C - 300 C temperature range, with average annual rainfall of 50-100 cms. It is cultivated in black loam and loamy soils even in areas with low rainfall. There are different stages in cotton cultivation.

- **Soil preparation:** It is necessary to plough the soil before harvesting for weed removal. Ploughing loosens and loosens the soil. It helps to transport air and water easily. Due to ploughing of the cultivable soil surface, the plant residues (litter) remaining in the field are incorporated into the soil and becomes compost.
- **Sowing of seeds:** Seeds must be purchased from a certified company. Seed should be treated before sowing. For this, fungicides @ 3 g / kg cotton seeds or with bio-fertilizers like Azotobacter, Azospirillum @ 25 g / kg seeds are used. Cotton seeds are sown in rows and at certain distances by manually or with the help of machines. In traditional cultivation methods, special equipment fitted to a plough (plow) or tractor is used for planting. Cotton seeds are sown till the end of June. Per acre, @ 1.25 kg hybrid cotton seeds or @ 3 kg domestic cotton seeds are required.
- **Field Management** (Fertilizer, Irrigation, Weeding, Diseases and Their Control): Cotton seeds germinate in 10-11 days. About6 - 8 weeks after planting, flower buds appear on cotton plants. In another three weeks, bloom. After three days, they wither and fall off. Cotton nuts are called 'cotton bolls'. When the boll is ripe, it turns brown and burst. White cotton is seen outside when bolls burst.
- **Irrigation:** It depends on the nature of the soil and climatic conditions. The stages of flowering and the formation of bolls are the critical stages that require irrigation. Crops planted in summer require frequent irrigation over a period of 8-12 days.

Fertilizers Requirement (kg/acre)

Varieties	Urea	DAP or SSP	
Bt	65	27	75
Non Bt	130	27	75

- **Weeding:** Weeds can be removed by manual, mechanical and chemical methods. Weeding is carried out 5-6 weeks later or before the first irrigation. This should be done even after each irrigation. Do not allow *Parthenium* to grow around cotton fields as they increase the chance of melee bug insect infestation.
- **Diseases and their control:** Crop must be protected from diseases, because after flower bud formation the attacks of diseases begin. Diseases such as *Fusarium* wilt, anthracnose, *Alternaria* leaf spot, and American ball worm are common. There are many types of chemicals are available in the market. Alternative methods should be adopted for these in crop care.

❑ **Border and intercrops:** Border crops such as marigold, castor, maize, sorghum, red gram and peas are grown in cotton fields, which serve as insect trap crops (mostly boll worms) and as a barrier or guard crops. Green gram is an intercrop that not only provides extra income but also helps in conserving soil moisture.

❑ **Harvesting:** Cotton can be harvested by humans or machines. The refined cotton is compressed as bales for further storage and economic storage for transportation. After harvest (post-harvest) sheep, goats and other animals should not be allowed to graze on the cotton field as these animals may be at risk of getting sick from eating the leaves affected by the pesticides.

CHECK YOUR PROGRESS.

- Compare paddy cultivation with cotton cultivation.
- How are trap or inter crops useful in cotton crop?
- What are the important stages of rice production?
- Draw the cycle showing important practices of cotton production.

5.4 Animal husbandry

* What are the food items that are obtained from animals?

Animal husbandry is the branch of agriculture concerned with tending and increasing production of animals that are raised for meat, milk, eggs, or other products like honey and wool.

Here are some ways in which we acquire some products -

5.4.1 Dairy farming

* What is white revolution? What is the purpose of white revolution?

Dairy farming includes all those animals which produce milk and meat. Species commonly used are cows, and buffalos, but goats, sheep and camels are also used in some areas. The quantity and quality of the milk produced depends on their diet and health. Milch animals should be cleansed regularly; in case of illness veterinary specialists should have consulted constantly.

Prof. J.K. Kurian, father of white revolution in India, worked a lot in increasing milk production through cooperative societies to fulfill the needs of our country. He proposed innovative activities in producing hybrid varieties of cows and buffaloes, and achieved a great improvement in production of milk under the scheme called - Operation flood.

5.4.2 Poultry farming

Eggs and chicken meat are major sources of proteins, vitamins and minerals. Poultry farming not only contributes to a better quality of food, but is also a major source of income for many farmers in the country. Hens reared for eggs are called 'layers' and those reared for chicken meat are called 'broilers'.

5.4.3 Aquaculture

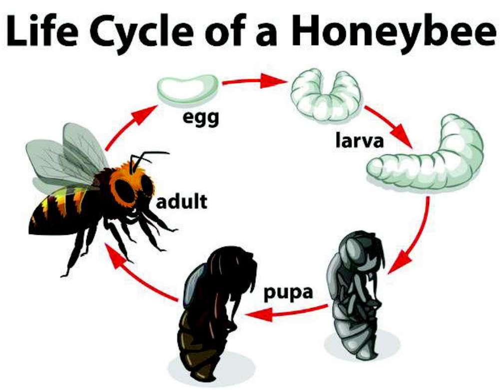
* What is blue revolution?

Nowadays fish and prawn culture is a large scale industry. Sardines, mackerel, crustaceans, tunas, mollusks, catfish, ribbon fishes are some of the marine varieties are cultured in fisheries. Besides these, the sea weeds may be included which form an important living source from the sea. Prawns, lobsters, and crabs together constitute the crustacean fishery also grown. Murrel (korramenu), katla (jalla), katrana (bochalu), rohu (mosu), seer (Vanjiram) are the local varieties are cultured.

5.4.4 Bee farming (Apiculture)

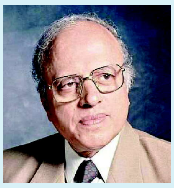
Culture of Honey bees is called 'apiculture'. Apiculture is not only for honey production but also very much useful for crop pollination since honey bees are best pollinators of many agricultural crops.

Apiculture is the technique of scientific rearing of honey bees in specially designed wooden boxes and honey and wax are collected from artificial hives.



Honey bee species are social insects which live in colonies. A honey bee colony consists of three types of bees. One queen, several thousands of workers, few hundreds of drones. The life span of queen, bee is two to three years, a worker has 5-6 weeks and the drone has 57 days. The primary function of a queen bee is to lay eggs (800-1200 eggs per day). The worker bees in the hive will attend the duties during first three weeks of their lives such as secretion of royal jelly, feeding of the brood. After 3 weeks they attend outdoor duties like collection of nectar, pollen and water. Drones are the male members of the colony. Their main duty is to participate in mating. Mating takes place in the open air when the queen is in flight. The Drone dies immediately as their abdomen burst open during mating process.

NECC (National Egg Co-ordination Committee): An egg a day keeps the doctor away. This is the slogan of National Egg Co-ordination Committee. Egg is a good nutritious food which is easily available for all.



During 1968-1988 period Dr. M.S. Swaminathan Introduced high yielding wheat and paddy varieties into our country and contributed for self-sufficiency in food grain production. Hence he is called as father of green revolution in India

CHECK YOUR PROGRESS.

- What are the benefits of animal husbandary?
- Which organisms are grown in aquaculture? Give examples.
- Differentiate green revolution and white revolution.
- What are produced in apiculture?

KEY POINTS

- Agriculture is a composite term that includes all those activities which involve appropriate utilization of earth's resources for fulfillment of human needs of food, fodder, fibre and fuel
- In agriculture grow crops of cereals, pulses fruits, flowers vegetable etc on one hand and practise animal husbandry on the other.
- Rainy season crops are called as Kharif and winter season crops are called as Yasangi Crops (Rabi crops)
- Growing more than one crop on a piece of land during the year is known as multiple cropping.
- Along with hybrid seeds, fertilizers and pesticides are used to increase crop yield.
- Methods like crop rotation; organic farming helps to increases crop productivity and maintains soil health.
- The use of organic fertilizers like Vermi-compost, Farmyard manure, Panchagavya, Biofertilizer has become very popular in recent times.
- Paddy is cultivated in areas where water availability is abundant and cotton in the areas with average annual rainfall of about 50-100 cms.
- Hens reared for eggs are called ‘layers’ and those reared for chicken meat are called ‘broilers’.
- Fish and Prawns (shrimps) are cultured as a part of the blue revolution.
- Rearing of honey bees is called ‘apiculture’.

PRACTICE FOR LEARNING OUTCOMES

1. Name a crop that has highest market price in your state.
2. Minimum support price (MSP) is the price fixed by the government. This ensures that a buyer pay that amount or more to the farmer. Do you think this is required? Why /why not?
3. Write the differences between organic manures and chemical fertilizers.
4. What are the different photo-periods? How do plants respond to them?
5. Explain the important stages of cotton cultivation.
6. Explain the main methods used to increase crop yield.
7. Identify the macro-nutrient from the following. (   )

   A) Iron (Fe)   B) Copper (Cu)   C) Calcium (Ca)   D) Chlorine (Cl)
8. Identify the rainy season crop from the following. (   )

   A) Sugar cane   B) Mustard   C) Wheat   D) Tobacco
9. Which of the following is a bacterial disease of crop plants? (   )

   A) Paddy blast   B) Fire blight of apple

   C) Smut of sorghum   D) Tikka disease of groundnut
10. White Revolution is related to which of the following? (   )

    A) Production of food grains   B) Production of honey

    C) Production of milk   D) Production of meat
11. Match the following:

A)	Short day plant	( )	1.	Tomato
B)	Long day plant	( )	2.	Parthenium
C)	Day neutral plant	( )	3.	Beet root
D)	Weed plant	( )	4.	Soya bean

Parthenium is a common weed that grows in all open spaces. It came to our country from America (USA) along with wheat. Its pollen causes asthma, skin diseases and skin allergy.

CHAPTER

6

Ecosystems Within Us - Health

My friend is a doctor in a well known hospital. She has been handling COVID cases. She has tested positive. She is trying to remain healthy by eating vegetables and fruits, a lot of water, Medicines at proper time. Cleaning up and sanitizing her surroundings with sprays of sanitizers.

But the vegetable vendor has stopped supplying to her house and the man who used to come to collect waste earlier does not come to her house anymore.

Two of her neighbours have extended their support.

- Why do you think people are distancing her?
- Can we say for sure that someone who tests negative for COVID is healthy?
- What is health and does having a disease mean?
- How is our health maintained.
- What is immunity and how can we be immunized?

This lesson aims to make an effort to anser such questions.

LEARNING OUTCOMES

The learner...

- ☆ Can distinguish between healthy and unhealthy conditions.
- ☆ Understands the role of healthy habits in maintaining a good health.
- ☆ Appreciates the individual and social aspects of health.
- ☆ Explain the causes, symptoms and preventive measures of few communicable and non communicable diseases
- ☆ Express awareness about national immunization programme and how it prevents certain communicable diseases
- ☆ Appreciates the work of scientists in the discoveries leading to maintian health.
- ☆ Applies the knowledge of first aid to daily life

6.1 Health

"Health is a state of complete physical, mental and social well being and not merely the absence of disease". It means proper functioning of the body and the mind can leads to good health.

There are large number of factors which affects our health; like diet, environment, Our relationships, the constitution or genetic make up of our body.

6.1.1 Signs of good health

* Is the absence of disease a sign of good health?

Health is a general well - being of person influnced by physical mental & social conditions. There are three dimensions of health are together referred to as health triangle as shown in the Figure. Here is a cheklist of points. They help in assessing one's state of health. Put a tick mark on points you quality to.

A) Signs of Physical health: If in good physical health, you

❑ shall be energetic and alert.

❑ have normal weight appropriate height and age

❑ have good eye sight with bright eyes.

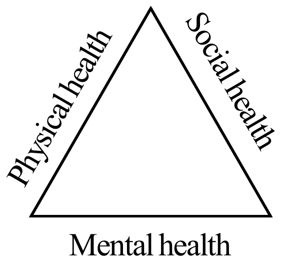
❑ have all the body organs functioning normally and fall sick less often.

❑ have clean and clear skin.

❑ have normal growing hair

❑ have odourless breath

❑ have good apetite



Health Traingle

B) Signs of Mental health: If in good mental health, you

❑ have control over emotions

❑ balanced feelings, desires, ambitions and ideas.

❑ the ability to accept the realities of life and face them

❑ the ability to cope with normal stresses of life

❑ the ability to give and seek help when needed.

❑ cope with conflict and disagreement

C) Signs of Social health: If in good social health, you

❑ have a positive attitude towards life

❑ get along with others

❑ have a pleasant personality

- fulfill responsibility/duties towards others
- have healthy inter personal relationships
- shall be able to express disagreement positively

6.1.2 Abiotic Vs biotic factors

You have studied in previous lesson about abiotic and biotic factors. Abiotic factors such as Oxygen, Carbondioxide, temperature, pH, Sunlight, water and biotic factors such as micro organisms, plants, animals affect our health.

We all know, we breath oxygen, helps in respiration. O_2 also helps in break down of food stuff that we eat, at cellular level in our body. The CO_2 aids in guarding the pH of our blood and inturn aids in maintaining the body temperature which is essential for us to survive.

Our body temperature may reveal a lot about your health. Normal body temperature is considered to be 98.6°F/37°c. Having a temperature around this could suggest that we are healthy. For all vital functions of our body, Proper body temperature is needed. Temperature and pH of our body are influenced by Carbondioxide. Water is an essential component for us, Proper intake of water replenishes the lost fluids from sweat. Water aids kidney to work efficiently, prevent kidney stones. All metabolic activities in our body require water - "Water is life".

The microbes also help us, to maintain good health. The microbes of the skin, mouth and nose fight against bad microbes that enter the body to cause diseases. Colonies of these microbes in some organs maintain an acidic environment that prevent the growth of other micro organisms that might cause diseases.

Plants make food with the help of Carbondioxide, Water, Sunlight, which are abiotic factors. Plants Form food to animals and humans. We get the nutrients (Carbohydrates, Proteins, fats, vitamins, minerals) from plant and animals. All the abiotic factors are inter linked and also linked to biotic factors. Which inturn help us to stay healthy.

CHECK YOUR PROGRESS.

- Mention the three dimensions of health
- Name the biotic and abiotic factors that affect our health.

6.2 Unhealthy Vs Diseases

From the check list that we had attempted earlier, we find that being healthy depends upon different conditions around us.

A person eating fatty foods all the time or a person appearing to be ill or a person having inability to fall a sleep, many more characteristics, which do not have a state of good or normal health is considered to be unhealthy. Unhealthy conditions can lead to diseases. The word disease is self explanatory. It literally means being un comfortable (Dis+ease).

It can be as mild as cold, sore throat or as serious as cancer. A disease can strike any part of the body at any age. If a person has an identifiable disease he may be said to have poor health.

6.2.1 Causes of diseases

* Think about the last time you had a disease. Enlist the causes of the same.

When we think about causes of diseases, we must remember that there are many levels of causes. Let us look at an example to understand it. Ramu caught cold from his classmate shyam, who is experiencing cold from couple of days.

When an infected person sneezes, the virus - containing droplets are released into the air. Such type of infected droplets when inhaled causes cold. This might be one of the cause of infection. But why did Ramu alone got infected though there were many students in that class who inhaled the same infected droplets? May be Ramu's immunity is low compared to other students, this can be another cause of infection. What might be the cause of low immunity? However, poor or improper nutruition, can be a factor in lowering the immune system, this is also one more cause. Poor economical conditions may lead to poor nutrition, which inturn leads to reduced immunity.

* Do you think improper nutrition causes cold?

The cause which support or prevent causing a disease is called contributory cause. In the above, discussion the virus that caused cold is the immediate cause of infection and all the other causes are the contributory causes. It is obvious that all diseases will have immediate causes and contributory causes Most of the diseases will have many causes rather than one single cause.

Activity

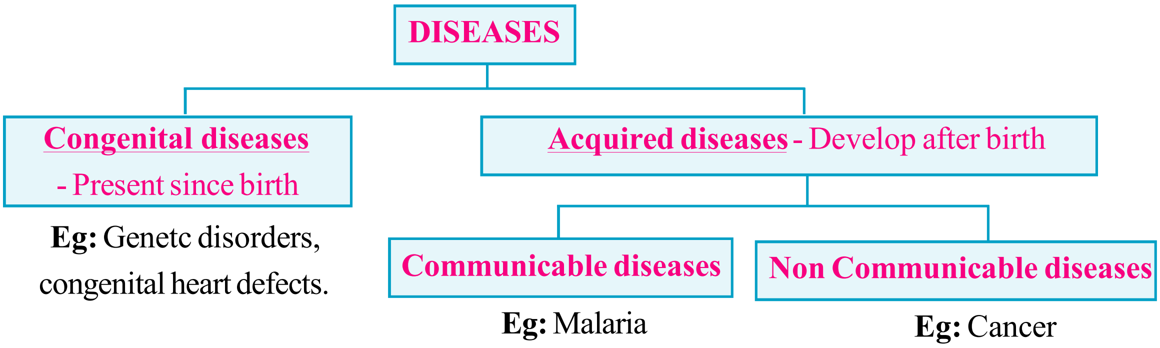
Taking as an example of disease, you have had, write its immediate and contributory causes.

6.2.2 Types of Diseases

Diseases can be categorized in many ways, some diseases are by birth (congenital diseases) and some can be acquired during life. (acquired diseases), some are caused by infectious agents (bacteria, virus etc)

An epidemic is the rapid spread of a disease to a large number of people in a given population with in a very short period of time. If an epidemic is spread across the multiple countries then it is termed as pandemic - SARS-COVID-19

Study the flow chart carefully.



Communicable diseases:

* Why do we use mosquito repellents? What happens if a mosquito bites us?
* Why are we adviced to drink boiled tap water?

Diseases that spread from one person to another are called communicable diseases, they are usually caused by Micro organisms called pathogens (fungi, bacteria, viruses, protozoans, worms)

Bacteria & Virus

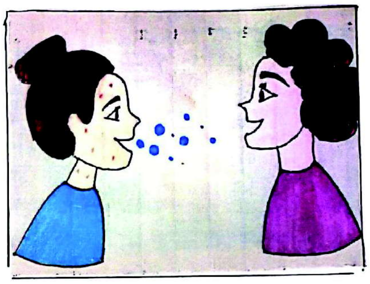
Bacteria:

- Bacteria are single celled living organisms, with diverse shapes and structural features.
- They can live in almost every possible environment including in or on the human body.
- Some of the bacterial diseases in human include - Tuberculosis, gonorrhea, cholera, tetanus, Diptheria, Syphilis, typhoid.
- One can kill harmful bacteria in food and water by proper cooking and boiling.
- Some of the bacterial diseases can be treated by taking antibiotics

Virus:

- Same as bacteria, viruses are diverse and have variety of shapes and features.
- These are much smaller than bacteria
- Viruses replicate only when they have living resources in their contact.
- Some of the viral diseases in humans include - dengue fever, chicken pox, measles, HIV-AIDS, COVID-19 disease.
- Antibiotics do not work for viral infections.
- It is difficult to develop antiviral drugs because it is challenging to target the virus which is in the host cells without harming them.

Method of Transmission:



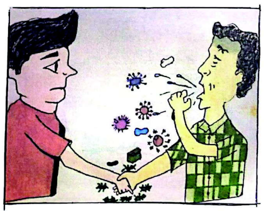
* Regarding the present COVID-19 pandemic it is repeatedly being said -

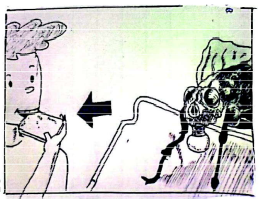
  "Stay home stay safe", "wear mask while going out", "maintain social distancing", "wash your hands with soap & water or use alcohol based sanitizer". These guidelines must be followed

* How can we reduce the risk of infection by following these guide lines?

The disease causing organisms can be transferred from one person to another by direct or indirect contact. Study the following flow chart..

Disease transmission
- **Direct**
  - **Direct Contact**
  - **Droplet Spread**
- **Indirect**
  - **Air borne**
  - **Water borne**
  - **Vector borne**
    - **Mechanical Vectors** — **Eg:** Houseflies, Cockroaches
    - **Biological Vectors** — **Eg:** Mosquitoe & Ticks





Diseases such as amoebiasis and cholera are spread by houseflies and cockroaches which contaminate our drinking water and food by carrying pathogens. Female mosquitoes feed on human and vertebrate animal blood, inturn allow the pathogens enter into our body causing diseases like Malaria and dengue. When an infectious agent (or) pathogen is carried by an insect or animal to susceptible host is termed as vector borne transmission, the pathogen may some times multiply in the body of the vector (mosquitoes, ticks) such vectors are called biological vectors. Some insects like houseflies, cockroaches simply carry the pathogen which do not multiply in their body, such vectors are called mechanical vectors. Some infectious diseases can be transmitted from an animal to humans when we are in close contact, zoonosis occurs when diseases are transferred from vertebrate animals to humans. Direct spread of droplets by sneezing /coughing from an infected person can infect others. One can even be infected through the droplets created when an infected person speaks. A wide variety of disease are transmitted by droplets include - influenza and forms of pneumonia, COVID-19 disease.

Activity-2

List out some comunicable diseases and write the preventive measures

Non-communicable diseases

- ✻ Other than ageing, what could be the cause of death in humans?
- ✻ Do you think only communicable diseases affect our health?

"Non infections health condition that cannot be spread from one person to another is known as Non-communicable disease".

In this fast paced life. That many of us live today, there is a lot of conflict and pressure. In this kind of lifestyle, People are likely to neglect their health and suffer from ailments like high blood pressure, increased blood sugar (diabetes) cardio vascular diseases, cancers and many others. Although some of these diseases have a genetic predisposition, they have started affecting younger age groups due to undisciplined life style.

6.2.3 Prevention of Diseases

Stress (over work, grief, depression) can depress the immune system and increase the chances of falling ill.

There are two methods to prevent diseases, they are general and specific methods. Preventing exposure to diseases is the general way. Specific way of preventing is by administering specific vaccine for specific disease. Many vaccines are now available for preventing a whole range of infectious diseases and provide a disease - specific means of prevention, by activating our immune system without making us sick.

CHECK YOUR PROGRESS.

- ✤ What are the other ways that you think by which diseas may be prevented?
- ✤ Name the disease which is spread through contaminated food and water?
- ✤ Write the difference between communicable and non communicable diseases giving examples?
- ✤ What are contributory causes of a disease? Explain with examples?

6.3 Immune System and Surveillance

- ✻ How often do you fall sick?

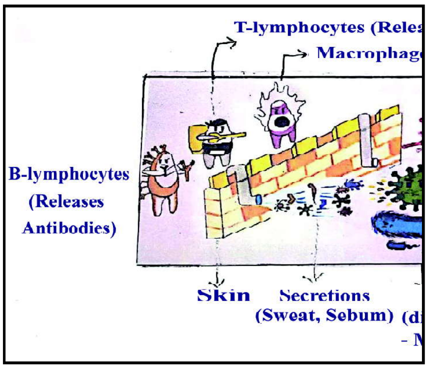
6.3.1 Immunity

We are exposed to a large number of disease causing agents (pathogens) everyday. Our body is able to defend against most of these foreign agents. This overall ability of the body to protect itself against the foreign agents including the disease causing organisms is called immunity.

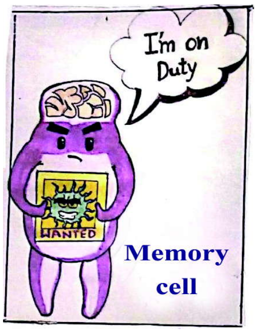
6.3.2 Nature of Immune system

Let us know what the immune system consists of and how the immune system fights common diseases.

Battle in the body



Let us assume our body as kingdom, which has strong and huge walls to protect and prevent the entry of the intruder. If by chance the foreign army enters into, there are different set of soldiers, one group that recognize the intruder, another that sends alarm to activate all the soldiers in the kingdom a third group are those who carry different weapons and finally kill the intruder. Like wise our skin is a huge and strong wall with various secretions (sweat, saliva, sebum, tears) and mucous membrane, which does not favour the entry and survival of the pathogens (Bacteria, Virus, Fungi etc), showing 1st line of defense. By chance if the pathogens enter the body the first level soldiers i.e., the blood cells called as macrophages (which are a type of white blood cells or WBC) attack. Macrophages kill and engulf - the antigens (the foreign bodies) infective agents. Showing 2nd line of defense. In case of severe infection? A chain of events follow involving. Another set of white blood cells called as Lymphocytes (T-lymphocytes and B-lymphocytes) take the charge by identifying and killing the pathogens by secreting, Antibodies and compounds called cytokines, eliciting the third line of defense.



The complete war and the techniques used by the soldiers (macrophages, lymphocytes) to kill the enemy (pathogens) is carefully observed by a minister, who will not take part in the battle but stores the information of the intruder. These are called the memory cells, having complete information regarding the immune response for the specific infection. In case the same kind of infection reccurs, these cells sends signals to the lymphocytes to identify and kill the pathogen with in short span protecting our body.

As in the border, the soldiers inside our body carryout a continous vigil. We come to know of their actions only sometimes when the effect shows up as symptoms.

6.3.3 Types of Immunity

The immunity present at the time of birth and help provide protection against the entry of foreign agent causing disease is known as innate immunity. Immunity that develop during one's life time is called acquired immunity. It is of two types 1. Active immunity 2. Passive immunity

Active Immunity

- Immunity developed in an individual in response to an infection is called Natural active immunity.
- For example immunity developed against diseases like Measles, Chickenpox or Mumps, once you have the disease you usually not have it again.
- Resistance developed by in organism due to inoculation of weak or killed antigens is called artificial active immunity as by Vaccination.
- In active immunity the response is slow.

Passive Immunity

- Passive immunity is protection from a disease provided by antibodies created outside our body.
- As for example, Resistance developed by transferring antibodies from an immunized donar to a non-immunised individual is artificial passive immunity. Transfer of antibodies from mother to child through the colostrum (first milk) is called natural passive community.
- It does not require previous exposure to a disease and does not last long.
- It provides immediate protection.

6.3.4 Primary immunization

You are aware of various immunization programme that are run by the government for the general public especially for the pregnant women, infants and children. The table here illustrates the primary immunization programme for a new born baby and their subsequent booster doses. Immunization is given free of cost, at all government dispensaries and hospitals.

National Immunization Schedule in India for children up to the age of 24 months and pregnant women

Vaccine	Age				
	Birth	6 weeks	10 weeks	14 weeks	9-12 weeks
Primary vaccination					
BCG against T.B	✓				
Oral polio	✓	✓	✓	✓	
DPT against Diphtheria, Pertussis, Tetanus		✓	✓	✓	
Measles					✓
Booster Doses					
DPT+Oral polio	16 to 24 months				
DT	5 years				
Tetanus toxoid (TT)	At 10 years and again at 16 years				
Vitamin A	9, 18, 24, 30 and 36 months				
Pregnant women					
Tetanus toxoid: 1st dose	As early as possible during pregnancy				
2nd dose	1 month after 1st dose				
Booster	Within 3 years				

The timing, sequence and frequency of the immunization should be followed as detailed in the chart above

Activity-1

Ask your parents about the vaccines given to you and your sibling during childhood and list them.

Routes of vaccine administration

Routes of vaccine administration is different for different vaccines. Some are given orally and some through injections.

Activity-2

Visit a healthcare centre in your locality and gather the information regarding different vaccines and their mode of administration. Make a table to gather information.

6.3.5 History of Vaccines

Edward Jenner

The word vaccine is derived from the latin word vacca, vacca means cow. Cow pox is a smallpox-like disease which infect cows. In 1770 symptoms of cow-pox disease appeared in milk maids who contracted disease from the cows. There was a belief that people who contracted cowpox did not catch small pox. A British physician Edward Jenner focused on this disease. on May 14, 1796 Jenner collected fluid from a cowpox blister and scratched it into the skin of James Phipps, an eight year old boy. A single blister rose up on the spot but James soon recovered. On July 1st Jenner inoculated the boy again, this time with small pox matter and no disease developed. The vaccine was a success and lead to drastic decline of devastating disease. Edward Jenner was the first in the world to give small pox vaccine as a preventive treatment.

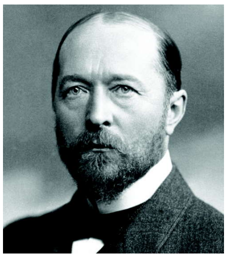
Louis Pasteur

The term "Vaccine" was coined by Louis Pasteur a French scientist. Based on Jenner's experiment in 1881 Pasteur developed a vaccine for cattle, sheep against anthrax disease. An animal that once had anthrax disease never contracted the same again. Pasteur did not find any disease similar to anthrax which showed less severity. After many tests, he then collected the bacteria causing the Anthrax disease from an infected animal and cultured them on special medium. Pasteur heated the bacteria till they become weak and passive (attenuated). He inoculated such attenuated micro organisms into the cattle. The weak bacteria grow slowly and enhance the immunity of the animal. He invented a vaccine for the terrible anthrax disease. Pasteur was also credited with the findings of vaccines for cholera and rabies in a similar manner.

After Pasteur, Robert Koch was the person who studies the relationship between disease and germs. He discovered the various bacteria that cause different kinds of diseases. He also discovered the causes of diseases such as Anthrax, TB, cholera and said "all bacteria's are not harmful". He used a glue like substance "Agar - Agar" instead of chemicals for culturing the microbes.

Robert Koch

Koch colleague Emil von Behring, a German doctor invented another method of preparing vaccines. He said harmful bacteria enter our body and release certain toxins which cause disease. Antitoxins are the substances released in the body of an organism to prevent diseases. The antitoxins from an animal is collected and transferred to other organism, temporarily immunises the organism. There by he invented vaccines against tetanus, Diphtheria and saved the lives of many children.



Emil von Behring

To cure diseases instead of using microbes and their substances, Paul Ehrlich & his coworkers in 1909 found a chemical arsphenamine that kill pathogens without harming the patient. This drug kills the bacteria that cause syphilis disease.

Since the period of Pasteur, Koch, Behring, Ehrlich Many other similar antitoxins and various drugs have been developed in the form of vaccines to treat a variety of diseases. However immune system is not an armour, its an adaptation.

Emil von Behring

CHECK YOUR PROGRESS.

- Mention the role of lymphocytes in fighting infections?
- List the diseases which are eradicated through vaccination
- Explain the different routes of vaccine administration?

6.4 First AID

Geeta was on her way to college suddenly, she saw a man fall down and show uncontrollable jerking movements of the arms and legs. Everyone gathered around him and were trying to slow him down. Some were asking for any object to keep in his hand and some were asking to make the person drink water. Gita noticed that the person was experiencing fits/ seizures and immediately asked everyone to move away so that the person gets enough air to breathe, she then folded her chunni and kept under his head to avoid any injury to his head. After he slowed down, she examined his breathing by slowly lifting his chin and carefully turned him to one side. The man regained consciousness within 2-3 min. Geeta told everyone that One should not force anyone to drink water, in such a condition, as it could worsen the situation.

There are many situations happening in our day to day life which may harm us or people around. First aid is the immediate care you provide when a person is injured or ill until the medical treatment is available. Timely intervention and immediate care can prevent further deterioration of the victim and even save a life. We can be a great help in such situation if we have the basic knowledge of first aid. However medical help should be sought after first aid.

* What will you do when your body is injured and starts bleeding?
* What can we do to treat burns?

1. Nose Bleeding

- Make the person sit up and lean forward, to prevent swallowing blood.
- Apply pressure to the soft part of nose just above the nostrils with the fingers for at least 10 min.
- Take breathing through mouth
- Apply ice on the bridge of the nose to decrease swelling (if any) and bleeding.
- Consult a doctor if bleeding does not stop.

2. Electric Shock

When a person experienced electric shock depends on the severity, the following first aid is useful.

- Turn off the source of electricity, if possible.
- If not move the person away from the source by using dry, non-conducting object made of wood or plastic.
- Lay down the victim and raise the legs
- Try to cover a blanket to prevent the injured person from becoming chilled
- Keep the person still and do not move him/her unless necessary.
- Loosen tight clothing
- Call the doctor immediately.

3. Severe Bleeding

The following first aid is useful.

- To stop bleeding, keep sterilized dressing or clean hand kerchief and press directly on the wound with the thumb.

- ❑ Make the injured person lay down and elevate the bleeding part to minimize flow of blood.
- ❑ Call the doctor.

4. Burns

The First Aid for burns depends upon the severity of the injury.

- ❑ Immediately immerse the injured area in cool tap water. Do this for about 10 minutes or until the pain subsides.
- ❑ Do not break blisters if any.
- ❑ Blot the area and apply a dry sterile dressing.
- ❑ In case of severe burns cover the injured part with clean towel/cloth to prevent infections and immediately rush to the hospital.
- ❑ Chemical burns caused by acids or alkalis should be flushed with large amounts of water till the pain subsides.
- ❑ Do not apply butter or oil on top of burn, which may retain the heal of the burn and slows down the healing process.

5. Animal Bites

Can be serious sometimes

- ❑ Wash the bite area with soap and water
- ❑ If the bite is bleeding, put pressure on it, using sterile gauge or clean cloth.
- ❑ Cover the area with a bandage or sterile gauze.
- ❑ Consult the doctor
- ❑ In case of dog bite, antirabies is to be taken by the doctor.

6. Insect Stings/Insect Bites

- ❑ Wash the area with soap and water
- ❑ Apply a cool compress
- ❑ Apply calamine lotion or a backing soda paste to the bite or sting.

KEY POINTS

- A person who is physically mentally and socially healthy is considered to be a complete healthy person.
- Abiotic factors like Temperature, Water, Oxygen, Carbondioxide and sunlight are inter linked and are combined with boitic factors to influence the health of a person.

- Diseases are two types conginetical and acquired diseases acquired diseases can be classified as communicable and non-communicable diseases
- Mode is disease transmission can be direct or indirect (Air borne, Vehicle bone, Vector borne)
- Immune cells like macrophage, lymphocytes play an important role in maintaining immunity
- Immunization programme (vaccination) is run by government for pregnant women and infants.
- The immediate care you provide when a person is injured or ill is called first aid.

PRACTICE FOR LEARNING OUTCOMES

1. How do biotic and abiotic factors affect our health?
2. Differentiate between communicable and non-communicable disease?
3. Differentiate Active immunity and passive immunity?
4. Why is it difficult to develop antiviral drugs?
5. What first aid measures you follow when a person experiences electric shock?
6. The mother's milk (colostrum) is rich in ( )

   A) glucose B) Antibodies C) fats D) vitamins
7. Non communicable disease is ( )

   A) diabetes B) malaria C) common cold D) Dengue
8. Antibiotics are generally used to treat diseases caused by ( )

   A) virus B) Fungus C) Bacteria D) parasites
9. Immune cells which engulf the foreign micro organisms ( )

   A) Memory cells B) Macrophages C) Lymphocytes D) Red blood cells
10. Match the following

A)	Tuberculosis	( )	1.	Vector borne disease
B)	Diabetes	( )	2.	Droplet transmission disease
C)	COVID-19 disease	( )	3.	Non-communicable disease
D)	Dengue	( )	4.	Air borne (transmission) disease

CHAPTER

07

Cell, Tissues and Organs

Have you ever observed a house which is under construction in your locality? What is the basic building block of that house? It is a single brick, of course. Like a house, our body and the living organisms live around us are also composed of basic building blocks, and the building blocks of our body are cells. Our body has different kinds of cells, each specialized for a specific purpose. New cells are formed from the pre-existing cells. For this cell undergo division. There are many phases in cell division. Group of cells which are similar in structure and functions are called tissues. Plant and animals have different kinds of tissues. Just like home is made from a variety of building materials; the human body is constructed from different types of cells, tissues, organs and organ systems.

* What are the organelles present in a cell? What do organelles do in a cell?
* How are tissues formed? What is the need of tissues?
* How do organs are formed? Which organs sense changes around us?

LEARNING OUTCOMES

The learner...

- ☆ Identifies the differences between Prokaryotic -Eukaryotic cells, Plant -Animal cells and Mitosis - Meiosis.
- ☆ Classifies the cells based on their genetic material.
- ☆ Explains structure and functions of a cell, organelles, tissues and organs.
- ☆ Gives reason for cells having different shapes and sizes.
- ☆ Draws the diagrams of plant cell, animal cell, mitosis etc.
- ☆ Applies the knowledge of preventive measures required to protect sense organs.

Organisms that are made up of only one cell, which carries out all of the functions are called unicellular organisms Ex: Amoeba, Chlamydomonas. Organisms that are composed of more than one cell called multicellular organisms Ex: plants and animals.

7.1 Cell

It was in the year1665 that Robert Hooke, a British scientist, observed thin slices of cork (soft bark) under a simple magnifying device which he had made himself. He observed that the cork resembled the structure of a honey comb consisting of many empty spaces or empty box like structures. Robert Hooke called these empty spaces as "cells".

7.1.1 Cell - Organelles

All living organisms are made up of cells.

* Are there any common features among cells?

All cells share common components: 1) a plasma membrane, 2) cytoplasm jelly-like region within the cell in which other cellular components are found; 3)The genetic material responsible for our characteristics.

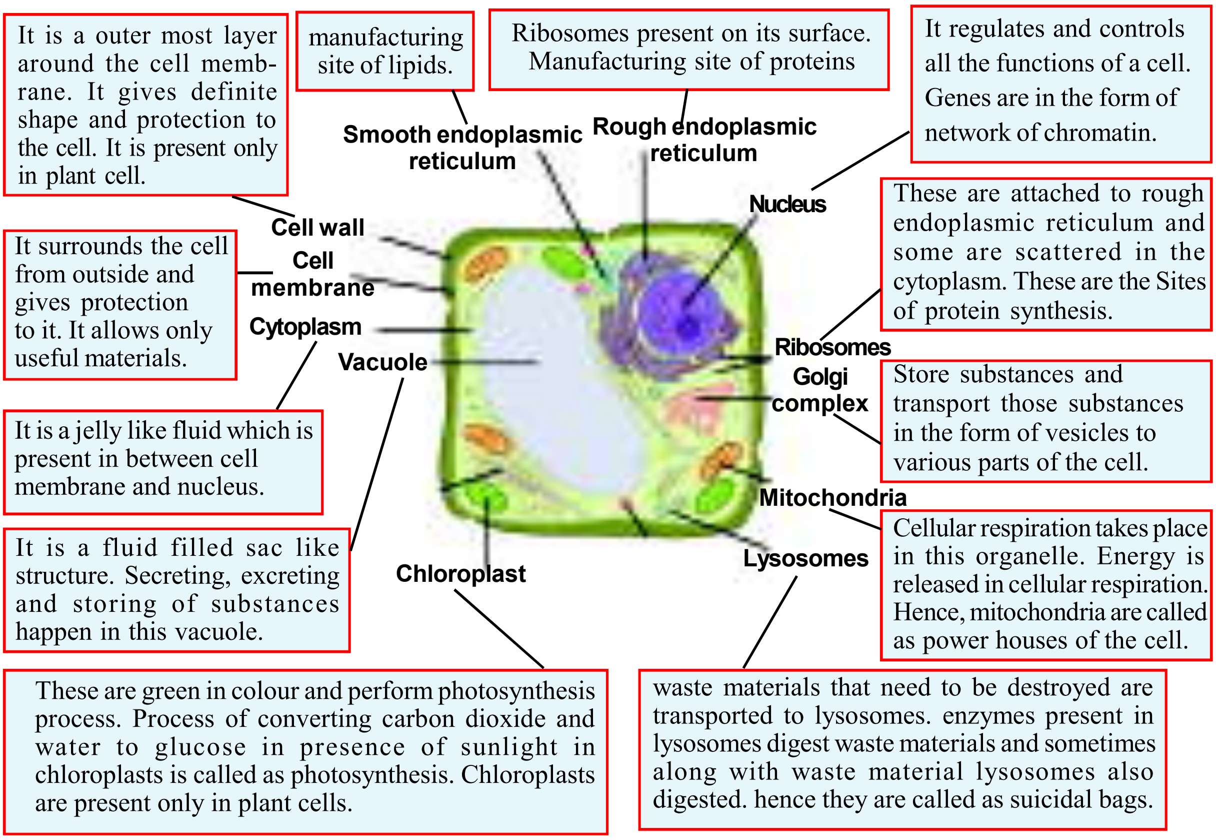
Based on the Nuclues structure cells are divided into prokaryotic and eukaryotic.

1. Prokaryotic cell: Single celled organisms. Genetic material found in the central part of the cell and it does not contain membrance around it. Ex: Bacteria, Cyanobacteria.

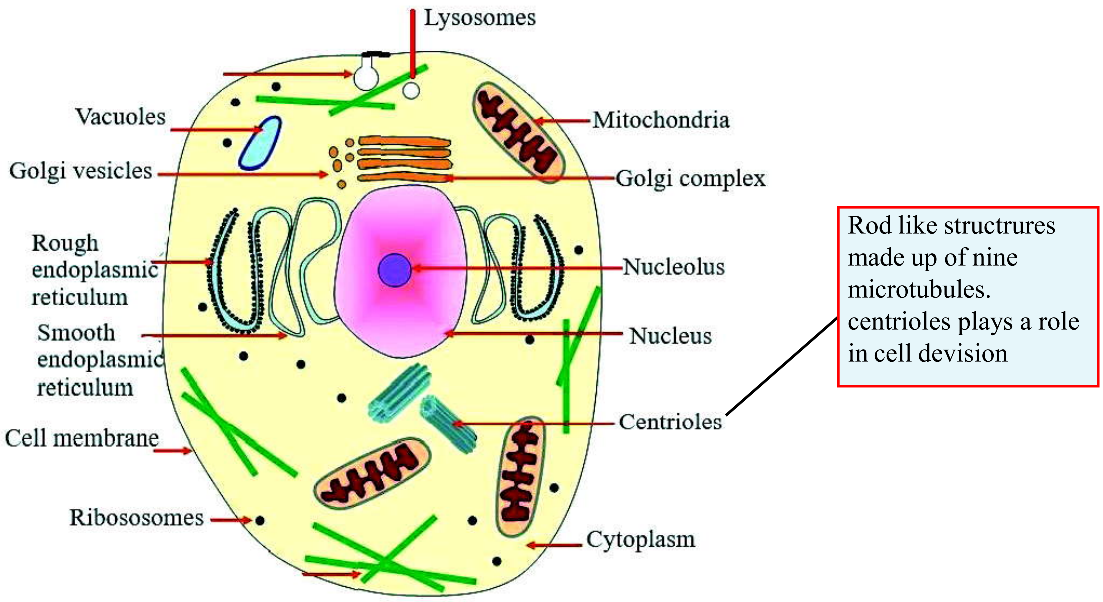
2. Eukaryotic cell: It is a cell that has a membrane-bound nucleus. This membrane separate genetic material from cytoplasm.**Ex:** Plant, animal cells.

Organelles present in a cell. Every organelle has its own structure and functions.

Do plant and animal cells have same structure?



Plant Cell



Animal Cell

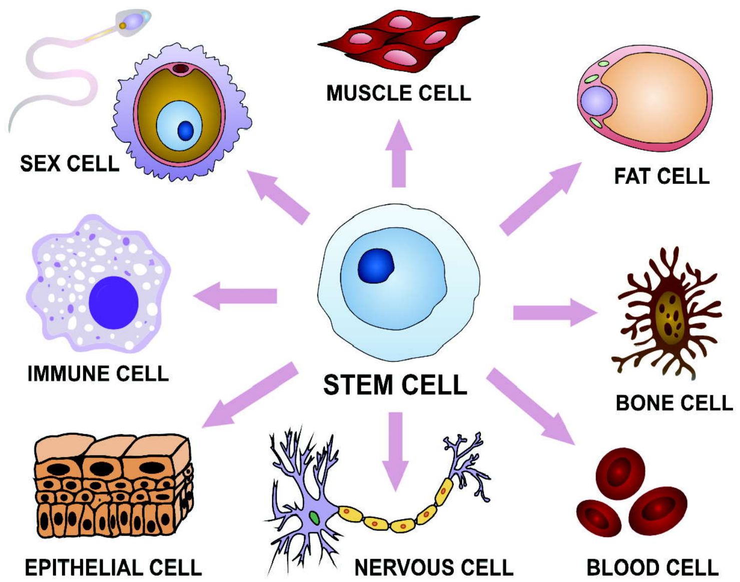
* Which organelles do a plant cell have in additional when compared to animal cell?

Despite their fundamental similarities, there are some striking differences between animal and plant cells. Animal cells have centrioles and small sized vacuoles, whereas plant cells do not. Plant cells have a cell wall, chloroplasts and a large central vacuole, whereas animal cells do not.

7.1.2 Diversity in cells

There are millions of living organisms in nature. They have different shapes, sizes and vary in the number of cells they contain.

Observe cells and answer the following questions. Why nerve cell has branches like a tree? What is the role of nerve cell? Why does a sperm cell has a tail?



Every cell has unique structure this helps the cell to perform a specific function. Nerve cell transport the information throughout the body. Tail of a sperm helps in its movement in the female reproductive system for reaching the ovum.

7.1.3 The Cell Theory

German scientists, Theodor Schwann, a zoologist (studies animals), and Matthias Jakob Schleiden, a botanist (studies plants), suggested that cells were the basic unit of structure and function of all life. Later, in 1858, the Rudolf Virchow observed that cells divide to produce more cells. He proposed that all cells arise only from Pre-existing cells. The collective observations of all three scientists form the Cell Theory, which states that:

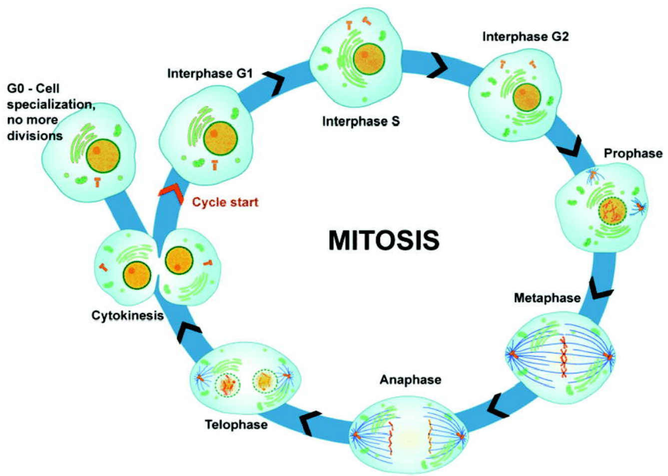
* All organisms are made up of cells and products of cells.
* All the life functions of an organism occur within cells,
* All cells come from pre existing cells.

7.1.4 How new cells are formed from the pre existing cells?

How do our wounds get healed after few days?

Cells which are around the wound divide many times, making new cells. These cells occupy the space of wound and gets normal. The division that takes place in these cells is mitosis. In between two cell divisions interphase takes place. Interphase can be subdivided into G1, S, G2 phases. Mitosis start after completion of interphase.

Mitosis: This division occurs in somatic cells. Mitosis actually occurs in four phases. The phases are called prophase, metaphase, anaphase, and telophase. After these phases cytokinesis occur in cell then two daughter cells formed. They are shown in Figure and described in greater detail in the following sections.



Prophase: The first and longest phase of mitosis is prophase. During prophase, chromatin condenses into chromosomes every chromosome split vertically and form chromatid, this chromatid attached to centromere. The nuclear envelope, or membrane, breaks down. In animal cells, the centrioles near the nucleus begin to separate and move to opposite poles (sides) of the cell. As the centrioles move, a spindle starts to form between them. The spindle, consists of fibers made of microtubules.

Cancer is a disease that occurs when the cell cycle is no longer regulated. Cancer cells grow rapidly and may from a mass of abnormal cells called a tumour.

Metaphase: During metaphase, spindle fibers attach to the centromere of each pair of sister chromatids. The sister chromatids line up at the equator or center of the cell.

Anaphase: During anaphase, sister chromatids separate and the centromeres divide. The sister chromatids are pulled apart by the shortening of the spindle fibers.

Telophase: During telophase, the chromosomes begin to uncoil and form chromatin. The spindle also breaks down, and new nuclear membranes form.

Cytokinesis: Cytokinesis is the final stage of cell division. During cytokinesis, the cytoplasm splits in two and the cell divides. There is no difference in the chromosomes of daughter cells and parent cell.

Meiosis: This division occurs in reproductive cells. Four daughter cells are formed in this division and the number of chromosomes reduced by half. This occur in reproductive cells.

CHECK YOUR PROGRESS.

- What are the main principles of the cell theory?
- What are the phases of mitosis? What are the changes occur in prophase?

7.2 Tissues

A tissue can be defined as a group of cells similar in size, shape, performing the same function and having a common origin.

Plants and animals have different types of tissues. They perform different functions.

7.2.1 Plant tissues

How will a Stump grow? Does it bear leaves?

How will a plant grow? How do plants produce flowers?

Plant tissues helps plants to produce leaves, flowers, fruits and also helps in growth of a plant. Now let us learn about plant tissues.

Plant tissues are of two types: 1. Meristematic tissue 2. Permanent tissue.

Meristematic tissue: Tissues that bring about overall growth and repair are called meristematic tissues. Found at the growing points of a plant such as at the tips of the roots, stems and branches.

i. Apical Meristem - Growth in the length of the plant

ii. Lateral Meristem /Cambium - Growth in the girth of the stem.

iii. Intercalary Meristem - Growth of branches, leaves, flowers

Permanent tissue: It is made up of cells, which have lost their ability to multiply. The permanent tissues are of three types.

1. Dermal tissue: We find this type of tissue over the entire surface of plant body. This tissue help plants by protecting them from parasitic invasion. Prevent loss of water from plant. Give mechanical support to the plant.

2. Ground tissue: This tissue Form the bulk of the plant body, helping in packing other tissues. There are mainly three types of ground tissues present in plants.

They are i. Parenchyma ii. Collenchyma iii. Sclerenchyma.

i. Parenchyma

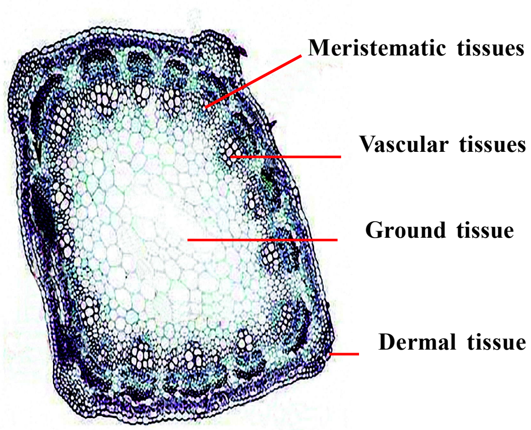
a) Chlorenchyma - Contains chloroplasts helps in photosynthesis

b) Aerenchyma - Contains air spaces between cells helps in floating (aquatic plants)

c) Storage parenchyma - Helps in Stores water or food or waste.

ii. Collenchyma: Thick walled cells provides structural support to the plant.

iii. Sclerenchyma: Thick walled tightly packed cells Provides mechanical support to the plant.



Dicot stem (TS) - Tissues

3. Vascular tissue: It is of two types- xylem and phloem. Xylem allows water and minerals absorbed from the soil to travel upwards in the plant. Phloem serves to conduct the food (sugar) synthesized in the leaves to flow downward and upward so that food reaches all other regions.

7.2.2 Animal tissues

There are different kinds of tissues present in animals to perform different functions like plant tissues. Four major types of tissues present in animals. They are: 1. Epithelial Tissue 2. Connective Tissue 3. Muscular tissue 4. Nervous tissues.

1. Epithelial tissue: Thin protective layer of cells. Generally located on the outer surface of the body, on the surface of the internal organs. There are three distinct types of epithelial tissues namely Squamous, Cuboidal, Columnar Epithelium.

a. **Squamous Epithelium:** Found in oesophagus, lining of mouth, lining of blood vessels, lung alveoli.

Function: where transportation of substances selectively occurs through permeable membrane of these cells.

b. **Cuboidal Epithelium:** It is commonly found in exocrine glands like salivary glands. Lining of ureters and provide mechanical support to salivary glands.

Function: Secretion of enzymes and absorption of water and mineral in ureters.

c. **Columnar Epithelium:** It is found in bronchi of respiratory tract, uterine tubes, uterus, bladder and digestive tract.

Function: Absorption and secretion of enzymes and mucous.

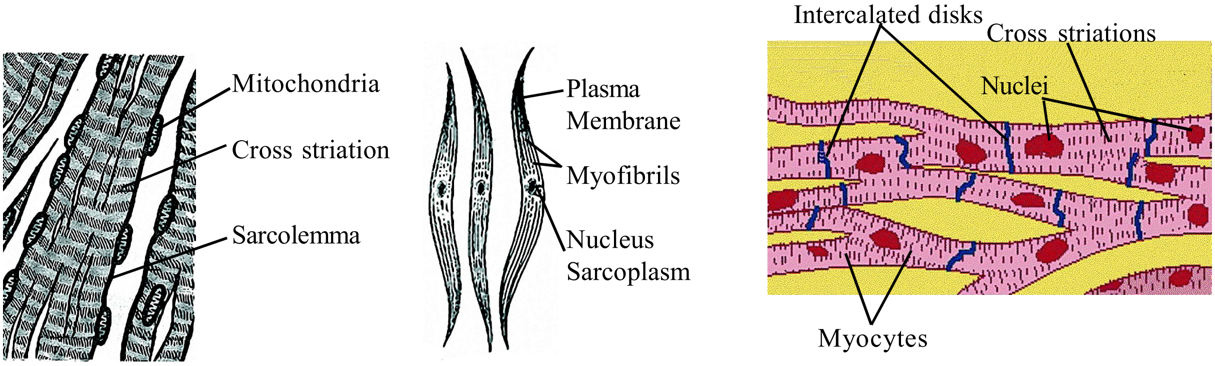
2. Muscular tissue: The muscular tissue consists of long, narrow cells called muscle fibres. Muscle fibres are the muscle cells. They are so named because of their long fibre like shape. Muscles bring about movement of body parts and locomotion in organisms. Types of muscular tissue In human beings, three types of muscles are present 'Striated muscles', 'Unstriated muscles' and Cardiac muscles.

Striated Muscles: There are Long, cylindrical, unbranched and have many nuclei in cytoplasm of these cells. particularly these cells have dark and light bands in them that is why they are called as striated muscles. These are attached to bones. Help in the movement of limbs whenever we want (voluntary muscles)

Unstriated muscles: There are Spindle shaped Shorter cells, one nucleus per cell, there are no striations in the cell. These muscles present in the walls of hallow internal organs like stomach, intestines, bladder, uterus, blood vessels etc. These are Involuntary muscles, helps in movement of food in digestive tract etc.

Cardiac Muscles: Present in the walls of the heart. Help in pumping and receiving of blood to various body parts by contraction and relaxation of these muscles.

Muscular tissue



Striated muscles *Non-striated muscles* *Cardiac muscles*

3. Connective tissue: Connective tissue help in binding of other tissues and organs together and provide framework and support to various organs in the body. . Examples of connective tissue are areolar tissue, adipose tissue, cartilage, bone and blood.

a. **Areolar Tissue:**

Structure: A type of loose connective tissue widely distributed in the body that contains collagen fibres, reticular and few elastic fibres.

Location: Found between the skin and muscles and around the blood vessels and nerves.

Function: Provides support and strength to various organ systems.

b. **Adipose Tissue:**

Structure: A specialised type of loose connective tissue that functions as the major storage site for fat.

Location: Found below the skin and around internal organs.

Function: Thermal insulator, mechanical protection, energy storage.

c. **Cartilage:**

Structure: It is soft bone with widely spaced cells in small cavities. have rubbery matrix.

Location: External ear, Larynx, rings around trachea, joint surfaces and growth zones of bones, between ribs etc.

Function : Eases joint movements, resists compression at joints, holds airway open, Shapes outer ear, moves vocal cords, growth zone of children bones etc.

d. **Bone:**

Structure : It consists of widely spaced cells in lacunae. Matrix in concentric onion like layers, hard mineralised matrix.

Location: Skeleton

Function: Physically support body and give definite shape to body, encloses soft organs, stores and releases calcium and phosphorus.

e. **Blood :**

Structure: It consists of red blood cells white blood cells, platelets and fluid part called plasma.

Location: Cardio vascular system

Function: Transports food materials, hormones, gases, waste materials etc.

f. **Ligament** is yet another type of connective tissue that connect bones at joints and hold them in position.

g. **Tendon** is also a connective tissue which joins the muscle to the bone. It is made up of collagen.

4. Nervous Tissue: Nervous tissue consists of nerve cells or neurons. A bundle of nerve fibres or axons of nerve cells forms nerves. A nerve cell or neuron is a structural and functional unit of the nervous system. Neurons transfer information from body parts to brain/spinal cord and brain to body parts. A typical nerve cell consists of the following parts. Cell body or cyton, Dendrons and dendrites.

CHECK YOUR PROGRESS.

- Which tissue helps plant to produce branches and flowers?
- What are the use of cardiac muscles?
- What would happen if plant do not have meristematic tissue ?
- Write examples for cartilaginous bones in our body.

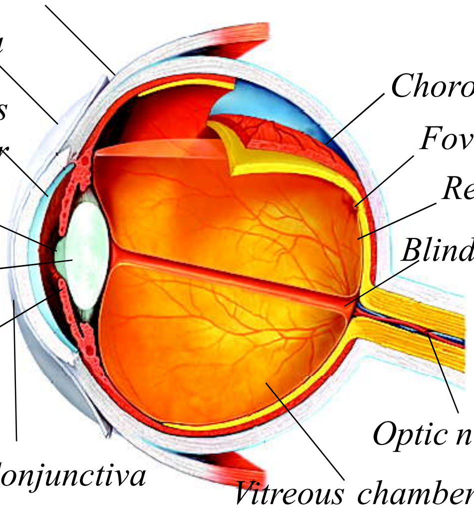
7.3 Organs

An organ is a collection of different tissues which work together to do particular work in living beings.

Most important organs in human body are sense organs. Taking care of sense organs provide good health which leads to better livelihood. Each sense organ has special cells, called sensory receptors, those respond to a particular type of stimulus. They give information about environment around us. Let us learn about the sense organs.

7.3.1 Eye

Eye is the organ that senses light. Light first passes through the cornea of the eye, which is a clear outer layer that protects the eye. Light enters the eye through an opening called the pupil. The light then passes through the lens, which focuses it on the retina at the back of the eye. The retina contains light receptor cells. These cells send nerve impulses to the optic nerve, which carries the impulses to the brain. The brain interprets the impulses and "tells" us what we are seeing.



How to take care of our Eyes: Wash eyes with fresh water at least thrice or four times per day. Keep the distance between the book and eyes about 25 cm while reading. Don't give continuous stress and strain to the eyes. Stop the work for some time when ever your eyes feel stressed. Eat food materials like green leafy vegetables, carrots etc rich in Vitamin A. Work under good lighting. Don't rub your eyes if anything falls in them, just wash the eyes immediately. Consult the eye specialist immediately whenever you face any vision related problems. Avoid to seeing lightening, gas welding sparks, eclipse with a naked eye.

Donate your sight - make blind one's future bright.

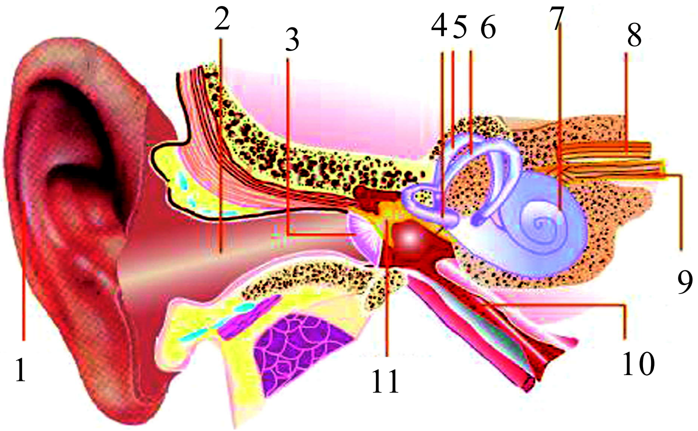
Conjunctivitis: Viral disease

Symptoms: Redness in the eye or inner eyelid, More tears than usual, Thick yellow discharge that crusts over the eyelashes, especially after sleep, Green or white discharge from the eye. Itchy eyes, Burning eyes, Blurred vision.

Spread: Communicable disease, spread from one person to other through air, water, hand kerchief, towels etc.

Treatment: Anti viral drugs.

7.3.2 Ear



1. External ear (Pinna)
2. *Auditory canal*
3. *Ear drum*

4,5,6. *Semicircular canals*

7. *Cochlea*
8. *Vestibular nerve*
9. *Cochlear nerve*
10. *Eustachian tube*
11. *Ear Ossicles (Utriculus)*

Ear is the organ that senses sound. Sound waves enter the auditory canal and travel to the tympanum. They strike the tympanum and make it vibrate. The vibrations then travel through several other structures inside the ear and reach the cochlea. The cochlea is a coiled tube filled with liquid. The liquid moves in response to the vibrations, causing tiny hair cells lining the cochlea to bend. In response, the hair cells send nerve impulses to the auditory nerve, which carries the impulses to the brain. The brain interprets the impulses and "tells" us what we are hearing. ears are also responsible for the sense of balance

How to take care of our Ear: Don't insert any sharp edged object in the ears to clean it. If any blockage occurs due to ear wax, use the ear drops, or a few drops of hydrogen peroxide oil to loosen it. A specialist may be consulted whenever needed. It is very dangerous to pour boiled oils, leafy juices in the ear. Sometimes it may causes deafness.

7.3.3 Skin

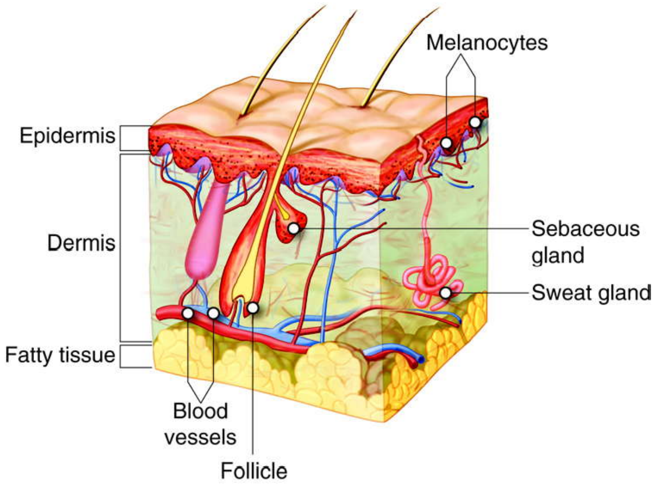
Our skin has cutaneous receptors to sense the touch. Touch is the ability to sense pressure. Pressure receptors are found mainly in the skin. They are especially concentrated on the tongue, lips, face, palms of the hands, and soles of the feet. Some touch receptors sense differences in temperature or pain. It also contains the separate receptors such as tactile receptors for touch, pacinian corpuscles for pressure, nociceptors for temperature etc.

How to take care about your Skin: We should take bath regularly. Use soap to clean the body.

* If any redness, itching, discoloration and rashes appear on the skin immediately consult the doctor.

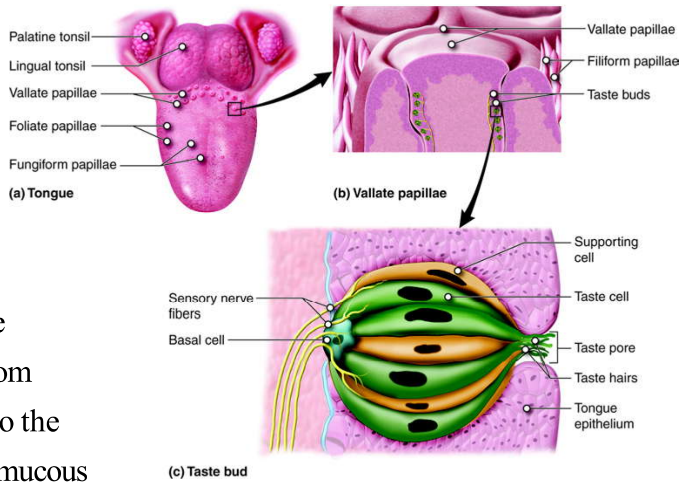
Why do people in adolescent age got more pimples when compare to other age groups?

When you hit puberty, there's an increase in sex hormones called androgens. The excess hormones cause your oil glands to become overactive, enlarge, and produce too much oil, or sebum. When there's too much sebum, the pores or hair follicles become blocked with skin cells. The increase in oil also results in an overgrowth of bacteria. If blocked pores become infected or inflamed, a pimple forms. We should not scratch the pimple it will leave scar on our face.



7.3.4 Tongue

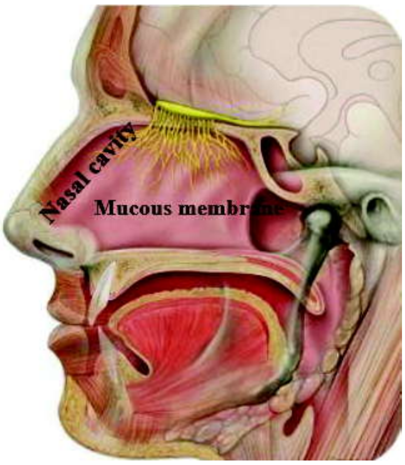
Taste receptors are found in tiny bumps on the tongue called taste buds. The taste buds are located in the walls of the papillae. There are separate taste receptors for sweet, salty, sour, bitter, and meaty tastes. The meaty taste is called umami. The taste receptor cells, located in the taste buds on the top and side of the tongue, sample flavours from food and drink as they pass by on the way to the stomach. These taste receptors cluster in small mucous membrane projections called papillae.



How to take care of your tongue: Clean and wash the tongue before going to bed at night and after rising up in the morning. Wash the mouth cavity after eating the food.

7.4.5 Nose

In our nose nasal cavity is lined with mucous membrane and small hairs. Olfactory receptors are present in the mucous membrane. The sense of smell or olfaction, begins with chemical events in the nose. There odors (in the form of airborne chemical molecules) interact with receptor proteins associated with specialized nerve cells. Nerve cells carry information to brain then we can feel good or bad smell based on the chemicals.



Taking care: Take proper care of your nose by washing it with water as you take bath and during nasal infection by washing them with lukewarm saltwater. Do not put fingers in your nose. Do not pour hot oils or castor oil in nose. If you get infection in nose consult ENT specialist immediately.

CHECK YOUR PROGRESS.

- How do we hear sounds through Ear?
- Name the type of receptors in nose.
- What are the two main functions of Ear?

KEY POINTS

- All living beings are made of cells. Cells are the structural and functional units of living beings.
- All cells share common components they are plasma membrane, cytoplasm and the genetic material.
- Basically cells are divided into two types based on membrane around the nucleus. Prokaryotic cells do not have nuclear membrane around the nucleus. Eukaryotic cells have a prominent nucleus.
- Plant cells have plastids, cell wall and large sized vacuole whereas animal cells do not have them. Animals cells have centrioles and small sized vacuoles these are absent in plant cells.
- All organisms are made up of one or more cells, All the life functions of an organism occur within cells, All cells come from pre existing cells. These are the main principles of cell theory.
- Mitosis occur in all vegetative cells and meiosis occur in reproductive cells to form gamets.
- Plants have different kinds of tissues i. e. meristematic, dermal, Ground and vascular tissues.
- Animals have various types of tissues i. e. Epithelial, Connective, muscular, and nervous tissue.
- An organ is a collection of different tissues which work together to do particular work in living beings like plants and animals.
- Sense organs are the gateways of knowledge. We have to protect them.
- In multicellular organisms different types of organs present to do particular works in them. various organs form organ systems in multi cellular organisms. Organ systems makes up an organism.

PRACTICE FOR LEARNING OUTCOMES

1. Write the organelles present in a cell.
2. Write the differences between prokaryotic and Eukaryotic cells.
3. In which cells mitosis and meiosis occur?
4. Why do cells show diversity ? Explain the role of meristematic tissue in plants?
5. Draw the diagrams of plant and animal cells and explain the differences between them.
6. Illustrate the connective tissues and their functions?
7. What are the measures suggested by you to protect ear and skin ?
8. What are the differences between mitosis and meiosis?
9. Name the fluid connective tissue ....
10. .... Organelle digest waste material present in cell.
11. Example for prokaryotic living being ....
12. Structural and functional units of living beings. ( )

    A) Tissues B) Organs C) Organ systems D) Cells
13. Find the odd organelle on account of plant cell ( )

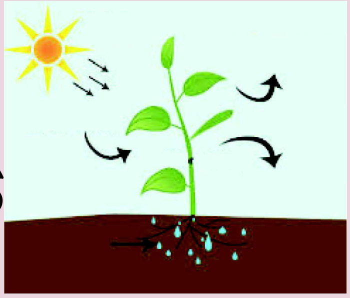
    A) Chloroplast B) centrioles C) Cell wall D) Large sized vacuole
14. Type of animal tissue useful in joins the muscle with bone ( )

    A) Areolar B) Adipose C) Cartilage D) Tendon
15. Match the following plant tissues with respect to their function.

A)	Chlorenchyma	( )	1.	Growth in the girth of the stem
B)	Sclerenchyma	( )	2.	Photosynthesis
C)	Dermal tissue	( )	3.	Gives mechanical support to plant
D)	Vascular tissue	( )	4.	Cover over the plant body
E)	Cambium	( )	5.	Transport water and food

CHAPTER 8

Life Processes Food: Synthesis and digestion



We do a lot of things in our daily life such as sitting, walking, running, talking and so on. Along with these, many other processes also occur in our body like growth, digestion, respiration etc. For doing all these activities energy is needed. Where do we get this energy from? Plants also show processes like growth and movement. From where do plants get energy? Like this there are many questions that come to one's mind.

* How do plants prepare their food?
* How does the food we take, gets digested?
* What happens if we do not take nutritious food?
* How do we plan our meal?

In this lesson you will learn about nutrition in plants and animals and seek some possible answers for these questions.

LEARNING OUTCOMES

The learner...

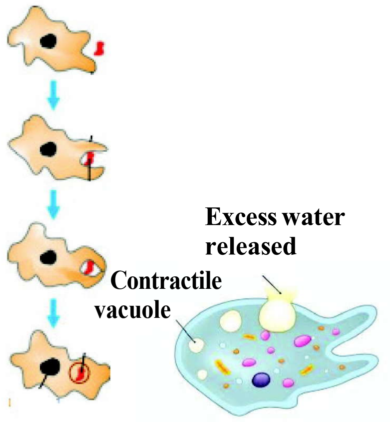
- Identifies the essential nutrients needed for human beings.
- Explains modes of nutrition, mechanism of photosynthesis, process of digestion in human, role of enzymes in digestion and importance of vitamins.
- Conducts experiments to show that carbohydrates and oxygen are end products in photosynthesis.
- Draws and explains diagrams of human digestive system and chloroplast.
- Designs model of 'My Plate'.
- Applies the knowledge, by taking a balanced diet, follows healthy eating habits.
- Appreciates the processes and mechanism involved in digestion, movement of food in digestive tract and photosynthesis.
- Understands importance of plants and thus strives for their conservation.

In all the organisms many processes are carried out continuously and simultaneously.

The processes that organisms perform for their survival, growth and continuing their species are called Life Processes. For example: digestion, respiration, transportation, excretion, control and coordination etc.

These processes occur in all living organisms, from single-celled organisms (eg. amoeba) to well-developed multicellular organisms (eg. humans, plants)

In unicellular organisms like amoeba, paramoecium, chlamydomonas etc., all the processes occur in the absence of any special organ systems. For example, amoeba takes food through cell membrane and also excrete waste materials through the same cell membrane. In developed multicellular organisms there are organ systems to perform life processes (eg.) Digestive system, respiratory system, circulatory system, excretory system etc.



Nutrition and Excretion in Amoeba

Energy is needed for all these life processes to occur, organisms obtain energy from the food they take.

Nutrition is taking in food and digestion of complex substances in food into simple substances. These simple substances are then absorbed into the body to release energy.

8.1 Types of Nutrition

There are two main modes of nutrition - Autotrophic nutrition and Heterotrophic nutrition.

8.1.1 Autotrophic Nutrition

The green plants, algae and certain bacteria prepare their own food by the process called photosynthesis. So they are called as producers or autotrophs and their mode of nutrition is called autotrophic nutrition.

8.1.2 Heterotrophic Nutrition

The organisms which are dependent on other organisms for food are called Heterotrophs. Their mode of nutrition is called heterotrophic nutrition.

Heterotrophic nutrition may again be classified into three types:

a) **Saprophytic Nutrition:** Some organisms break down the food materials outside their body and then absorb it. These are called saprophytes. example: bread moulds, yeast, mushrooms, etc.

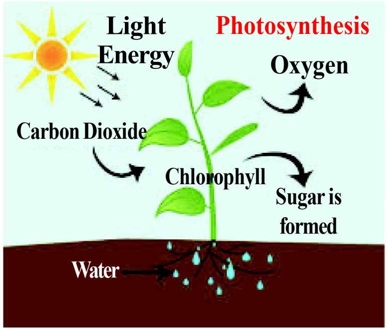
b) **Parasitic Nutrition:** Plants or animals which live in or on other plants or animals and get their food from them. Eg. Cuscuta, leech, head louse, tape worms etc.

c) **Holozoic Nutrition:** Some organisms take in whole food material and break it down into simple substances inside their body. Example: amoeba, dog, human etc.

CHECK YOUR PROGRESS.

- Write two differences between autotrophic and heterotrophic nutrition.
- What do you think can be effect of saprophytic organisms on other organisms?

8.2 Nutrition in Plants



The main source of energy for living beings on earth is sun. Green plants use this energy from sun and other simple substances like carbondioxide and water to produce carbohydrates and release oxygen. This process is called photosynthesis. Photosynthesis is an anabolic process (means complex substances are synthesised using simple substances).

$$\underset{\text{(Carbondioxide)}}{6CO_2} + \underset{\text{(water)}}{12H_2O} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \underset{\text{(Glucose)}}{C_6H_{12}O_6} + \underset{\text{(water)}}{6H_2O} + \underset{\text{(oxygen)}}{6O_2}$$

Carbondioxide, water, sunlight and chlorophyll are essential raw materials for photosynthesis. Even if one of them is absent photsynthesis does not occur.

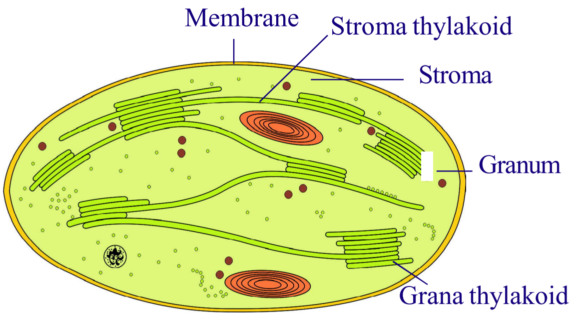
Chlorophyll: Chlorophyll is a pigment which is present in the chloroplast of different cells of the plant. This chlorophyll can trap sunlight. The green colour of the leaves is due to chlorophyll.

You might have seen some plants that have leaves with different colours. Do these type of leaves also perform photosynthesis? Leaves, fruits, flowers of different colours have different pigments like chlorophyll a, chlorophyll b, xanthophyll and carotenoids. These pigments can also trap sunlight and help in photosynthesis indirectly. But chlorophyll a is the most important pigment for photosynthesis.

Chloroplast-Food factory of plants

Chloroplasts are present mainly in the plant cells. Chloroplast is membranous structure. It consists of three layers, inner layer forms stacked sack like structures called Granum (Plural: Grana). It is filled with fluid called stroma.

Sunlight: Sunlight is absorbed by chlorophyll pigment in leaves. This light energy is then converted into chemical energy during photosynthesis.



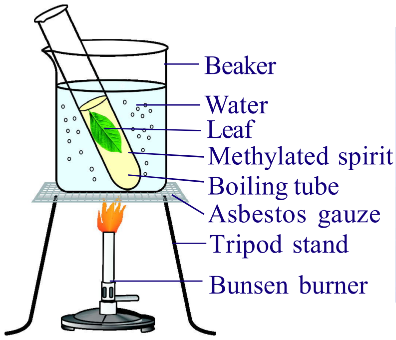
T.S of chloroplast

Carbon Dioxide and Water: Carbon Dioxide from air through stomata and water from ground through roots are taken up by plants for photosynthesis.

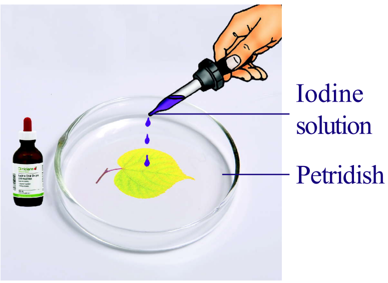
Starch and oxygen are end products in photosynthesis. Glucose (building block of starch) is used by the cells and some is stored in the form of starch. Oxygen is a byproduct which is released into atmosphere. To prove the formation of end products we shall do the following experiments.

Experiment 1: To prove that starch is formed in leaves during photosynthesis.

Apparatus required: Beaker, test tube, methylated spirit, bunsen burner, tripod stand, gauze.



Boiling the leaf in methylated spirit



Iodine test

Procedure: Collect leaf from a plant having thin leaves and put it in methylated spirit in test tube. Take some water in a beaker and heat it on bunsen burner. Keep this test tube in boiling water (water bath). By doing this, the leaf loses chlorophyll. Now carefully place the leaf in petri dish. Then put4-5 drops of iodine solution on leaf.

Observation: If the leaf turns into blue-black colour with iodine solution, then it is confirmed that starch is present in leaves and if leaf does not show blue-black colour, it shows starch is not present.

Inference: In iodine test leaf turns into blueblack colour, so it is proved that starch is present in leaves.

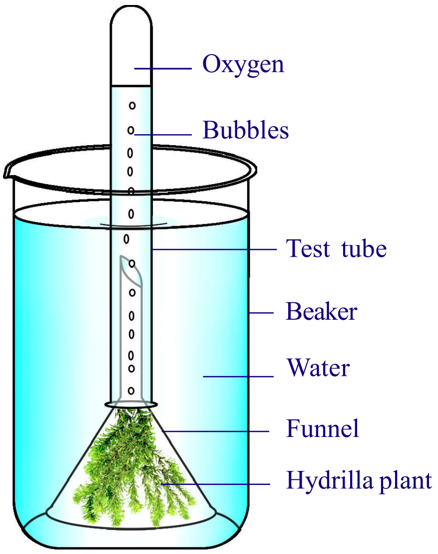
Experiment 2: To prove that O_2 is released during photosynthesis.

Apparatus required: Beaker, funnel, test tube, hydrilla plant.

Procedure: Place Hydrilla twigs into the funnel and keep it in the beaker with water. Invert a test tube with full of water onto the funnel. (See the figure) Keep this setup in sunlight for 4-5 hrs.

Observation: We can see that gas bubbles coming from hydrilla plant reach the upper part of the test tube.

Inference: After some gas collects in test tube, slowly remove it by closing with thumb and at the same time letting out water. Test this gas with glowing match stick, it glows brightly due to O_2. We can say that O_2 is released in photosynthesis.



Hydrilla experiment

8.3 Mechanism of Photosynthesis

Photsynthesis is a complex anabolic process. It includes many chemical processes, these can be studied under two phases.

1. Light reactions (photochemical phase) (Light dependent reactions)

In this phase a series of chemical reactions occur in a very quick succession initiated by light. These processes occur in grana in chloroplast. Steps in Light reactions are:

Step-1: Chlorophyll absorbs photons (Light energy is in the form of small energy packets called photons) and becomes excited.

$$\text{Chl} \xrightarrow{h\nu} \text{Chl}^*$$

Step-2: Excited molecule of chloroplast splits water molecule into hydrogen and hydroxyl ions.This process is called Photolysis of water (photo means light, lysis means split).

$$H_2O \xrightarrow{\text{Chl}^*} H^+ + OH^-$$

This was discovered by Robert Hill. Hence it is also called Hill's reaction.

Step-3 : OH^- ions through a series of steps produce water (H_2O) and oxygen (O_2).

H^+ is received by NADP and NADPH is formed.

2. Dark reactions (Biosynthetic phase) (Light independent reactions)

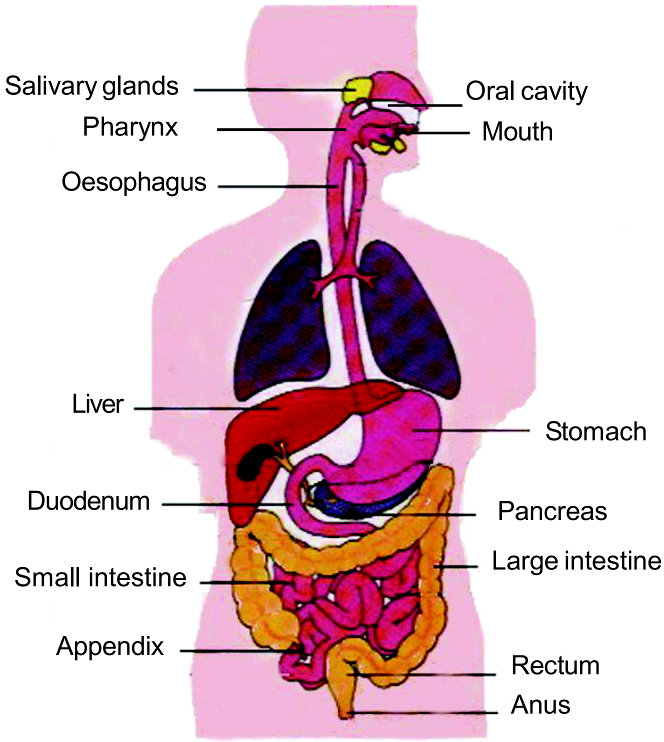
These reactions are not dependent on light. These occur in stroma of chloroplast. H^+ in NADPH (formed in light reaction) combines with CO_2 and using the energy from ATP produces glucose. Plant uses some glucose for its energy needs and stores some glucose in the form of starch. Food that we eat such as potato, carrot, fruits….. are all stored form of food in plants.

What will happen if photosynthesis doesn't occur in plants. Think!

CHECK YOUR PROGRESS.

- Define and write the equation for photosynthesis.
- What are the observations you find in hydrilla plant experiment?
- In what form is glucose stored in plants?
- Explain the mechanism of photosynthesis.

8.4 Nutrition in Human Being



Nutrition in Human Being

Locate the following parts in the picture of human digestive system. Mouth, oral cavity, pharynx, oesophagus, stomach, duodenum, small intestine, large intestine, rectum and anus.

The food we take passes through all these parts, so basically the digestive tract or alimentary canal is a tube like structure from mouth to anus. (nearly 27 feet long).

What does food contain?

The food we eat has nutrients like carbohydrates, proteins, fats, mineral salts, and vitamins.These complex substances break down into simple substances due to mechanical action and the action of enzymes. These simple substances are then absorbed into the blood.

Why should we chew our food:

Chewing food properly helps mixing it with saliva.Then food becomes soft and slippery and easy to swallow. Teeth and tongue help in chewing and swallowing food. Saliva contains an enzyme **ptyalin (amylase)** which helps in breakdown of complex carbohydrates and convert them into maltose.

Now the food is soft and is in semisolid form, this is called Bolus.

Why shouldn't we talk while eating?

Pharynx: This is the common passage for air pathway (for air from nose) and food pathway. Epiglottis is the flap like structure which closes the windpipe when we swallow food thus preventing food from entering into windpipe. If we talk while eating the epiglottis may slightly open and food may enter windpipe causing us to cough.

Oesophagus:

Place two fingers on your throat,now swallow some water. You can feel the movement in oesophagus. When we swallow, food enters esophagus and due to its peristaltic movements food travels down into the stomach.

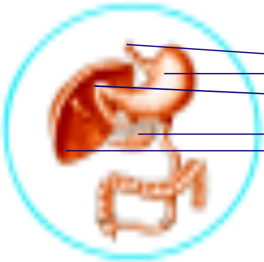
Stomach - A muscular bag:

Stomach is a muscular sac like structure. Stomach walls have gastric glands, these glands secrete gastric juice and HCl. Gastric juice contains enzyme pepsin. **Pepsin** acts on proteins and converts them into small fragments called peptones. HCl activates pepsinogen into pepsin and kills harmful bacteria in food. Notice that only proteins are digested in stomach. Now the food is in the form of thick liquid, it is called Chyme. Pyloric splincter present at the end of the stomach relaxes, so that food passes from stomach to duodenum in small amounts.

Stomach walls secrete mucous which protects the stomach walls from the action of HCl.

Duodenum:

The small intestine is the longest part of the alimentary canal. The first part of the small intestine is called duodenum. Liver secretes bile juice into the duodenum. Bile does not have any enzymes but helps in breaking down of large fat molecules into small globules. This is called **emulsification.**



Locate parts liver and pancreas in the digestive system diagram.

Pancreas also secretes pancreatic juice into the duodenum. The pancreatic juice contains three enzymes.

i) **Amylase-** acts on carbohydrates in food and converts them into maltose.

ii) **Trypsin-**acts on proteins in food and converts them into peptones.

iii) **Lipase-**acts on fats in food and converts them into fatty acids and glycerol.

Small Intestine

Walls of small intestine have intestinal glands. These secrete intestinal juice into the small intestine. Intestinal juice contains enzymes like

i) **Peptidase -** acts on peptides to give amino acids

ii) **Sucrase -** acts on sucrose to give glucose.

How do we get energy from digested food?

The digested food material from small intestine gets into blood (through walls of small intestine), this is called **Absorption.** The inner surface of the small intestine contains thin finger-like projections called microvilli, which increases the surface area for absorption of digested food into the blood capillaries, lining the villi.

The blood then carries the absorbed food to all the cells in the body, in cells glucose is oxidised to release energy. You will learn more about this process in chapter Respiration.

What happens to the undigested food?

Large intestine:

The undigested food is pushed into the large intestine. The faeces pass on to the lower part of the large intestine, called the rectum, and are pushed out of the body through the anus. This is called defecation.

CHECK YOUR PROGRESS.

- Where in the body does digestion of food starts?
- What are the changes that food undergoes in mouth?
- What is emulsification? Where does it happen?
- Name the enzymes present in pancreatic juice and mention their function.
- What is the role of HCl in process of digestion?

8.5 Food and Nutrients

"You are what you eat", this is actually a true statement. Eating food containing all nutrients keeps us healthy. Overeating and eating only one type of food for long period leads to illness.

You may prefer to eat your favourite food to satisfy your taste buds, but what does your body need? Think!

Many nutrients are present in the food we take.

Nutrients are broadly divided into three groups.

(i) Energy-yielding nutrients - carbohydrates and fats

(ii) Body-building nutrients - proteins

(iii) Growth-regulating nutrients - vitamins and minerals

Along with all these nutrients, water is also an important part of our diet.It makes 65-70% of our body weight. Water regulates the body temperature and provides a medium for biochemical reactions taking place in the body.

Carbohydrates

Carbohydrates are the main source of energy in our diet. The energy in food is measured in a unit called Calorie. One gram of carbohydrates provides 4 kilo calories of energy. Carbohydrates may be in the form of sugars, starch or cellulose. Sugars are found in sources like fruits, milk and sugarcane. Starch is found in sources like potato, wheat, rice and sweet potato.

Cellulose, a type of carbohydrate also called roughages or dietary fibre cannot be digested but add bulk to the food and helps in smooth movement of food in alimentary canal, thus helps in absorption.

Proteins:

Milk, pulses, eggs meat are rich in proteins. Growth of body tissues is the main function of proteins.

Fats: Some common sources of fats are edible oil, ghee, butter, meat and groundnut oil. You need to eat small amounts of fats for good health. Taking in large amounts is harmful, especially if they contain saturated fatty acids.

Vitamins

Vitamins and minerals are needed in very small amounts, still they play important role in having good health. Vitamins may be classified into two groups.

i) Water-soluble Vitamins: Vitamins B-complex and vitamin C

ii) Fat-soluble Vitamins: Vitamins A, D, E and K

Vitamins	Sources	Functions	Deficiency disease
A Retinol	Leafy vegetables, carrot, tomato, pumpkin, papaya, mango, meat, fish, egg, liver, milk, cod liver oil, shark liver oil	Keeps eyes and skin healthy	Night blindness (poor vision in dim light), poor vision, dry eyes, scaly skin.
B_{12} Cyano cobalamin	Milk, eggs, liver, kidney	Needed in formation of RBC	Anaemia
C Ascorbic acid	Amla, tomato, citrus fruits	Healthy growth of blood vessels	Scurvy (a disease in which gums swell up and bleed)
D Calciferol (Sunshine Vitamin)	Sunlight, milk, whole grains and vegetables	Form strong bones and teeth	Rickets (a disease which affects bones in children making them soft and deformed)
E Tocoferol	Vegetable oil, milk, butter, whole grains, vegetables	Protects cell membranes	Affects fertility
K Phylloqui-none	Green vegetables like spinach and cabbage	Helps in the clotting of blood	Excessive bleeding from wounds

Vitamin B-Complex is a group of vitamins …it includes vitamins B_1, B_2, B_3, B_5, B_6, B_7, B_9, B_{12}.

Minerals

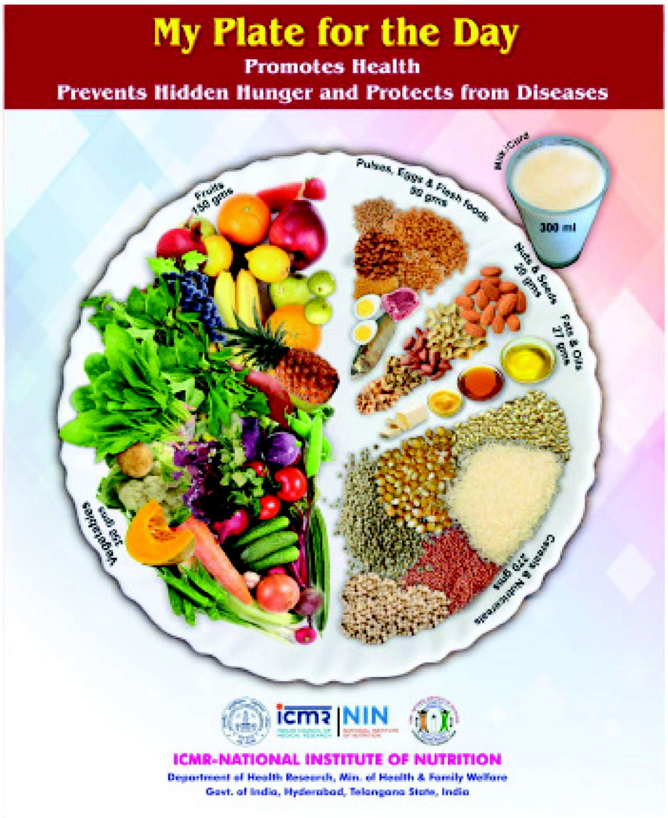
Minerals such as iron, calcium, sodium, potassium, iodine etc. are required by the body in small quantities. The table below table indicates the sources and functions of some important minerals.

Minerals	Sources	Functions
Iron	Green leafy vegetables, sprouts, liver, eggs, meat	Forms haemoglobin.
Calcium	Milk and milk products	Forms strong bones and teeth and needed for muscle movement, clotting of blood.
Potassium	Green and yellow vegetables	For cell growth and keeping osmotic balance of cell fluids.
Iodine	Seafood, iodized salt	Body metabolism, development of brain.

8.5.1 Balanced Diet

A diet containing all nutrients in sufficient proportions is called balanced diet. By taking balanced diet, we can have good health.

MY PLATE



The concept 'My Plate' has been designed by 'National Institute of Nutrition' (NIN).

Observe the picture. It shows the nutrients to be included in our meal plate from all food groups per day.

Cereals	-	270 gm
Pulses, eggs, meat	-	90 gm
Vegetables	-	350 gm
Nuts	-	20 gm
Fruits	-	150 gm
Fats, oils	-	27 gm
milk/curd	-	300ml

Regular consumption of foods in proportions as per the model plate

- improves immunity and resistance to infections
- maintains goods microbial flora (beneficial bacteria in the intestine)
- prevents Diabetes Mellitus and Cardiovascular Diseases
- maintain appropriate alkalinity in body and thereby reduces inflammation and decreases chances of kidney stone formation
- prevents insulin resistance and maintains appropriate insulin sensitivity and glycemic index
- ensures adequate intake of fibre and therefore prevents constipation
- prevents adverse effects of environmental pollution and toxins such as heavy metals and pesticides by working as a detoxifying diet

- Eggs/fish/meat can be substituted with pulses.
- Vegetables may be consumed either in cooked form or as salads.
- It's good to eat fresh fruits than fruit juices.
- Use different varieties of cooking oils.

CHECK YOUR PROGRESS.

- What is the role of roughages in digestion?
- Mention the food sources for water soluble vitamins.
- Write the food items you would include in your plate to have a balanced diet?
- Other than affecting your health, what are the other bad effects of over eating?

8.5.2 Malnutritional Diseases

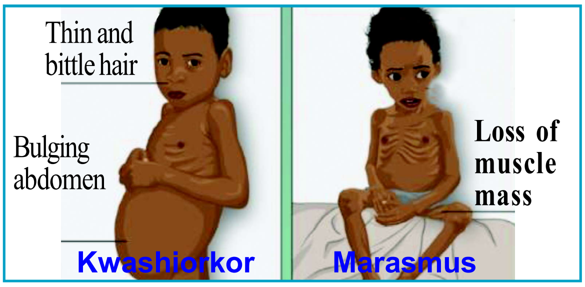
Eating of food that does not have one or more than one nutrients in required amounts is known as malnutrition.This kind of intake of food causes deficiency diseases.Malnutrition is harmful for children as it retards their mental and physical growth.

Deficiency diseases due to inadequate nutrition are of three types:

1. Protein Calorie deficiency diseases
2. Mineral deficiency diseases
3. Vitamin deficiency diseases

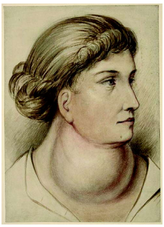
Protein Calorie deficiency diseases:

This type of malnutrition disease may occur due to poor intake of proteins or carbohydrates or both. eg. Marasmus, Kwashiorkor



Marasmus: This is due to deficiency of both proteins and carbohydrates. Lean and weak, less developed muscles, dry skin, diarrhea etc are the symptoms of this disease.

Kwashiorkor: This is due to protein deficiency in the diet. Body parts become swollen, very poor muscle development, fluffy face, bulging abdomen, diarrhea, dry skin are the symptoms of this disease.



Mineral deficiency diseases

1) Goitre: Caused due to prolonged iodine deficiency which causes enlargement of thyroid gland. By taking iodised salt and seafoods which are good sources of iodine, goitre can be prevented.

2) Anaemia: Iron deficiency causes lesser production of haemoglobin, resulting in anaemia. An iron-rich diet consisting of spinach, apple, banana, guava, eggs, groundnuts, etc. can help to prevent anaemia.

You can refer to the table for vitamin deficiency diseases.

8.5.3 Healthy eating habits

1. Having simple, well balanced meals.
2. Do not eat food in a hurried manner. Thoroughly chew the food.
3. Drinking sufficient amount of water.
4. Doing exercises daily.

Digestive system disorders occur mainly due to unhealthy food habits, lack of physical activity, change in life style and some other reasons. Indigestion, vomiting, constipation, ulcers, diarrhea, hemorrhoids are some of the commonly seen disorders in most of the people.

In this lesson you have learnt about one of the life processes (ie) nutrition. In the coming chapters you will learn about some more life process like respiration, transportation, excretion, control and coordination and reproduction.

CHECK YOUR PROGRESS.

- How can you prevent yourself from protein deficiency disease.
- Explain about two mineral deficiency diseases.

KEY POINTS

- Processes that help in growth, repair and continuation of species are called life processes. Eg. nutrition, respiration, transportation, reproduction, excretion, coordination.
- Photosynthesis is the process in which green plants containing chlorophyll produce glucose and oxygen in the presence of sunlight, carbon dioxide and water.
- Chloroplast are the sites of photosynthesis.
- In human, digestion occurs by mechanical churning and chemically due to action of enzymes on food.
- Taking in of all the nutrients in required amounts is called balanced diet.
- Carbohydrates, proteins, fats, minerals and vitamins are essential nutrients needed for human body.
- Marasmus is a protein calorie deficiency disease, Kwashiorkor is protein deficiency disease.
- Goitre is caused due to iodine deficiency, anaemia is caused due to iron deficiency.
- Vitamin B and C are water soluble vitamins, vitamins A, D, E, K are fat soluble vitamins.

PRACTICE FOR LEARNING OUTCOMES

1. What is the enzyme present in saliva?
2. What are the essential nutrients present in our food?
3. Draw a neatly labelled diagram of chloroplast.
4. Explain the digestion process in small intestine.
5. Write in a form of a table, fat soluble vitamins, their sources and deficiency diseases.
6. 'Anaemia is one of the most seen problem in Indian adolescent girls'. What recommendations do you give to them individually and to government to overcome this problem.
7. Where do light reactions take place? ( )

   A) Grana B) Stroma C) Stomata D) Mitochondria
8. Iodine is used to test the presence of .... in leaves ( )

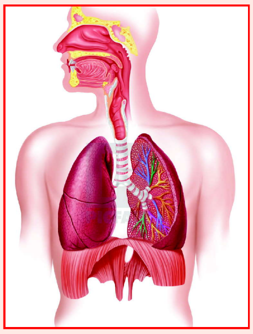
   A) Chlorophyll B) O_2 C) Water D) Starch
9. Match the following.

A)	Plants	( )	1.	Peristaltic movements
B)	Oesophagus	( )	2.	Folds in small intestine
C)	Microvilli	( )	3.	Producers
D)	Vitamin C	( )	4.	Yeast, mushrooms
E)	Saprophytes	( )	5.	Citrus fruits

CHAPTER

9

Respiration



We do different types of activities in our daily life. We all know that the energy we need to do all these things come from the food we eat. But the most interested thing is how the energy contained in food is generated. Many questions arise when we think about how energy is actually released in our body.

* Is energy generated immediately after eating food?
* What type of changes need to occur to release energy from food?
* Does the release of energy have any relation with the air we breathe?
* Why can't we live without breathing air?
* Is air equally important for all living organism?

We can live without food and water for few days. But we can't live without air.

There seems to be something more important in air than food and water ... so we are constantly breathing it.

Living Cells need energy to perform their functions. Digested food materials reach cells where a part of it is oxydized releasing energy, CO_2 and water. Cells use this energy for various metabolic activities. In this way, to release energy specialised organs and organ systems have been developed in living organisms. This is called the "respiratory system".

LEARNING OUTCOMES

The learner...

- ☆ Explains about inhalation and exhalation processes, cellular respiration, human respiratory system and Process of respiration.
- ☆ Differentiates between various processes like inhalation and exhalation; Aerobic respiration and Anaerobic respiration.
- ☆ Ask questions to know about respiration in plants.
- ☆ Collects information about respiratory diseases in humans.
- ☆ Draws labelled diagrams of Human respiratory system and stomata.
- ☆ Conducts experiments to show that germinating seeds releases CO_2, heat in respiration and exhaled air contains carbon dioxide.
- ☆ Knows about pranayama and applies the importance of pranayama to daily life.

9.1 Breathing - Respiration

Breathing is the process of inhaling and exhaling air. It occurs in two stages. They are 1. Inhalation 2. Exhalation.

Inhalation: The entry of outside air (breath in) into the body is called 'inhalation'.

Exhalation: The removal of air (breath out) from the body is called 'exhalation'.

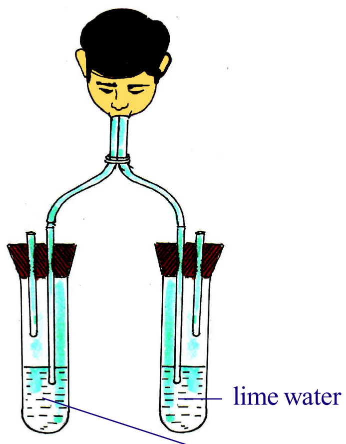
Breathing is a physical process. It involves only the exchange of gases in a diffusion mode. Respiration is a metabolic activity that releases energy from glucose. In this process oxygen is utilized and carbon dioxide is released.

9.1.1 What gasese are there in the air we breathe in and out?

Activity-1

Take two test tubes. Fill Water up to half in one test tube, and lime water in another test tube. Arrange two holed rubber corks to both the test tubes. Arrange bent tubes in two test tubes as shown in the figure.

Blow air into the test tubes. Observe the change of solutions by inhaling and exhaling air continuously.



Presence of CO_2

- ✻ In which test tube colour change is observed?
- ✻ Why did the lime water turn white?
- ✻ What is the chemical reaction happening there? What happens if you go on blowing for a very long time?

Exhaled air contains more amount of Carbon dioxide. When this CO_2 reacts with lime water it turns into milky white.

Some of the elements in the air we breathe in are high and some are low. Similarly, in the air we breathe out, some elements are more and some less. Observe the following table.

Gas	Percentage of gas in breathe in (Inhaled) air	Percentage of gas in breathe out (Exhaled) in air
Oxygen	21	16
Carbondioxide	0.03	4.4
Nitrogen	78	78

✻ Write four inferences that you can draw from this table.

Joseph Black identified that, when limestone is heated or reacted with acids, it gives rise to CO_2 gas which turns lime water into milky white.

* Why does exhaled air contain less oxygen?
* Why does exhaled air contains more carbon dioxide?

The inhaled air contains more amount of Oxygen as compared to exhaled air. The oxygen present in the air that enters into the body passes into the blood and to the cells. In the cells food materials are oxidised and carbon dioxide is produced. This reaches to the lungs and expelled during exhalation. So, the amount of carbon dioxide is high in exhaled air than in the inhaled air.

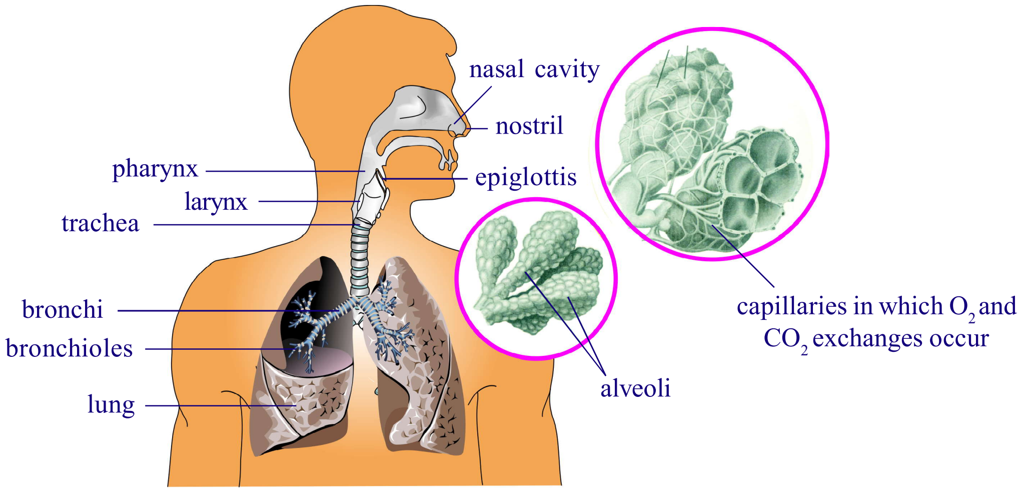
CHECK YOUR PROGRESS.

- How is breathing different from cellular respiration?
- What is the difference between the air we breathe in and air that we breathe out?

9.2 Human Respiratory system

* What are the different parts in human respiratory system?
* How transportation and exchange of gases take place?
* How cellular respiration occurs in humans?

Human respiratory system consists of nostrils, nasal cavities, pharynx, larynx, trachea, bronchi, bronchioles and lungs.



Respiratory system of man

Nostril: Air enters into the body through a pair of nostrils.

* What are the uses of moist surface and hair in the nose?

Nasal cavities : It is a tube-like structure that connects the nostrils and internal nares. Nasal cavities are lined with mucous membrane which secrets mucous. It keeps the nasal cavity moist which helps in adjusting relative to body temperature. The hair in nasal cavity prevents the entry of dust and dirt particles.

Pharynx: It's a common passage for food and air. The food we eat and the air we breathe passes through the pharynx. . The muscular valve called 'epiglottis' is present in the pharynx that regulates the passage of food and air, allowing them to enter their systems properly.

✳ Why we can't speak properly when we close our nose?

Larynx: This is also called as 'Voice box'. It contains vocal cords. The air coming out of the lungs causes them to vibrate as it travels through the vocal cords. This produces sound so that we can talk and sing songs, etc.

Trachea: It is a structure that carries air to the lungs. It has ring-like structures made of cartilage that allows it to stay firmly in place during inhalation and exhalation without contracting.

Bronchi: As the trachea enters the larynx, it splits into two branches called bronchi. These enter into the lungs.

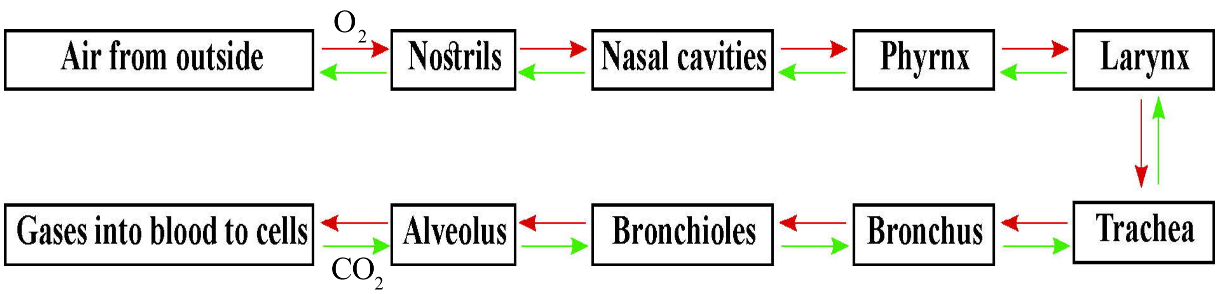
Bronchioles: The bronchi that enter the lungs divides into many smaller branches called bronchioles. Each bronchiole enters into the alveoli.

Lungs

Humans have a pair of lungs. The lungs are surrounded by a two-layered membrane called as **'pleura'.** There is a pulmonary fluid between these layers. It protects the lungs. The right lung is larger than the left lung because right lung has three lobes whereas left lung has only two lobes.

The lungs contain several 'alveoli' and each alveolus supplied with blood capillaries. The exchange of respiratory gases takes place by the process called diffusion in alveoli. Hence these are called as 'structural and functional units' of lungs.

✳ Observe the flow chart showing the pathway of air in human respiratory system.



Joseph Priestley identified that the gas required for combustion of substances is released by plants. Lavoisier named this gas as Oxygen.

9.2.1 Diaphragm

* What is the role of the ribs and the diaphragm in human respiration?

Movements of the diaphragm are very useful for inhaling and exhaling in relation to breathing. The diaphragm is located at the lower end of the thoracic cavity. The diaphragm is umbrella (dome) shaped when at rest and the bulging part of the diaphragm is directed towards the chest cavity. When the diaphragm contracts during inhalation, it flattens out a bit or the dome moves downward. As a result, the volume of the chest cavity is increased. When the volume of the chest cavity increased, its internal pressure decreases and the air from the outside rushes into the lungs through nostrils. This is inhalation which we may also call as insipiration.

The next process is reverse. The chest cavity returns to its original position. The diaphragm relaxes and assumes its dome shape. These changes increase the pressure on the lungs, their elastic tissue contracts and squeezes the air out through the nose to the external side.

* What do we calle this process?

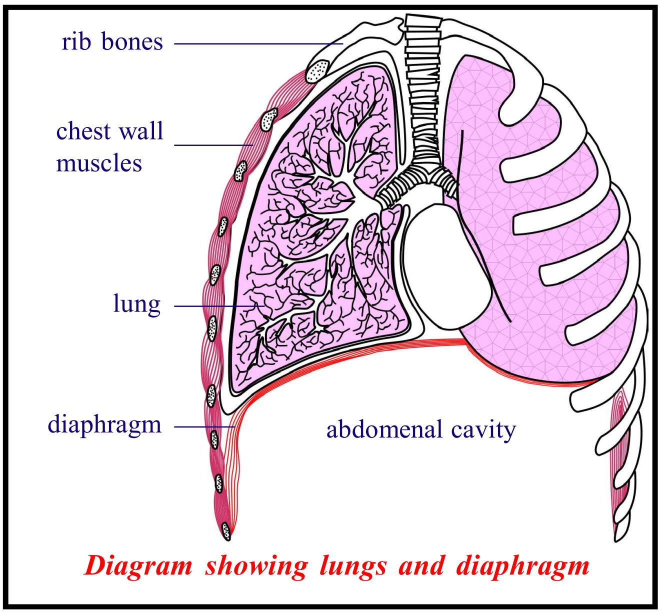


Diagram showing lungs and diaphragm

* What is meant by the word ‘expiration’?

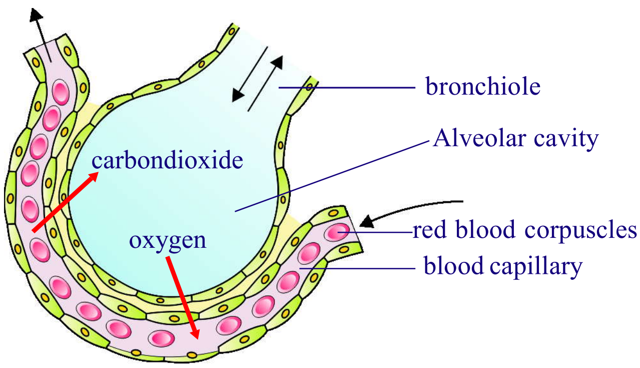
Our breathing is slow and shallow when we are at rest. It is deeper and faster when we exercise hard. Breathing rate is also depends upon the age of the person.

The lungs are the only organ in the human body that floats in water. Even after exhalation about 1200 ml. of air remains in the lungs. This is called residual volume without which our lungs would collapse.

9.2.2 Exchange of Oxygen and carbondioxide

During inhalation the air that enters into the lungs reaches the alveoli. Oxygen present in the air diffuses into the blood present in the capillaries of alveoli. Similarly, carbon dioxide from the blood diffuses out into the alveoli. This carbon dioxide is expelled out through the process of exhalation.

Oxygen that enters the alveoli is transported by the blood to the cells. Haemoglobin in the blood plays an important role in the transportation of gases. As oxygen enters the bloodstream, it binds with haemoglobin and converts into oxyhaemoglobin. When it reaches the tissues/cells through the blood it breaks down into oxygen and haemoglobin. The oxygen that enters the cell is used in cellular respiration.



Alveolus with pulmonary capillary

9.2.3 Cellular Respiration:

Digested food materials from the digestive system is absorbed into the blood and supplied to all the cells of the body. Similarly, Oxygen from the respiratory organs is absorbed into the blood and transported to cells. The food materials reacts with the oxygen in cells and release energy. This mechanism is called cellular respiration.

Cellular respiration usually occurs in two ways. The respiration in the presence of oxygen is called aerobic respiration, and in the absence of oxygen is called anaerobic respiration. Glucose is the most commonly used substance for energy release in all plants, animals and microorganisms. Glucose is oxidized by various chemical reactions in different stages.

In the first stage glucose which is a six carbon compund breaks down into two pyruvic acid molecules (These are 3 carbon compunds). This process is known as glycolysis. It occurs in the cytoplasm of the cell and does not require the presence of oxygen. If oxygen is available in the next stage, pyruvic acid is oxidized to carbon dioxide and water. This process occurs in the cell organelle called mitochondria. The chemical reactions occuring at this stage were first identified by Sir Hans Krebs. All the reactions occur in a cyclical manner and are collectively called as the "Krebs cycle". In this process a large amount of energy is released. This is called 'aerobic respiration'.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy (38 ATP's)}$$

The rate of respiratory is high in women and children.

If oxygen is not available, pyruvic acid is converted to ethanol or lactic acid. A small amount of energy is generated in this process. This is called 'Anaerobic respiration'. In anaerobic respiration only glycolysis stage is seen and the kreb's cycle, Electron transport chain are absent. This type of respiration takes place in the prokaryotes like bacteria, yeast-like cells, and muscle cells of humans.

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2 + \text{Energy (2 ATPs)}$$

The energy released by the breakdown of glucose is stored in the form of a special substance called adenosine triphosphate (ATP). This is called the 'Energy currency' of the cell. This stored energy is transported to the required place in the cell. Each ATP carries 7200 calories of energy. When one glucose molecule is oxidised approximately 38 ATPs are formed in aerobic respiration, whereas only 2 ATP molecules are formed as net profit in anaerobic respiration.

The energy released during respiration is stored in the mitochondria in the form of ATP. Hence mitochondria are called 'Power houses of the cell'. Some energy would be used to perform certain biochemical reactions and the rest of the energy is released in the form of heat.

CHECK YOUR PROGRESS.

- What is the role of diaphragm in human respiration?
- What are the differences between aerobic respiration and anaerobic respiration?
- How epiglottis controls the pathway of air in pharynx?

9.3 Some examples of Respiratory system in other living organism

Exchange of gases in respiration is a common process that takes place in all living organisms for the production of energy. But this does not happen the same way in all living organisms. Single-celled organisms such as amoeba, hydra, planarians, roundworms, and earthworms obtain oxygen and expel carbon dioxide directly from the body by the process of diffusion.

Do all living things have lungs?

Multicellular organisms have specialized respiratory organs for exchange of respiratory gases. Different types of respiratory organs have developed in different organisms depending on body size, water availability and type of circulatory system, etc. The aquatic organisms, such as fishes, have developed specialized organs called gills for respiration. These gills are thin and supplied with more blood capillaries. The exchange of gases through gills is known as **'Branchial Respiration'**.

The lungs contain over 300 million air sacs (alveoli). If the internal space of all the air sacs in our lungs are laid out, they would occupy about 160 sq.m. are which is equal to are of a tennis court.

How does frogs respire in different habitats?

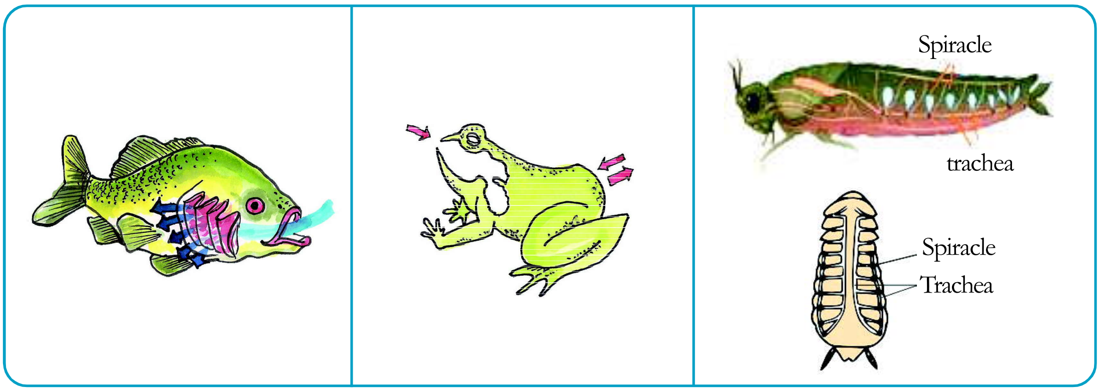
The frogs commonly live in water, on land. It is an amphibian.

Frogs can respire through the skin, lungs, and bucco-pharyngeal cavity. Frogs breathe with their lungs when they are on land. Oxygen dissolved in water is taken up by the gills when the frog is in larval stage called tadpole.

Is blood white in insects?

Insects such as cockroaches and grasshoppers do not have haemoglobin in their blood. So blood is colour less. They have a system of tubes called **'Tracheal system'** for the transport of gases. The cockroach body has small holes in the lateral side. These are called 'spiracles' through which air enters into the body. In the tracheal system, tubes called trachea are arranged throughout the body, starting from the spiracles. The ducts called trachea divides into smaller branches delivering oxygen directly to the cells.

Other terrestrial organisms, such as reptiles, birds, and mammals, breathe through the lungs. Breathing through the lungs is called **'pulmonary respiration'**.



CHECK YOUR PROGRESS.

- On what factors the evolution of the respiratory system depends in different organisms?
- What helps frogs to respire in different habitats?

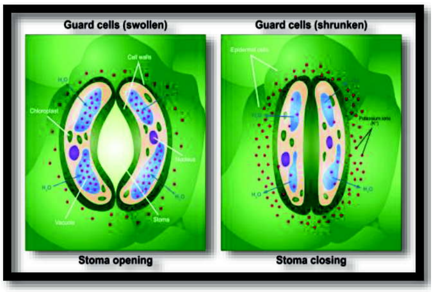
9.4 Respiration in plants

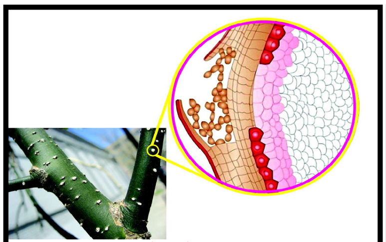
- How exchange of gases takes place in plants?
- What are the organs / adaptations are present in plants for respiration?

If one of the two lungs in humans is damaged the other will perform the function of both without any difficulty.

Our nose or mouth are organs through which air enters our body. Likewise 'lenticels' on the stems and certain other structures on roots through which surrounding air enters the inner tissue in the plants. The walls of the air chambers in the inner tissue contain a layer of water and are moist. Oxygen from the air entering through the stomata and lenticels dissolves in the water layer. It reaches the cell components through the cell wall. It reacts with the glucose in the cell and releases energy.

Plants growing in coastal mangrove forests and plants which grow in wet places, such as ponds, marshy soils have developed special structures called 'Respiratory/Aerial roots' for respiration. In these plants roots penetrate the soil and becomes arial. Exchange of gases takes place with these roots. In the same way, the stems of these plants are hollow and contain a large number of lenticels.




Lenticels on stem


Aerial roots/Respiratory roots

9.4.1 Do germinating seeds also respire?

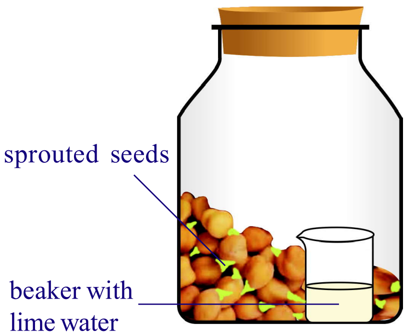
* How do germinating seeds respire?
* What are the products formed during the respiration of germinating seeds?

Germinated seeds contain active living cells. Germinated seeds also respire and in which carbon dioxide and energy is released in the form of heat. Let us do some experiments to know about respiration in germinating seeds.

Activity-2

Materials required: Glass bottle, Bengal gram seeds, beaker and lime water.

Procedure: Soak the Bengal gram seeds one day before the experiment. Take the germinating seeds into in a glass bottle. Take lime water in a beaker. insert the beaker into the bottle carefully with the help of thread. Close the beaker and left the entire setup without disturbing for two days. Observe the lime water in the beaker.



Evolved CO_2 in respiration

* What change is observed in the lime water?
* What is the reason for change of lime water?
* Which gas was released by germinating seeds?

Due to the respiration in Germinating seeds Carbon dioxide gas is produced. This gas reacts with lime water and turns into milky white.

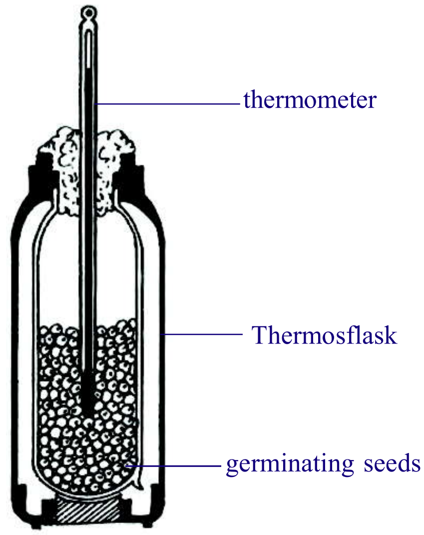
Is heat also produced during Respiration?

Activity-3

Materials required: Thermos flask, Thermometer, Germinating seeds, cotton or single holed rubber stopper.

Procedure: Take some germinating seeds into a thermos flask.

Arrange a single holed rubber cork to the flask. Insert a thermometer through the cork in such a way that it should be in the middle of the seeds. Record the temperature for every two hours.



Heat evolved during respiration

* What change is observed in the thermometer readings?
* What is the reason for increase in the reading of thermometer?
* Why heat is released by germinating seeds?

The germinating seeds in the thermometer undergoes aerobic respiration. So energy is released in the form of heat. Hence the thermometer reading increased.

9.5 Respiratory Diseases

- **Asthma:** Inflammation of the trachea and bronchi can make breathing difficult. Coughing, wheezing, chest congestion and difficulty in breathing are the major symptoms. Allergic factors in asthma include the release of inflammatory substances such as histamine that cause the airways to constrict and make breathing difficult.
- **Bronchitis:** Due to the inflammation of the mucous membrane in the bronchioles, mucus production increases and decreases the diameter of the bronchioles. Prolonged cough, accompanied by thick mucus / sputum formation are the major symptoms of the disease.
- **Pneumonia:** This disease is caused due to a bacterial infection of the lungs called Streptococcus pneumonia. Some types of viruses, fungi, protozoa, and mycoplasmas also cause this disease. Symptoms include swelling of the lungs, accumulation of mucus in the airways, cough, fever, and decreased gas exchange. This may lead to death if left untreated in time.
- **Emphysema:** It is a chronic disorder of the respiratory system. In this case, the air sacs(alveoli) walls collapse and the breathing space where the exchange of air takes place is reduced. The lungs become larger, the air sacs shrink, and the more fibrous tissue becomes less elastic. The main reason for this is the habit of smoking.

- **SARS (Severe Acute Respiratory Syndrome):**

  This corona viral disease was identified firstly in china in 2002. Fever, dry cough, headache, muscle pains and difficulty in breathing are the Symptoms of this disease. This is transmitted to others through saliva droplets and nasal discharges.

- **Why COVID-19 is dangerous?**

  This disease is caused by the novel corona virus, began in the Wuhan city of China in October 2019 and spread around the world, causing many deaths. Fever, Sore throat, difficulty in breathing, Pneumonia, Fatigue and Cold are the Symptoms of this disease. The disease is transmitted from person to person through various sources such as droplets of saliva and nasal discharge. Patients with high blood pressure and cardiovascular disease are more likely to be affected by this disease compared to the general population. Many patients had to be arranged with ventilators due to severe difficulty in breathing.

- **What are ventilators? Why are they important to COVID-19 patients?**

  In cases where patients with respiratory problems or lung defects are unable to inhaling and exhaling air on their own Ventilators are fitted to pump air into and out of the lungs. Accumulation of mucus-like fluid in the air sacs (Alveoli) reduces the ability to absorb oxygen and causes oxygen deficiency. In such a case ventilator are arranged to provide adequate oxygen to the patient.

- **Is it risk to the lungs with air pollution?**

  Some chemicals released into the air due to air pollution and other harmful pollutants enter the respiratory tract and cause allergies. This can cause problems with breathing, cough, asthma, and lung cancer.

- **Is smoking injurious to health?**

One person dies every eight minutes due to tobacco addiction. 4.9 million deaths per year are due to this only. This number is expected to reach ten million by the year 2030. In our country 10.8 % people are consuming tobacco in different forms. Of these, 82% suffer from infectious diseases and nine lakhs die with the effect of tobacco. Smoking is the leading cause of 90% of lung cancer. Lungs that are damaged by smoking can easily become infected. There is also the possibility of contracting various chronic diseases. About 30% of smokers and secondary smokers (who inhale the smoke) develop lung cancer. In view of this, the Central Government enacted a law in 2004 banning smoking in public places.

9.6 Pranayama

Pranayama is the process by which we can increase the breathing capacity of our lungs. Patanjali defined 'pranayama' as the control of the inhaling and exhaling processes.

The Indian ayurvedic physician, Patanjali developed a scientific breathing practice called Yogabhyasa. Maharshi Patanjali proposed a theory called 'Ashtanga yoga'. The art of breathing in Yogabhyasa is called 'Pranayama'.

In Pranayama practice air is allowed to enter three lobes of lungs in order to increase the amount of oxygen to diffuse into blood. Deep breaths in Pranayama help us to reduce breathings per minute from 20-22 to 15. Because of these deep breaths more amount of oxygen available to brain and tissues of the body will be more active. All people irrespective of age and sex should practice Pranayama to improve the working capacity of lungs. It is very important to practice Pranayama regularly to make our life healthy and active.

KEY POINTS

- Inhalation and exhalation are the two stages of respiration. During inhalation air enters into the body where as in exhalation air sent out of the body.
- Respiration is the metabolism that releases energy by oxidizing food materials such as glucose.
- The amount of carbon dioxide is higher in the air that we breathe out than the air we breathe in.
- The human respiratory system consists of the nostrils, nasal cavity, Pharynx, larynx, trachea, bronchi, bronchioles, and lungs.
- Alveoli are called as the 'structural and functional units' of the lungs.
- The diaphragm plays an important role in inhalation and exhalation in men, whereas in women the ribs as well as the diaphragm contribute to respiration.
- If Cellular respiration occurs in the presence of oxygen it is called aerobic respiration, and If Cellular respiration occurs in the absence of oxygen then it is called anaerobic respiration.
- Some amount of energy from the respiration is stored in the form of ATP in the cell organelle called Mitochondria. Hence Mitochondria are called as power houses of the cell.
- Different types of respiratory organs have been developed in different organisms depending on body size, water availability, type of circulatory system, etc.
- In plants, in addition to the 'stomata', lenticels also participate in the exchange of gases. Plants growing in marshy soils have developed special structures called Respiratory roots.

PRACTICE FOR LEARNING OUTCOMES

1. What is the difference between the respiratory system of an insect and a human?
2. How exchange of gases occurs in the unicellular organisms like Amoeba?
3. How do the movements of the diaphragm help in the breathing process?
4. Write the procedure and observations to prove that CO_2 is released by germinating seeds.
5. More energy is released when cellular respiration takes place in the presence of oxygen compared to oxygen-free conditions. Why?
6. Explain the structure of human respiratory system with the help of a diagram.
7. Respiration is complicated in humans compared to amoeba. Analyse the evolutionary sequence of the respiratory system in different organisms.
8. Aerobic respiration occurs at. ( )

   A) Mitochondria & Chloroplast B) Chloroplast & Cytoplasm

   C) Mitochondria & cytoplasm D) Endoplasmic Reticulum & Cytoplasm
9. The correct pathway of respiration in human beings ? ( )

   A) Nostrils → Nasal cavity → pharynx → Larynx → Trachea → Bronchi

   B) Nostrils → Nasal cavity → pharynx → Trachea → Larynx → Bronchi

   C) Nasal cavity → Nostrils → larynx → pharynx → Trachea → Bronchi

   D) Nostrils → nasal cavity → larynx → Trachea → Bronchi → pharynx
10. Find out the structures that help in the exchange of gases in the plants ( )

    i) Stomata ii) Lenticels iii) Respiratory roots iv) Bark

    A) i and ii B) i and iii C) i,ii and iii D) i, ii, iii and iv
11. Match the following. ( )

A)	Pulmonary Respiration	[ ]	1.	Cockroach
B)	Tracheal Respiration	[ ]	2.	Fishes
C)	Cutaneous Respiration	[ ]	3.	Lungs
D)	Bronchial Respiration	[ ]	4.	Earthworm

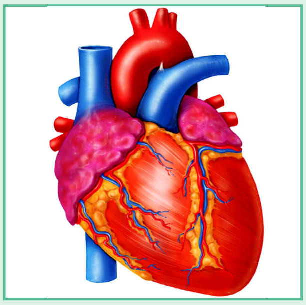
    A) i-c, ii-a, iii-d, iv-b B) i-c, ii-b, iii-d, iv-a

    C) i-c, ii-d, iii-b, iv-a D) i-d, ii-b, iii-c, iv-a

CHAPTER

10

Transportation



We know that all organisms need food, water and oxygen for survival. All organisms have some mechanisms in their body that help in carrying these substances inside their bodies. We have blood and Lymph following through a net work of tubes and pumps in our body facilating this. Food and water in the digestive system reaches blood vessels. In the same way the oxygen that enters the respiratory system is diffuses into blood. Digested food and oxygen must be supplied to all cells in the body, via blood and lymph the wastes produced by various cells as a result of metabolism reach the excretory organs via blood. Other multicellular organisms also have different elaborate arrangements through which such functions own.

Plants also have a network of tubes of mainly the tissues xylem and phloem that contribute to the transport of substances in plants. The excretory products formed by metabolic activities are stored in different parts of the plants without being excreted.

- What are the components of human circulatory system?
- How does our heart function?
- What are the factors that contribute to transport of resources in our body?
- What are the factors that contribute to the transport of resources in plants?

LEARNING OUTCOMES

The learner...

- ☆ Explains closed circulation of blood, the structure and functions of heart.
- ☆ Identifies the components of blood importance of blood groups, blood donation, functions of heart and role of osmosis in water absorption.
- ☆ Illustrates the reasons for high blood pressure and heart attack.
- ☆ Draws a well labelled diagram of heart and flow chart of components of human blood circulatory system.
- ☆ Appreciates importance of blood and write about it.
- ☆ The health principles that are needed to keep the heart healthy are followed in daily life.

Movement of resources from environment to body of a living organism and back to the environment is a continuous process. If the body is small resources reach different parts just by simple processes like diffusion. This is what we observe in unicellular organisms. As the size and complexity increases as in multicellular organisms complexity arrangements for movement of resources for different functions is observed. We also find fluids that help carry the resources in a faster and more efficient manner.

10.1 Transportation in Animals

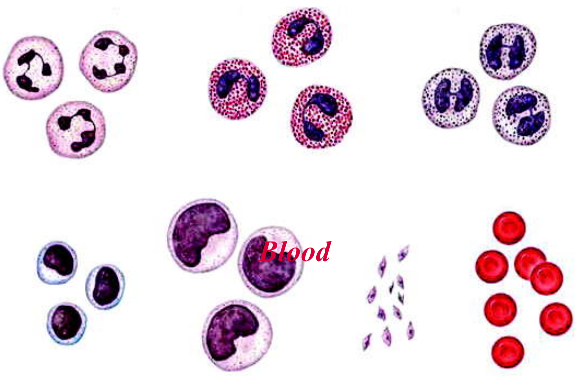
Movement from one place to another is a function attributed to the animal body. Moving more often increases need of more resources and a faster and more flexible systems of transport of resources. The Human body for example has a network of blood vessels, heart that is a powerful pump, valves facilitate movement of resources in the body.

10.2 Blood

10.2.1 What happens when you get a cut on your body?

We see blood arising out blood is a liquid connective tissue. Normal adult human beings possess about 5 litres of blood in their body. Blood consists of two main components. 1. Liquid state plasma 2. Bloodcells. 90 percent of the plasma is water. Plasma contains 7 to 8 percent of proteins, 1 percent of salts, fats, glucose, vitamins, hormones, and many other substances.

Blood cells: The blood cells which float in plasma are red blood cells, white blood cells and platelets.



Why blood is red in colour?

Red blood cells are bi-concave and round in a shape and nucleus is absent. Due to the presence of haemoglobin, blood appears red in colour. When oxygen binds to the iron molecule, haemoglobin is converted into oxy haemoglobin and delivered to the cells of body. Carbon dioxide in the cells enters the blood stream. The average life span of Red blood cells is 120 days.

Blood cells that protect our body from diseases.

White blood cells do not contain haemoglobin (pigment). Therefore they are white in colour. They protect our body from many infections and diseases.

We classify WBC into 5 types as 1) Eosinophils, 2) Basophils, 3) Neutrophils, 4) Lymphocytes and 5) Monocytes.

Blood cells that help the blood to clot when injured.

In certain cases where our body is injured and bleeding, blood cells called platelets form a net near the wound and prevent the blood loss by clotting of blood.

Importance of blood

Humans cannot survive without blood. Without a certain amount of blood, various metabolic activities cannot function properly. Blood is needed to regulate body temperature, to protect against diseases, and to eliminate waste materials from our body.

When does a person needs blood?

Human body requires blood after massive injury during, surgeries, and in certain types of diseases.

* How is blood given (transfused) in such situations?

Blood transfusion is the transfer of blood or blood products from one person to another through his large vein. We need to match blood of a person who gives blood (donor) with one who receives it (recipient). This is done with the help of certain factors present in blood. The discovery of blood groups led us to them.

10.2.2 Blood groups

Karl Land steiner a german doctor found that blood from only certain people could be transfused into others. In all other cases blood would coagulate. Land steiner collected samples of all the people in his lab (inculding himself), separated the plasma part (a straw coloured fluid) and blood cells of each of them and started mixing plasma of one person with blood cells of another. This lead him to grouping of blood as A, B, and C. C was later changed to 'O' (actually zero, that is absence of factors present in A and B blood groups) Land Steiner, a German doctor AB, Rhesus factor and several other factors were discovered subsequently.

People with "AB" blood group human beings can receive blood from any other group. Hence they are called "Universal Recipient". 'O' blood group can donate blood to any other group, so these people are known as "Universal donars".

Donar / Recipient	A	B	AB	O
A	✓	×	×	✓
B	×	✓	×	✓
AB	✓	✓	✓	✓
O	×	×	×	✓

Observe the table and answer the following.

* To which groups can people having blood group 'A' donate blood to?
* A recipient with blood group 'B' can receive blood from which groups?

✻ How is blood transported to different parts of the body?

CHECK YOUR PROGRESS.

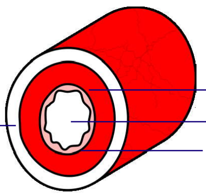
- What is blood transfusion? When do we need it?
- What are the functions of blood? How many types in blood cells? What are they?
- Who is known as universal donar and universal recipient?

10.3 Blood vessels and transport system

The blood transport system consist mainly of blood, blood vessels and heart. Blood vessels in our body were named and discovered nearly 400 years ago. A remarkable observation was made by a British Physcian named William Harvey. He observed that there were two major path ways of blood flow. 1. Towards heart 2. Away from heart.

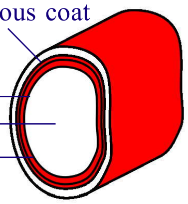
10.3.1 Arteries

Arteries carry oxygen rich blood from the heart to all parts of the body. Since the blood flow is rapid and at a high pressure, the arteries have thick elastic walls. There are no valves in arteries.



10.3.2 Veins

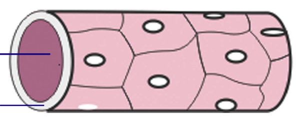
Veins are the vessels which carry carbon dioxide (CO_2) rich blood from all parts of the body back to the heart. The veins have thin walls and valves are also present which allow blood to flow towards the heart only.



Let us learn about the blood capillaries that combine the arteries and veins at the cells of the body organs.

10.3.3 Blood Capillaries

Blood capillaries are the microscopic vessels made of single layer cells. They allow diffusion of various substances and establish continuity between arteries and veins. Blood reaches the cells via capillaries.



Girolamo Fabrici (who was a teacher it William Harvey) found that valves in the veins allow one way blood flow.

Activity

Fill in the following table. Use the clues / options given in the first column.

Table

Sl.No.	Structure / Function of blood vessel	Artery	Vein
1	Thickness of walls (Thick/thin)	Thick	Thin
2	Valves (Present/absent)		
3	Capacity to retain shape when blood is absent (can retain / cannot retain)		
4	Direction of blood flow (heart to organs / body organs to heart)		
5	Pressure in the vessel (Low / high)		
6	Oxygen contente (Usually high/ usually low)		

CHECK YOUR PROGRESS.

- Why blood pressure in arteries is higher than veins?
- Which blood vessels have valves?
- What are the differences between arteries and veins?

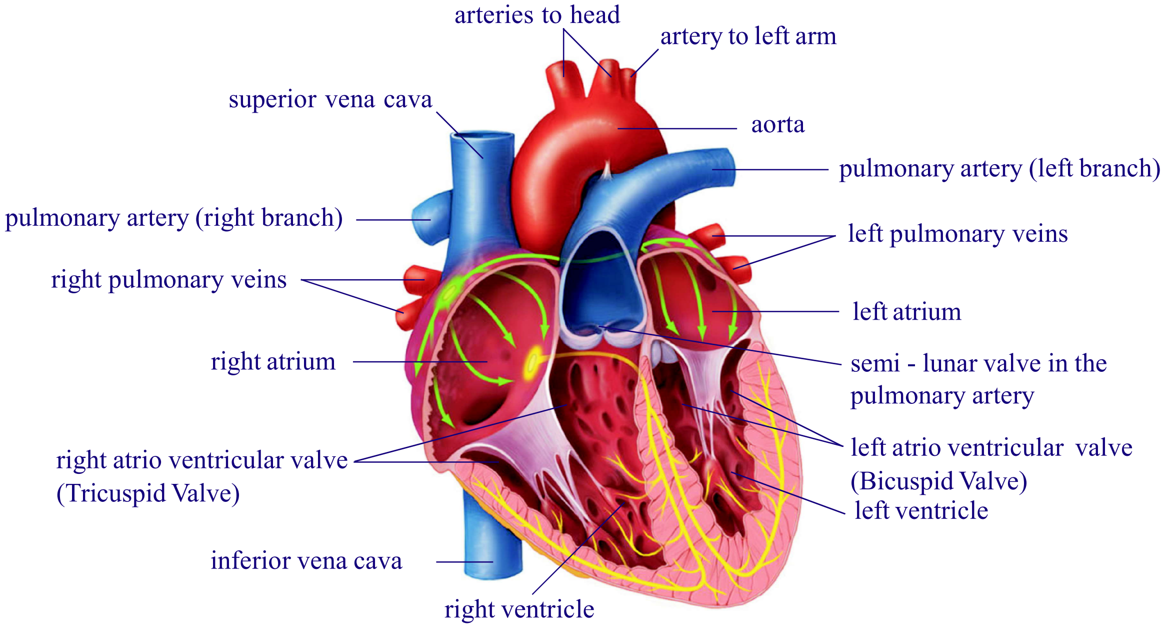
10.3.4 Structure and functions of heart

Heat is a device that maintains pressure to push blood through vessesls. Heart acts as a pump in our transport system. We also called our transport system is cardio vascular system, cardio - is related to heart. Let us know about structure and functions of heart.

* Where is the heart located?

The heart is situated slightly to the left between the two lungs in the chest cavity. Two pericardial membranes, chest cavity and pericardial fluid, which protect heart from mechanical shocks. The Heart is a muscular structure. Your heart is about the size of your frist.

Marcello Malpighi observed the blood capillaries in the wings of bats.



Internal structure of heart

The heart is divided into four chambers. Two upper chambers are called atria, and the lower two chambers are called ventricles. Right atrium and ventricle are separated from left atrium and ventricle with septa.

The valve present on the Right Auriculo - ventricular septum between Right atrium and Right Ventricle is referred as "Tricuspid Valve". The valve present on the left Auriculo - Ventricula septum between left atrium and left ventricle is referred as Bicuscid valve or Mitral valve. The semilunar values are located at the begining of the pulmonary artery and at the begining of the aorta.

How the heart works?

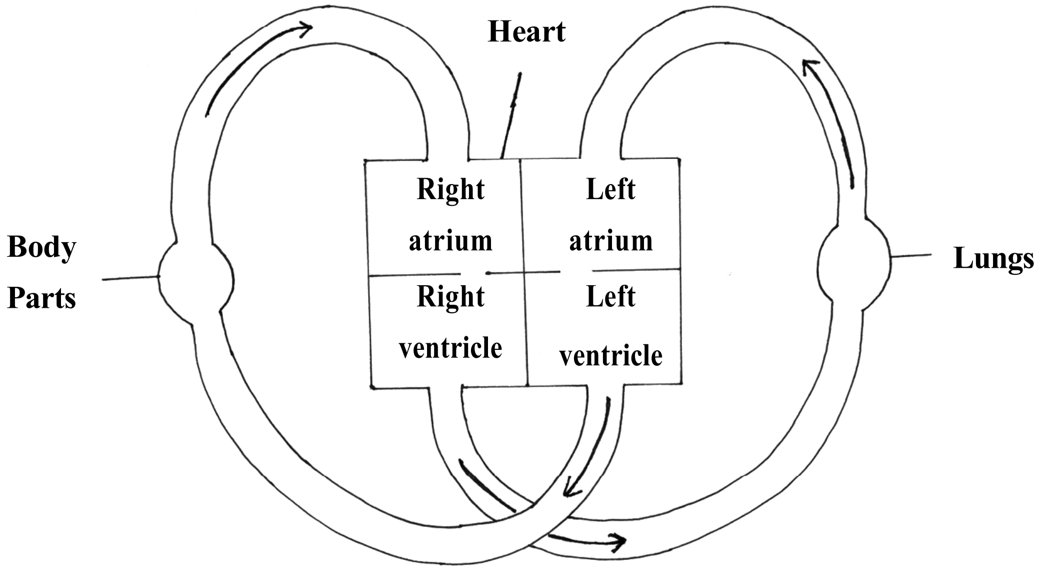
The blood flows into heart and fills in the right and left atrium. Blood from all parts of the body flows into right atrium while which that from lungs into left atrium from posterior. Blood flows out of the heart from the ventricles. Blood from right ventricle reaches lungs. Blood from left ventricle to all parts of the body. Pulmonary vein (carrying blood from lungs to head) brings oxygenated blood t the left atrium. If is the upper part of the left ventricle. A thick blood vessel called aorta arises from left ventricle. It supplies oxygenated blood to different body parts. Coronary blood vessels supply blood to heart.

See figure of heart and answer the following questions.

- Which blood vessel carries blood from heart to lungs?
- Which blood vessel carries blood from heart to all parts of the body?
- Which blood vessel carries blood from lungs to heart? Comment on oxygen content of the vessel.

Let us try to understand, the working mechanism heart through the following flow chart.

Body parts (Deoxygenated blood) → Superior, Inferior vencave → Right atrium → Right ventricle → Pulmonary arteries → Lungs → Pulmonary veins → Left atrium → Left ventricle → Aorta → Body parts (oxygenated blood)



Double circular blood transportation

10.3.5 Blood circulation

Careful examination of the above flow chart reveals that blood flows in two circles. When the blood flows through the heart twice to complete. It is called as double circulation.

Single circulation system is found in fishes. When blood flows through heart only once to complete one circulation, it is called as single circulation.

How the lub-dub sound arises when the heart beats?

Rhythemic contractions and relaxations of the heart muscle are called heart beats. The heart beats as long as we live. The contraction of the heart is called systole and relaxation is called diastole.

Closing and opening of the valves during heart contractions and relaxations causes the lub-dub sound.

The four chambers in the heart do not contract or relax at once. When heart contracts the blood in the left ventricle flows through the arota to the body parts as well as the right ventricle pushes the blood to the lungs through pulmonary artery. When heart relaxes blood enters into the left atrium through the pulmonary veins. Similarly the blood reaches the right atrium through vanacavas. These processes must take place without interruption for the heart to be healthy. The heart of a healthy person beats about 72 times per minute.

Doctor examines the heart beat rate with a stethoscope.

CHECK YOUR PROGRESS.

- Draw and labelled diagram of structure of heart.
- Describe the path way of double circulation of blood.

10.4 Heart diseases

The heart continues to work all through our life. So if we neglect the health of heart it can lead to severe heart diseases including heart failure/heart attack.

10.4.1 High blood pressure

When heart contracts blood flows rapidly into the artery, causing pressure on the walls of the arteries. This pressure may increase due to several reasons one of them being accumulation of fat in the walls of the arteries. It does not happens in a single day. Indiscriminate intake of fat rich food is one of the reasons for the increase in fat in the arterial walls. As you grow older your blood vessels become less elastic so that the elasticity of the blood vessels also decreases and Blood pressure rises. About 90 to 95 percent of people with high blood pressure fall into this category.

- Blood pressure is measured with the help of a device called as sphygmomanometer. Normal blood pressure is 120/80.

Preventive measures

Exercise regularly. Do not smoke or drink alcohol. Do not stress yourself . Medication should be used with a doctor's advice when high blood pressure is diagnosed.

10.4.2 Heart attack

Symptoms of heart attack

- Heart attack symptoms are not the same in everyone, Heart attack does not have to come with severe pain.
- Shortness of breath, cold hands and feet, and shock may occur. These should be suspected of causing a heart attack.
- Pain may occur in the left breast on the right and left side, in others in the lower jaw, and in the upper abdomen in some people.
- May cause nausea, vomiting and shortness of breath. In some people, sweating, falling blood pressure, nervousness, muscle weakness, and defection may occur unknowingly.

10.4.3 Tests to detect heart attack

- E.C.G. shows symptoms of heart attack. A slight heart attack on the E.C.G. is evident on 'Scanning' and angiogram.

- An increase in the amount of "Creatine kynage" enzyme in the blood is also a symptom of a heart attack. Let us know about E.C.G.

E.C.G. (Electro Cardiograph)

The heart beats 60 to 108 times per minute. These responses should show up without any interruption on the E.C.G. graph. If not, the doctor will diagnose heart failure and recommend further tests, including treatment.

Precautions:

- Smoking, drinking alcohol and chewing gutka must be stopped.
- The use of oils, ghee and butter should be reduced. Use a little amount of palm oil, bran oil and suffola oil as cooking oils. Reduce salt in the diet.
- The body needs regular exercise. Avoid stress and anxiety.
- People with high blood pressure and diabetes should definitely keep them under control.
- Even if you are diagnosed with a heart attack, it is best to call doctor for first aid.

10.4.4 Coagulation of blood

* How does the blood clot? What processes are involved in blood coagulation?

When you have a cut on your body the blood flows out of the wound for only a short time. Then within 3-6 minutes the cut is filled with a reddish solid material. This solid is called as blood clot. It blood did not clot, any one with even a slight would bleeds profusely.

Steps in blood clotting:

- When the blood flows out, the platelets release an enzyme called thrombokinase.
- Thrombokinase acts on prothronbin which is present in the blood; converting into thrombin.
- Thrombin acts on fibrinogen, that is present in dissolved state, converting into insoluble fibrin.
- The blood cells entangle in the fibrin fibres forming the clot.
- The fibrin fibres are attached to the edges of the wound and pull them together.
- The yellowish straw coloured fluid portion found after formation of the clot is known as serum.

10.4.5 Evolution of circulatory system

The circulatory system formed in advanced mammals, such as humans, is not all developed at once. Let us know the evolutionary pattern of the circulatory system from primitive to developed organisms.

- Organisms belonging to movements occurs, the phylum protozoa, such as Amoeba converts food into food vacuole, and (Brownian) which are natural movements in the organism, to supply nutrients equally to all parts. Oxygen and Carbon dioxide are diffused in the amoeba through plasma membrane directly.
- The parazoans like sponges, use sea water for transportation. The sponges create their own water currents by beating of flagella that are present in their body.
- The cnidarians like Hydra and jelly fish have developed gastro vascular cavity, which has taken up the function of digestion and transportation of nutrients to each and every cell of the body.
- In platyhelmenthes (e.g. Fasciola hepatica), the digestive system is highly branched and supplies digested food to all the cells directly. In these animals the excretory system collects nitrogenous wastes from each cell individually.
- In animals belonging to Ne mathelminthes (round worms), the pseudo coelom has taken up the function of collection and distribution of materials.
- The Annelids, the first Eucoelomate animals have developed a pulsatile vessel, to move the fluid and the transporting medium is blood.
- The Arthropods have developed a pulsatile organ to pump the blood, the heart. The blood instead of flowing in blood vessels, floods the tissues, directly supplying the nutrients to the tissues which is known as oxygen is directly supplied to the tissues by the respiratory system.
- In most of Molluscs and lower level cardates the supply of different substances takes place through the open blood circulatory system.
- Evolved from a two chambered heart in fish to a four chambered heart in mammals.

CHECK YOUR PROGRESS.

- What are the diseases of heart? How can they prevented?
- Write down the process involved in blood coagulation.
- Which device is used to measure blood pressure?

10.5 Transport of substances in plant

The water absorbed by roots and food by leaves are supplied to the remaining parts of the plants by xylem and phloem. In the root, the xylem tissue is situated towards the exterior where as in the stem is arranged in bundles towards the center.

Does the difference in xylem position have any benefit to the plant?

- What is the mechanism involved in water absorption?

10.5.1 Transport of water in plants through xylem

Absorption by root hair

Root hairs are cylindrical extensions of root epidermal cells that are important for acquisition of water and nutrients. Root hair cells are adopted for taking up water and mineral ions by having a large surface area to increase the rate of absorption. Osmosis, root pressure, transpiration and the cohesion, adhesion forces help the plants to absorb water through root hair and xylem.

Plants will die if over-fertilizer. Do you know why?

Osmosis

Each living cell has anosmatic characteristic. The soil water is an extremely dilute solution of salts. Soil water concentration is more dilute than that of the cell sap in the root hair, therefore water will pass into the vacuole of the root hair by osmosis. So, water passes into the neighbouring cell which in turn becomes diluted, finally water enters the xylem vessels. Xylem vessels supply water and nutrients to the plant. It high doses of fertilizer are applied to the plants, the plants will die due to reverse - osmosis.

Root pressure

Root pressure can also be called as osmotic pressure that occurs within the cells of a root system. It causes the sap to rise through a plant stem to the leaves. It occurs in the xylem of some vascular plants when the soil moisture is high.

The role of transpiration in transport

The evaporation of water through leaves is called transpiration. Water evaporates through stomata of leaves and lenticels of stem.

* How does water reaches from the roots to the top in the tallest trees like Rose wood and Eucalyptus?

The main driving force of water uptake and transportation in a plant is transpiration of water from leaves. Transportation is the process of water evaporation through stomata. The transpiration creates a negative water vapour pressure in surrounding cells of the leaf. Once this happens, water is pulled into the leaf from the vascular tissue, the xylem is a continuous water column that extends from the leaf to the roots.

* Think about the transpiration that takes place in plants, whatever the clouds have to do with rain.

Adhesion force

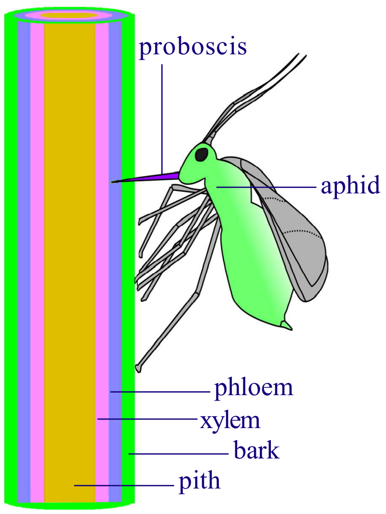
When water enters the xylem vessels, the attraction between the molecules in the xylem and the water holds the water and is called cohesion force. The water molecules within the xylem tend to stick together, which allows them to help pull other water molecules up through the xylem - even against the flow of gravity.

Cohesion force

The force of attraction between water molecules in xylem vessels is called the cohesive the force. Water is transported in plants both cohesive and adhesive forces. These forces pull water and the dissolved minerals from the roots to the leaves and other parts of the plants.

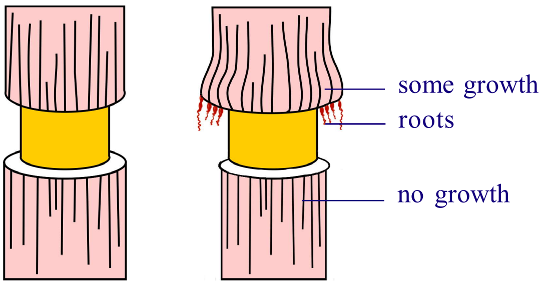
10.5.2 Transport of food in plants through phloem

Food such as sugar is synthesised in the green parts of plants, mainly the leaves, but this food has to be transported to all the living cells. The veins of a leaf consist of xylem and phloem. Xylem transports the water, phloem transports the food. Does xylem transport only water or water and nutrients from soil? or some thing else as well?



Aphid extracting food material from plant

Biologists studies about food transportation in plants with the help of aphids. Aphids clustering round the young stems of plants as feed on the plant juices. To obtain this juice an aphid pierces the plant tissues with its long needle like organ 'proboscis'. An aphid is killed while in the act of feeding and the body is then carefully cut away, leaving the hollow proboscis still inserted into phloem. The fluid cut end of the proboscis in the form of drops; these drops are then collected and analysed. The fluid contain sugar and amine acids.



Removing ring of bark (Ringing experiment)

Further experiments to illustrate the conduction of sugar by the phloem have been done by removing a ring of bark from a shoot to expose the wood. Remove all tissues from the centre outwards, including the phloem. After a few days, food had accumulated above the ring, but was not present below it. It proves that the phloem supplies food from the leaves, young stems to the utility places.

CHECK YOUR PROGRESS.

- How do root hairs absorb water?
- How does transpiration contribute to water absorption?

KEY POINTS

- Transport system in humans mainly consists of the heart and blood vessles.
- Blood consists of plasma, red blood cells, white blood cells and platelets
- Heart acts as a pumping organ.
- The upper two chambers of the heart are called the atria and the lower are the ventricles.
- Tricuspid valve is present in between right atrium and right ventricle. Bicuspid valve is present between left atrium and left ventricle.
- Transport system of plants mainly consists of a network of xylem and phloem tissues.
- Osmosis, root pressure, cohesion and adhesion forces and transpiration losses help the plants to absorb water and minerals.

PRACTICE FOR LEARNING OUTCOMES

1. What are the components of blood?
2. Write differences between: a) veins - arteries b) xylem - phloem
3. Explain the blood circulation in the human body with the help of an illustration.
4. What kind of care would you advise your family members to take to stay heart healthy?
5. Draw and label the diagram of heart
6. When blood transfusion is done? How does information about blood groups contribute to blood transfusion?
7. Water reaches great heights in the trees because of suction pull caused by - ( )

   A) Osmosis B) root pressure C) transpiration D) phloem
8. Which of the following statement is wrong? ( )

   A) Stethoscope measures heart beat

   B) Sphygmomanometer indicates the blood pressure

   C) E.C.G. report tells about heart function

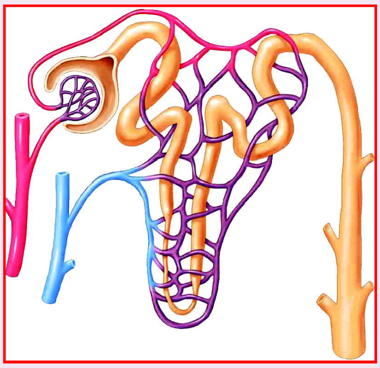
   D) X-ray film counts pulse rate of a person
9. Match the following:

A) Stomata	( )	1.	Absorption of water
B) Xylem	( )	2.	Transpiration
C) Root hair	( )	3.	Transport of food
D) Phloem	( )	4.	Transport of water

CHAPTER

11

Excretion



No factory can manufacture new products without generating any waste. The body of all organisms are like living factories. So, waste is also generated at regular intervals from the body of most organisms.

- Where are wastes produced in humans?
- How is urine formed?
- Under what circumstances is dialysis performed?
- How do plants excrete?

We will discuss all of these in this lesson. Various metabolic activities occur in our body and different substances. Various products are generated as a result of these metabolisms. Many chemical reactions take place inside the cells of the body. Certain products are not needed by the body while some others may be harmful if they accumulate in large quantities in the body. Their removal from the body is called excretion. In Latin 'ex' means out, 'crenere' means shift.

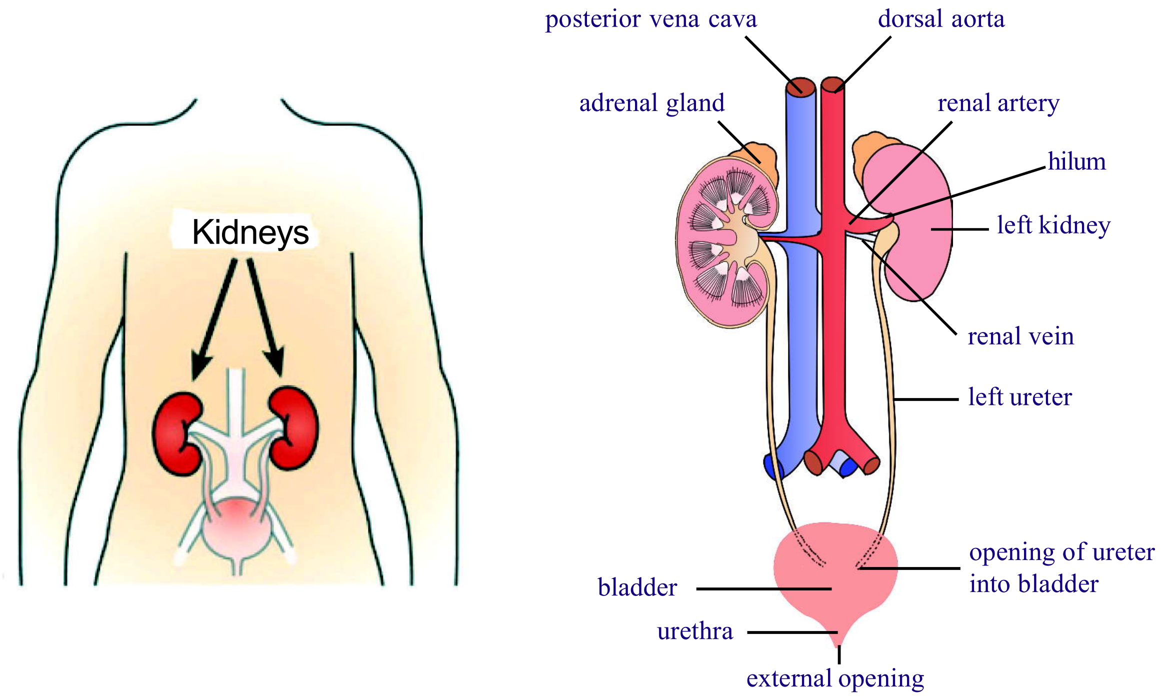
LEARNING OUTCOMES

The learner...

- ☆ Explains structures in the excretory system of humans.
- ☆ Lists out the components of urine.
- ☆ Draws the excretory system, internal structure of a kidney and nephron.
- ☆ Explains the function of excretory system especially, role of the kidneys in homeostasis.
- ☆ Describes the structure of a nephron.
- ☆ Justifies why nephron is considered the structural and functional unit of a kidney. Prepares model of a kidney.
- ☆ Identifies kidney diseases and describes dialysis.
- ☆ Appreciates the importance of organ donation.
- ☆ Appreciates the role of other organs such as lungs, liver, skin, and large intestines in managing wastes.
- ☆ Explains excretion in other organisms especially plants.

11.1 Human excretory system

Excretory system makes, stores and excretes urine. It consists of a pair of kidneys, a pair of ureters, urinary bladder and urethra.



Excretory system

11.1.1 Kidneys

In human beings, there are a pair of bean-shaped, reddish-brown structures called kidneys. They are present in the abdominal cavity attached to the dorsal body wall, one on either side of the spine. Just like your heart they are also just the size of your fist.

* How are they arranged?

The position of the right kidney is lower than that of the left kidney. This is due to the presence of the liver above. The kidneys filter and clean the blood and form urine. Each kidney is convex on the outer side and concave on the inner side. The inner side of each kidney has a raised structure called fissure or hilus where the renal artery enters, and a renal vein and ureter exits. Renal artery brings oxygenated blood filled with waste products (mainly urea) into the kidney. Renal vein carries blood with less wastes and oxygenated blood out of the kidneys.

* What do you think happens in the kidneys?
* Starting from kidneys, how are wastes removed to the exterior of our bodies?
* What are the major structures of human excretory excretory system?

11.1.2 Ureters

Each ureter arises from the hilus of the kidney. The ureters are muscular tubes. The movement of urine from kidney to the urinary bladder is done in the ureters through peristalsis.

11.1.3 Urinary Bladder

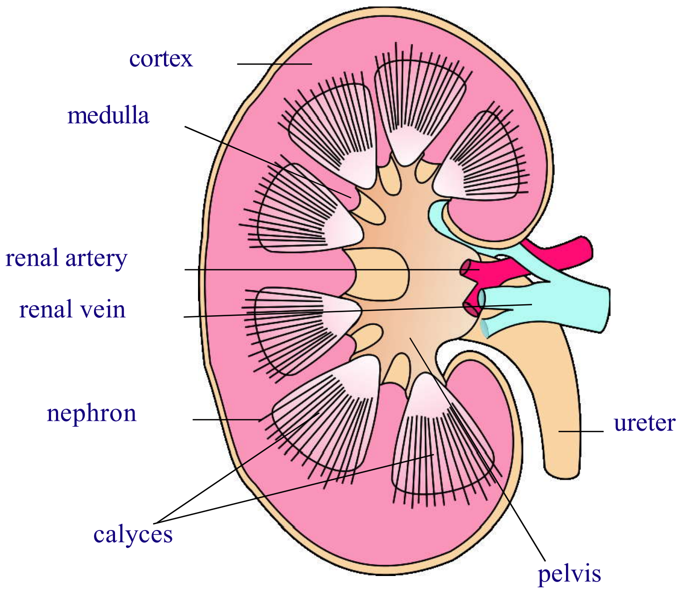
It is a pear shaped and distensible sac like structure. It is situated in the pelvic region on the ventral side of the rectum in the abdomen. It stores urine brought by two ureters and capacity of the bladder is 300 - 800 ml.

11.1.4 Urethra

It is the tube that excretes urine from the bladder. The opening of urinary bladder into the urethra is guarded by a ring of muscles helping in closing and opening of it called as a sphincter. It regulates the movement of urine. Urethra is 4 cm long in females and in males it is about 20 cm long. Its opening is common with the reproductive tract in males (urino-genital duct) but separate in females.

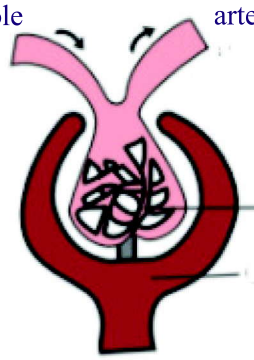
11.2 Kidney - Internal structure

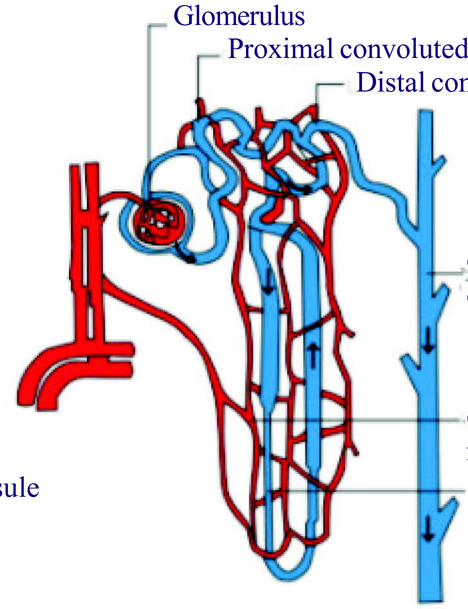
Let's look at the longitudinal section of the kidney. The inside of a kidney appears in two parts. The dark brown outer part is called the cortex and the lighter inner part is called the medula. Each kidney is made up of approximately one million microscopic units. Each unit is called a nephron, contains blood vessels and a fine tube varying in diameter along its length. At one end of the nephron is a cup shaped structure we call the Bowman's capsule. (it got its name from the person who first observed it)



Internal structure of kidney

A fine artery enters the Bowman's capsule, forms a dense network of finer blood vessels called as capillaries, and move out of it (see figure - Nephron). The fine artery entering the capsule is called afferent arteriole and the one moving out is called efferent arteriole. The network of blood capillaries is called glomerulus.





Nephron

* The diameter of the efferent arteriole is less than that of the afferent arteriole. Why?

The narrower outlet (efferent arteriole) builds up pressure in the glomerulus. Fluid filters out from the capillaries in to the Bowman's capsule due to this pressure. This is the first step in the formation of urine. The filtrate passes on beyond Bowman's capsule to the tube of the nephron. Some substances in the initial filtrate like glucose, amino acids salts and a major amount of water are selectively reabsorbed as urine flows through the tube. The amount of all these to be reabsorbed depends on their level in the blood. Let us take the example of water. The amount of water reabsorbed depends on how much excess water there is in the body and how much of dissolved waste there is to be excreted. Filtrate of all nephrons together pass into collecting vessels that together move out of the kidney. This is the urine that passes from kidney via ureter to the bladder.

11.3 Functions of kidney

The kidneys play a major role in homeostasis (the ability of an organism to maintain internal stability to compensate for environmental changes). It filters the blood in the body several times each day and produces approximately 1.5 liters of urine. Kidneys regulate the level of water, ions and other substances in the blood. The kidneys also secrete hormones that help maintain homeostasis. The kidneys are also regulated by hormones. When this balance in the blood is disturbed a person becomes ill.

After the age of 40 years, the number of functioning nephrons usually decreases by about 10% every 10 years.

* What happens when you drink large amount of water?
* In which season do you urinate more? Why do you think it may be so?

11.4 Composition of urine

It is a transparent fluid produced by the urinary system. Urine has amber colour due to the presence of urochrome. Composition of urine varies considerably depending on several factors. For example, a protein rich diet can lead to an increase in urea in the urine, sugar may appear in the urine after a heavy intake of sweets, or a large intake of liquids and water rich food increases the amount of water in the blood, which results in excretion of more urine.

Urine usually contains 96% water, 2.5% organic substances (like urea, uric acid, creatine, creatinine, water-soluble vitamins, hormones and oxalates, etc.) and 1.5% inorganic substances (sodium, chloride, phosphate, sulphate, magnesium, calcium, iodine, etc.). Initially, urine is acidic (pH =6) but gradually becomes alkaline due to the decomposition of urea to form ammonia. Ammonia is the most toxic of all waste products produced during metabolism. The range of pH of urine is 4.5 to 8.0.

CHECK YOUR PROGRESS.

- What are the most toxic nitrogenous wastes?
- Draw a rough diagram of the nephron and identify the part where the first filtration occurs?
- Name the organ of the excretory system that stores urine before its removal from the kidney?

11.5 How do you test the functioning of kidneys?

Generally two tests are used to check for kidney diseases.

* A blood test checks your glomerular filtration rate (GFR) which tells how well your kidneys are filtering.
* A urine test checks for albumin in your urine, a sign of kidney damage.

Why should we check our kidneys frequently?

Kidney diseases can be detected by the above tests. Kidney tests are very important for people who have diabetes, high blood pressure or heart disease.These conditions can hurt the functioning of kidneys. That is why it is mandatory to check our kidneys frequently.

Antidiuretic hormone (ADH) which is also known as vasopressin, helps the body conserve water when body fluid volume, especially that of blood, is low.

What happens in kidney disease?

If kidney disease is detected, it must be treated immediately. Treating kidney disease may also prevent heart disease. Kidney diseases can be treated. Treatment goals are to:

- ❑ Keep your GFR from going down.
- ❑ Lower your urine albumin.

To maintain kidney health:

- ❑ Keep your blood pressure, blood glucose and blood cholesterol in your target range.
- ❑ Choose foods that are healthy for your heart and cut back on salt.
- ❑ Be physically active and workout until you sweat.
- ❑ Drink sufficient water.
- ❑ If you smoke or drink liquor, take steps to quit.
- ❑ Take medicines only when prescribed by doctors.

11.5.1 Kidney failure

Certain diseases or accidents can lead to kidney failure. Since the number of nephrons in each kidney is about one million, a person can live a normal healthy life even with one kidney. Complete and irreversible kidney failure is called End Stage Renal Disease (ESRD). If kidneys stop working completely, our body is filled with excess water and waste products. This condition is called uremia. Our hands or legs may swell. However at least one kidney must function properly to maintain life. Diseases that threaten health and function of kidneys are kidney stones, infections, etc.

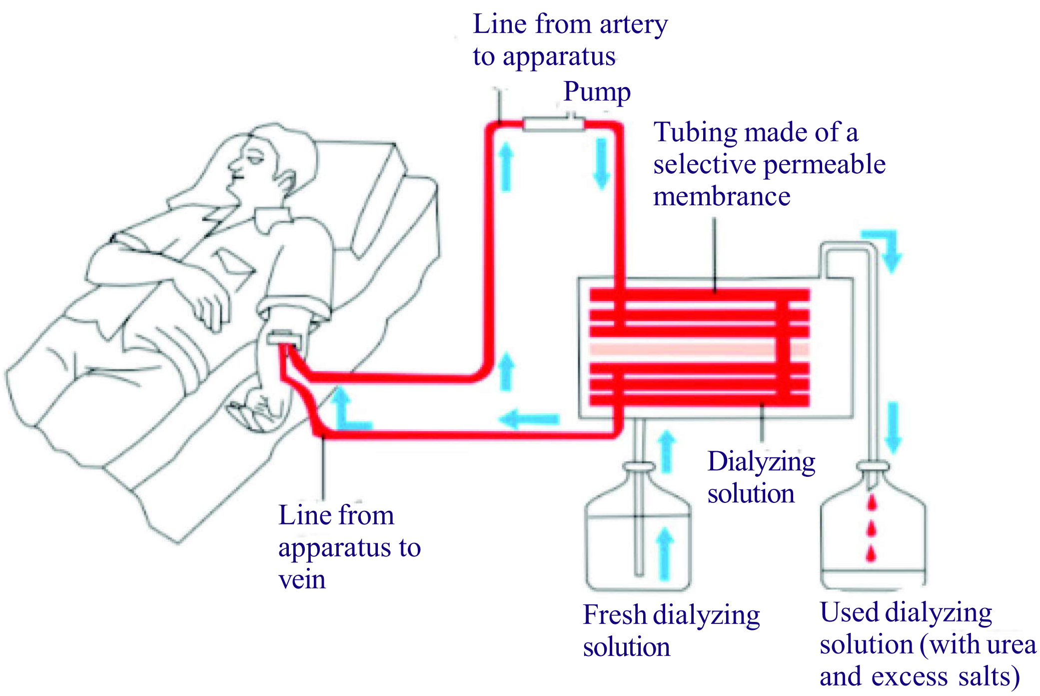
11.5.2 Dialysis (artificial kidney)

If both kidneys are damaged, it is difficult to stay alive. Modern technology can now protect patients with the help of new methods such as dialysis and kidney transplantation.

When two kidneys are damaged, a machine called dialysis is used to artificially filter a person's blood. This process is called Haemodialysis. In this process blood is taken out of the main artery, mixed with an anticoagulant such as heparin, and then pumped into a device called a dialyzer. In this apparatus, blood flows through channels or tubes made of cellophane (semi permeable membrane). These tubes

About 170 liters of blood flows through the kidneys of an adult human being in a day. Only 1.5 liters of urine is produced while the rest of the fluid goes back into the bloodstream through circulation.

are immersed in the dialyzing fluid. The membrane separates the blood flowing inside the tube and dialyzing fluid which has the same composition as that of plasma, except that the blood has nitrogenous wastes.



Kidney dialysis

As Nitrogenous wastes are absent in dialyzing fluid, these substances from the blood move out freely, thereby cleaning the blood of its wastes. This process is called dialysis.This is similar to the function of the kidney but is different as there is no reabsorption involved. The purified blood is sent back into the body through a vein after adding the anticoagulant heparin. Each dialysis session lasts 3 to 6 hours. This method is used for thousands of Uremic / kidney failure patients worldwide.

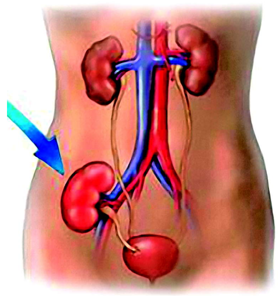
11.5.3 KidneyTransplantation

✻ Is there any long-term solution for kidney failure?

The best long-term solution to kidney failure is kidney transplantation. It is a surgical procedure to implant a healthy kidney from a living or deceased donor into the patient. The recipient's immune

The first kidney transplantation was performed between identical twins in 1954 by Dr. Charles Hufnagel who was a surgeon in Washington, USA. In India, the first kidney transplantation was done on 1st December 1971 at the Christian Medical College, Vellore, Tamil Nadu.

system is more likely to reject the transplanted kidney. So, the kidney that is received by the recipient must be a good match to his body to minimise the chances of rejection. To ensure this, it is advisable that the donor be a close-relative of the recipient. Modern clinical procedures have increased the success rate of such complicated techniques.



Transplantation

* Where is the transplanted kidney placed in the body of the patient with kidney failure?

Donated kidneys are placed as shown in the figure. Damaged kidneys are not removed from the body as some of the nephrons are still active.

11.5.4 Live even after death

Nowadays the process of organ donation helps a lot for kidney failure patients. Organs are collected from brain dead patients and transplanted to the recipients. This is called organ donation. We can save many lives who are in need of different organs from donors for their survival. Instead of living in memories of the deceased, let us give them a chance to live in others for one more life.

Let us donate organs. Let us live even after death.

11.6 Accessory excretory organs

In addition to the kidneys, lungs, skin, liver and large intestine also remove wastes from our body.

Lungs:

During respiration, lungs remove carbon dioxide and water.

Skin:

It consists of a large number of sweat glands richly supplied with blood capillaries from which they extract sweat and some metabolic wastes. Sebaceous glands in skin eliminate sebum which contains waxes, sterols, hydrocarbons and fatty acids.

Liver:

When dead RBCs breakdown they produce bile pigments such as bilirubin, biliverdin and urochrome, which are metabolic wastes of haemoglobin.The lifespan of RBC is 120 days. They are destroyed in the liver. Urochrome is eliminated through urine. Bilirubin and biliverdin are excreted through bile along with cholesterol and derivatives of steroid hormones, extra drug, vitamins and alkaline salts. Liver is also involved in urea formation.

Large intestine:

Excess salts of calcium, magnesium and iron are excreted by epithelial cells of colon (large intestine) along with faeces.

Small amounts of nitrogenous wastes are also eliminated through saliva and tears.

11.7 Excretion in other organisms

Different organisms use varied strategies in excretion. Structural and functional complexity of excretory organs increases from sponges to humans. Specific excretory organs are absent in unicellular organisms. Excretory structures that appeared for the first time in flatworms (Platyhelminthes) are known as flame cells.

Let us now see how the excretory process takes place in plants.

Name of the Phylum	Excretory Ststem
Protozoa	Osmo regualtion, diffusion
Porifera and Coelenterata	Diffusion
Platyhelminthes	Flame cells
Nemathelminthes	Renette cells
Annelida	Nephridia
Arthropoda	Green glands, malpighian vessels
Mollusca	Metanephridia
Echinodermata	Water circulation system
Fishes, Amphibians, Reptiles, Birds, Mammals	Kidneys

CHECK YOUR PROGRESS.

- What is the function of a nephron?
- Draw a labelled diagram of a nephron.
- Why is dialysis required?
- Write slogans to promote organ donation.

11.8 Excretion in Plants

- Do plants also excrete like animals?
- Do they also have excretory organs?
- How do plants manage to get rid of waste products from their body?

Plants produce a variety of waste products during metabolism but they do not have specific organs to excrete. Plants breakdown waste substances at a much slower rate than the animals, therefore accumulation of waste is also much slower. They also are capable of managing and recycling wastes.

Plants use completely different strategies for excretion than those of animals. Oxygen itself can be considered as a waste product generated during photosynthesis in plants, that exits through the stomata of leaves and lenticels of the stem.

Exeretory products may be stored in leaves, bark and fruits. When these dead leaves, bark and ripe fruits fall off from the tree then waste products in them are get rid off. Waste may get stored in the fruits in the form of solid body called Raphides. Several toxic compounds are synthesized by the plants for protection against herbivores. Most plant products that we think are wastes may actually be beneficial to the plant in some way or the other. Alkaloids, tannins, gums etc. are products that are often protective for the plant body.

The biochemical substances produced in plants are of two types - primary metabolites and secondary metabolites. A primary metabolite is a kind of metabolite that is directly involved in normal growth, development and reproduction etc. Eg: Carbohydrates, proteins and fats. Conversely, a secondary metabolite is not directly involved in those processes. Secondary metabolites are derivatives of primary metabolites and have no function in the physiology of the plant. Eg. alkaloids, tannins, resins, gums, latex etc. Though plants produce these chemicals for their own use, man found the usage of these chemicals for his own benefits.

11.8.1 Alkaloids

These nitrogenous by-products are toxic in nature. Common alkaloids in plants and their uses are given below.

Alkaloid	Plant	Part	Uses
Quinine	*Cinchona officinalis* (cinchona)	Bark	Antimalarial drug
Nicotine	*Nicotiana tobacum* (Tobacco)	Leaves	Insecticide, stimulant
Morphine, cocaine	*Papaver somniferum* (Opium)	Fruit	Pain killer
Reserpine	*Rauwolfia serpentina* (Snakeroot)	Root	Preventing High blood pressure
Nimbin	*Azadirachta indica* (Neem)	Seeds, bark, leaves	Antiseptic
Caffeine	*Coffea arabica* (Coffee plant)	Seeds	Nervous system stimulant
Scopolamine	*Datura stramonium* (Datura)	Fruit, flower	Sedative
Pyrethroids	*Chrysanthemum* (Chamomile)	Flower	Insecticides

11.8.2 Tannins

These are organic compounds. These are stored in different parts of the plant and are dark brown in color. Tannins are used in leather, tanning and pharmaceuticals. Eg: Cassia, Acacia

11.8.3 Resins

Resins mostly occur in gymnosperms in specialised passages called resin passages. These are used in varnishes. Eg: Pinus

11.8.4 Gums

Plants like Neem, Acacia ooze out a sticky substance called gum when branches are cut. The gums swell by absorbing water and help in healing damaged parts of a plant. Gums are economically valuable and used as adhesives and binding agents in the preparation of the medicines, food, etc.

11.8.5 Latex

Latex is a sticky, milky white substance secreted by plants. Latex is stored in latex cells or latex vessels. From the latex of Hevea brasiliensis (Rubber plant) rubber is prepared.

Biodiesel is prepared from the Jatropha plant.

11.9 Excretion - secretion

Excretion is the removal of materials from a living being. Excretion is passive in nature. Humans excrete materials such as urine, carbon dioxide, sweat and urea. In plants we find excretion through roots into its surroundings include and, falling off of leaves, bark and fruits.

Secretion is movement of material from one point to other point. It is active in nature. Secretions include enzymes, hormones and saliva. Secretions occur in the plant body in the form of latex, resins, gums etc.

CHECK YOUR PROGRESS.

- What is the difference between primary metabolites and secondary metabolites?
- Plants do not have excretory organs. How do they send out their waste products?
- Name the alkaloids which are harmful to us.

KEY POINTS

- During metabolism several harmful excretory products are formed and the process of removing toxic waste from the body is called excretion.
- The human excretory system comprises a pair of kidneys, a pair of ureters, urinary bladder and urethra.
- Each kidney is composed of approximately one millions of nephrons, which are structural and functional units of kidney.
- Kidneys remove nitrogenous waste from the body and maintain water balance, salt content, pH and blood pressure in the human body.
- Dialysis machine is an artificial kidney which filters the blood to remove the metabolic wastes outside the body.
- Plants do not have specific organs to excrete. Plants store waste products in their leaves, bark, roots, seeds, and fruits. When these ripen, they fall off from the tree and waste products in them are removed.
- Plants produce two types of metabolites. i) Primary metabolites. Ex - Carbohydrates, proteins and fats ii) Secondary metabolites. Ex - Alkaloids, tannins, resins, gums, and latex
- Excretion means removal of substances from the organism, and secretion is the movement of materials from one point to another.

PRACTICE FOR LEARNING OUTCOMES

1. What happens if waste products accumulate in our body?
2. When and why vasopressin is secreted?
3. Write the differences between excretion and secretion.
4. When urine is formed, initially it is acidic in nature. Later it becomes alkaline. Give reasons.
5. Explain the process of formation of urine.
6. Why are nephrons called functional and structural units of the kidney?
7. What is the composition of urine?
8. What is the long-term solution for kidney patients?
9. What steps do you take to bring awareness in society about organ donation in your day to day life?
10. The structural and functional unit of human kidney is ( )

    A) Alveoli B) Nephron C) Neuron D) Capillaries
11. The most toxic of all metabolic waste products is ( )

    A) Urea B) Uric acid C) Ammonia D) Water
12. Flame cells are excretory organs in the following organism ( )

    A) Arthropods B) Annelids C) Nemathehelminthes D) Platyhelminthes

12. Identify the secondary metabolic derivative among the following. ( )

    A) Carbohydrates B) Proteins C) Fats D) Alkaloids

13. Which of the following hormone has a direct impact on urination? ( )

    A) Vasopressin B) Estrogen C) Testosterone D) Progesterone
14. Match the columns "A" and "B"

	Column A			Column B
A)	Nimbin	( )	1.	Anti malarial drug
B)	Riserpine	( )	2.	Sedative
C)	Scopolamine	( )	3.	Insecticide
D)	Quinine	( )	4.	Antiseptic
E)	Pyrethroids	( )	5.	Preventing high blood pressure
			6.	Pain killer

CHAPTER

12 Control and Coordination

Every day we perform various activities, for doing any activity coordination between various body parts is essential. When we drive a car coordination between eyes, ears, legs and muscles of the hand is essential. While playing tennis game eyes, ears, legs and muscles of the hand should work together with coordination. In the same way various life processes which are taking place in our body work together with coordination.

* Which organ in our body is responsible for our thoughts feelings and emotions?
* Which system in our body is responsible to show responses to stimulus?
* Why change takes place inside and outside of our body during adolescent period?
* How plants will responds to stimulus?

In our body one system depends upon another system and work together with coordination. The nervous system and endocrine system work together to control and coordinate all our activities such as physical actions, our thinking processes and our emotional behaviour. In plants, phytohormones control the life processes.

Now in this lesson we shall try to know about the various activities which are controlled and coordinated by nervous system and endocrine system together in our body.

LEARNING OUTCOMES

The learner...

☆ Explains the role of nervous system and endocrine system in controlling and coordination of various activities in the body.

☆ Explains the structure and function of Nerve cell, Brain, Spinal cord, Reflex arc with the help of diagram.

☆ Differentiates between sensory nerves and motor nerves

☆ Identifies the location of endocrine glands and hormones secreted by them in our body

☆ Gives the suitable examples for stimulus and responses.

☆ Explains the role of phytohormones in regulating the growth of the plant.

☆ Explains the central Nervous system and peripheral nervous system.

12.1 Nervous system

The nervous system includes the brain, spinal cord, sense organs and nerves. The sense organs receives the stimulus and this stimulus with the help of sensory nerves reaches the brain and spinal cord. This information will be sent to different organs by motor nerves for action.

12.1.1 Showing Response to stimulus

- When cat sees the mouse why does it run towards the mouse?
- Why plants grows in the direction of sunlight?

Stimulus is an external (or) internal factor which initiate a reaction called response. Response is the ability of living organisms to respond towards stimuli are the cause for response.

External stimuli: These are external factors like light temperature water wind and touch. For example folding of leaflet of plant, touch me not. Secretion of saliva from salivary glands of a hungry dog on seeing food

Internal stimuli: These are intrinsic factors within the body for example desire of hunger on empty stomach, desire of thirst on drying throat.

All living organisms respond to stimuli. There are sequential steps in showing response to stimulus. Detecting the changes in environment (both external and internal) is the first step, transmission of the information is the second step, analysing the information is the third step and finally the responses will be detected and appropriate action will be executed.

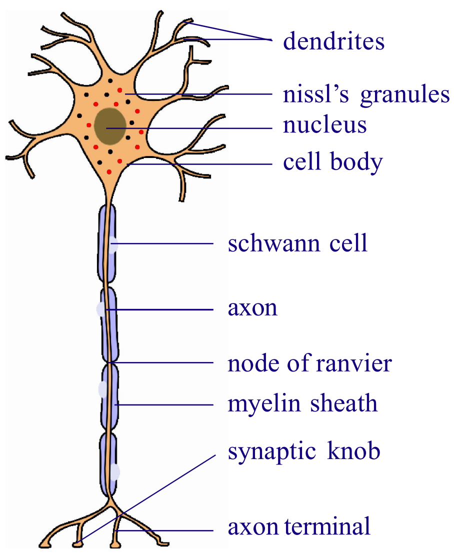
12.1.2 Nerve cell

To know the function of nerve cell let us observe the structure of nerve cell.

Every nerve cell consists of 3 parts they are 1. Cyton 2. Dendrite 3. Axon

Cyton (Cell body): The cell body contains a well defined nucleus, surrounded by cytoplasm. It has cell organelles like any other cells. The cell body further transmit the impulse to the axon.

Dendrites: These are branched projections from the cell body. The dendric tip of the nerve cells receives impulses and sets off a chemical reaction that create more electrical impulse which are further transmitted to the cell body.



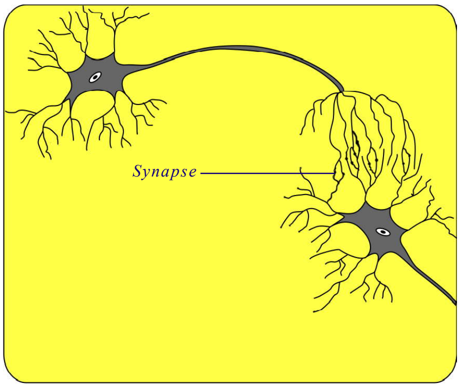
Nerve cell

Axon: The longest branch arising out of the cell body is called axon (or) nerve fibre. The axon is surrounded by a specialized fatty sheath called myelin sheath. The nerve cell containing myelin sheath is called myelinated nerve cell. The myelin sheath is interrupted at regular intervals called nodes of Ranvier. Nerve cell not having myelin sheath is called non myelinated nerve cell. Myelin sheath separates the one axon with adjacent axon. The information from one nerve cell to another nerve cell will be passed through synapse.

12.1.3 Synapse

* How the synapse is formed?
* Which part of nerve cell is connected to another nerve cell in the figure.

Synapse is the functional region of contact between two nerve cells, where information from one nerve cell is transmitted or relayed to another nerve cell. Though these are the regions of minute gap and essentially nerve cell do not have any protoplasmic connection between them, yet information is passed from one nerve cell to other through these gaps either in the form of chemical (or) electrical signals (or) both. These synapses are mainly found on the brain, spinal cord and around the spinal cord. Beyond these areas the axon carries the signals to respective areas in our body. In this way by basing on the ways of carrying message nerves are divided in to three types.

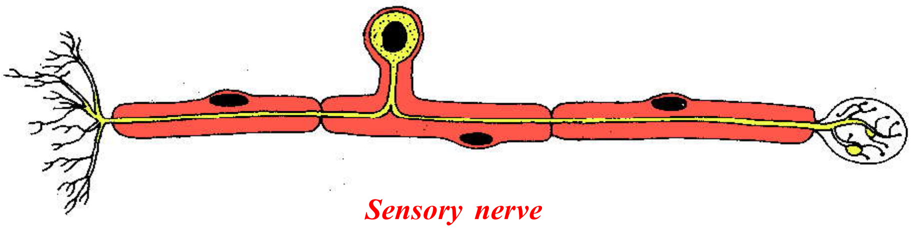


Synapse

12.1.4 Types of Nerves

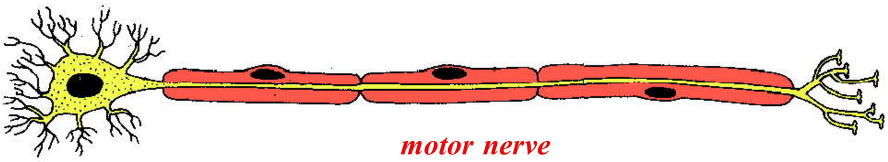
Based on the function, nerves are divided into 3 types

1) Sensory nerves (Afferent nerves) (2) Motor nerves (Efferent nerves) (3) Mixed nerves



Sensory nerve

Sensory nerves: Sensory nerves contains sensory fibres. Sensory nerves are also called as afferent nerves. They carry the impulse from receptors (sense organs) to the central nervous system (Brain and Spinal cord)



Motor nerves: Motor nerves contains motor fibres. Motor nerve is also called as efferent nerve. They carry impulse from central nervous system to different body parts.

Mixed nerves: These nerves contains both sensory and motor fibres, and performs the function of both sensory and motor nerves.

12.1.5 Sense organs

- ✳ What are sense organs? How many types of sense organs are there?

A receptor (or) sense organ is a group of highly specialized cells. Receptors helps sensory nerves to collect information from sensory organs. The sense organs which are present in our body are eye, ear, nose, tongue and skin receives the stimulus. The stimulus then reaches the spinal cord and the brain through sensory nerves where it is integrated. The message is then sent by motor nerves to the required organ (muscle (or) gland) for suitable action. In this way response is generated.

- ✳ How do we able to see and hear?
- ✳ How do we know the taste smell and touch?

Human eye acts as photographic camera in which conjunctiva, cornea, lenses and humorous refract the light rays to focus on retina of eye Photo receptors are stimulated which change usual stimuli into nerve impulses which are carried by nerve fibres of optic nerves to the visual area of cerebrum which interprets these impulses and initiate proper response by which we are able to see.

The receptors present in Ear detect the sound stimuli. Nerve impulse from ear are carried to auditors of cerebrum by auditory nerves thus we are able to hear.

Once the food enters in the mouth we grind and chew it, as a result the chemicals released from food stimulates the taste buds. Each taste bud is composed of larger cluster of taste cell. Each taste cell is a chemoreceptors and detect the chemicals of food and initiate nerve impulses which are carried by nerves to taste area of brain to interpret the message. Thus we are able to taste the food.

The upper part of nasal chamber have olfactory cells. These cells detect the chemical stimuli and convert them into nerve impulse and send this impulse to an olfactory area of the brain through olfactory nerve thus we know the smell.

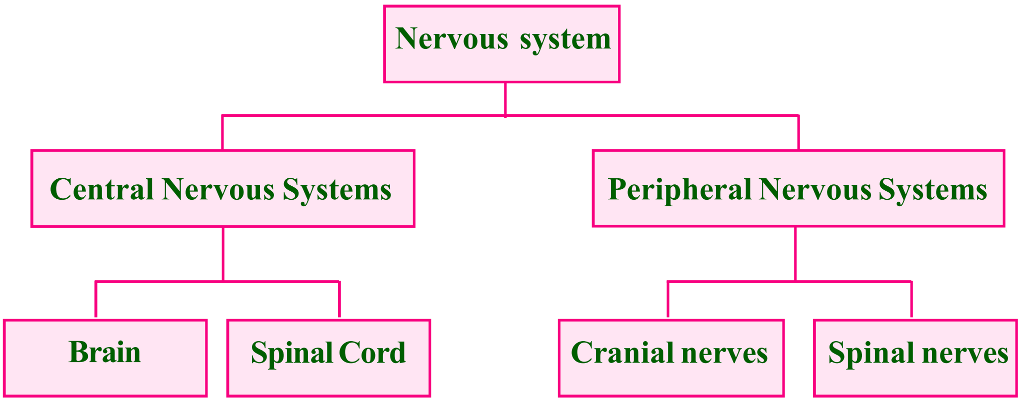
Skin is sensitive to touch, temperature, pressure, skin contains tactile receptors for touch. These receptors create sense of touch. This message is passed on to brain through sensory nerves due to this we are able to feel sense of touch, cold, hot.

CHECK YOUR PROGRESS.

- What are the stages involved in showing response to stimulus?
- Explain about the synapse?
- How we are able to see with our eye?

12.2 Divisions of Nervous System

Observe the flow chart of Human Nervous System

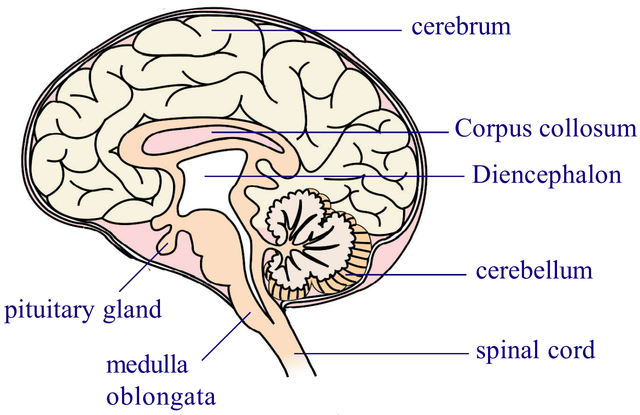


12.2.1 Central Nervous System

The Central Nervous System consists of brain and spinal cord.

Brain: Observe the figure of human brain

Brain is a soft structure present inside the cranium of skull. It is protected by three layers. The fluid present in between these layers are called cerebrospinal fluid. This fluid protects the brain from the shocks.



Brain

What is the colour of brain? The outer portion of brain contains cell bodies of the nerve cell these are being grey coloured. This portion is called grey matter. The inner portion of the brain contains axons of the nerve cell. As these axons contains white mylean sheath this portion of the brain is called white matter.

Brain contains following parts

1. Fore brain: It contains cerebrum and diencephalon

2. Mid brain: It contains optic lobes

3. Hind brain: It contains cerebellum and medulla oblengata

Brain	Parts	Structure	Functions
Fore brain	Olfactory lobes	Clubshaped	Sense of smell
	Cerebrum	It contains two lobes called cerebral hemisphere. The surface of the cerbrum has folds. The elevations of the folds are called Gyri and depressions are called Sulci.	• seat of mental abilities • controls thinking, memory, reasoning perceptions and speech
	Diencephalon	It is in Rhomboidal shape. It is divided into thalamus and hypothalamus	Controls emotions such as anger, Reflex centre for muscular activities, centre for water balance, blood pressure, body temperature, sleep and hunger. The hypothalamus controls the pitutary gland.
Mid brain	Mid brain	Small stalk like structure	It relays motor impulse from the cerebral cortex to the spinal cord and relays sensory impulses from spinal cord to thalamus. Reflexes for sight and hearing
Hind brain	Cerebellum	It contains two large cerebral hemispheres.	Maintains posture, equalibrium and musule tone.
	Medulla oblongata	It is in traingular shape.	Controls cardiac, respiratory, vasomotor activities, coordinates reflexes like swallowing, coughing, sneezing and vomting

12.2.2 Spinal cord

* What is the structure of spinal cord?
* Where do you find spinal cord?

Spinal cord

Spinal cord extends from the back of the hind brain to the back of the stomach (or) lumbar regions through the neural canal of vertebral column. It is almost cylindrical in shape. In spinal cord the white matter is towards periphery while grey matter is towards the centre of spinal cord. The myelinated axons leave the spinal cord from both the sides of the vertebral column.

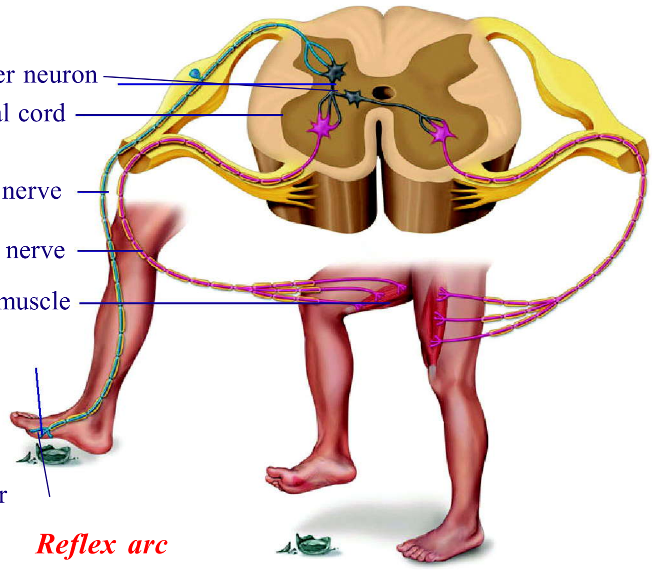
The spinal cord is not only a road for passing instructions from the brain but it also acts as controlling centre.

12.2.3 The Reflex arc

The Reflex action which are showed occasionally in our body are under our control. Sometimes these reflex actions may not be in our control. Same responses shown towards stimuli are under our control. Some times we respond involuntarily and those responses are not under our control, they are called Reflexaction.

* Why you withdraw your leg when accidentally it hits any sharp surface?

When our leg touches the sharp surface the information is carried by sensory nerves to spinal cord from there this information reaches effector muscles by motor nerves which makes the muscles of leg to with draw the feet.



Reflex arc

The single path way going up to the spinal cord from detectors and returning to effector muscles is a reflex arc.

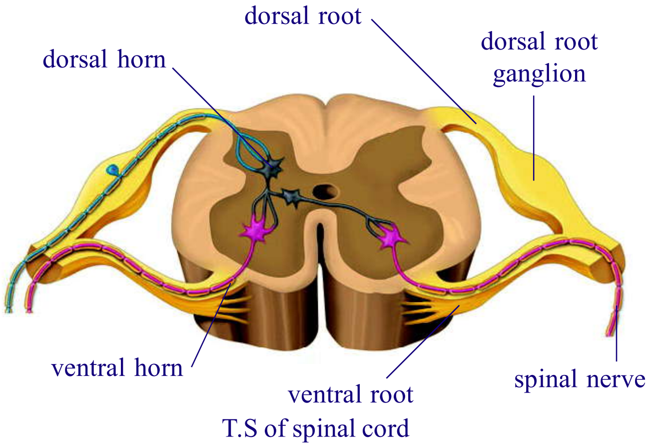
This type of responses are called reflex action. For example we rub our eye when any dust particles enter in our eye. In the same way we withdraw our hand immediately when we touch any hot objects.

During actions which are involuntary and have to be carried out in very short intervals of time the pathway that nerves follows is a shorter one it does not go up to the brain, while voluntary pathways are usually longer passing through the brain and thus causing the response.

Reflexarc can be shown as stimulus → Receptors of sense organs → sensory nerve fibres → Brain → Spinal cord → Motor nerve fibres → muscles/glands.

12.2.4 Peripheral Nervous system

As shown in the figure nerves attached to spinal cord have two types of connections (or) roots - one to the back or dorsal side and other to front or the ventral side of the cord. The dorsal root carries messages of sensation inwards, while the ventral pathway carries outwards the instruction for muscular contraction. The peripheral nervous system is a vast system of the dorsal and ventral root spinal and cranial nerves that are linked to the brain and spinal cord on one end and muscles on the other. In our body 12 pairs of cranial nerves arise from the brain and 31 pairs of spinal nerve arises from the spinal cord.



Peripheral nerves system

12.2.5 Autonomous nervous system

* When we enter a dark room we cannot see any thing immediately, then slowly we are able to see the things around us in the room - why?

The peripheral nervous system involuntarily controls the several functions of region like our internal organs (for example blood vessels) so it is called autonomous nervous system. It has voluntary control of muscles of some areas of skin and the skeletal muscles.

When we enter a dark room we cannot see any thing immediately slowly we able to see the things around us in the room. This is because of increase in diameter of pupil which allows more light in it when we come out of the dark room into broad day light the diameter of the pupil decreases allowing less light to enter into the eyes both these functions occur under the influence of the autonomous nervous system.

Ganglia near the vertebral column are connected to the spinal cord by nerves. The sympathetic nervous system is formed by the chain of ganglia on either sides of the vertebral column and the associated nerves. The para sympathetic systems is formed by the nerves arising from the ganglia of the brain and the posterior part of the spinal cord. These together constitute autonomous nervous system.

The increase in the diameter of the pupil is by sympathetic nervous system regaining its original position is controlled by para sympathetic nervous system.

Meningitis is contagious disease caused by bacteria, fungi virus that infect the meninges and the cerbrospinal fluid surrounding the brain and spinal cord

CHECK YOUR PROGRESS.

- What is the function of cerbro spinal fluid?
- What are the components of peripheral nervous system?
- Give the daily life examples for autonomous nervous system?

12.3 Endocrine system

Endocrine system works with the chemical substance known as 'hormone'. These hormones are secreted directly in to the blood by endocrine glands.

Generally we find rapid growth and development in between 13 to 19 year of the age. This period is called adolescent period. During this period lot of changes takes places inside and outside the body. For example increase in height, change in voice, let us observe the reasons for these changes.

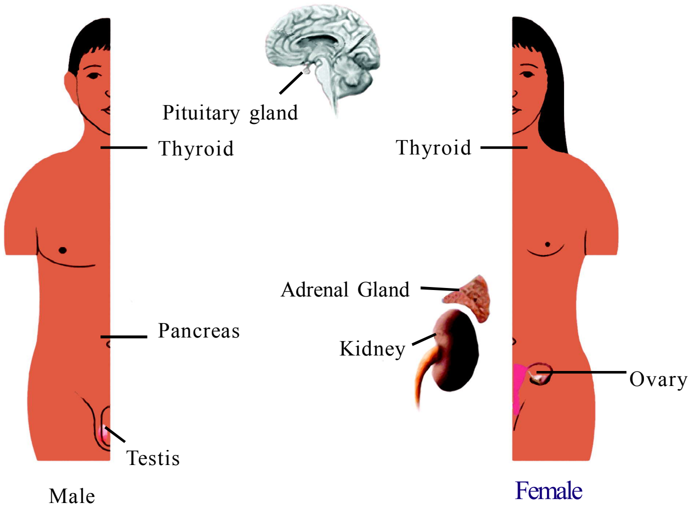
12.3.1 Endocrine gland (ductless glands)

The endocrine glands controls the changes that occur in our body through out life. Endocrine glands secretes chemical substance known as hormones. The hormones plays an important role in control, coordination and regulates the functioning of tissues, organs and systems in the body. The endocrine system is responsible for the chemical coordination in our body.

What is the difference between duct glands and ductless glands?

The secretion of some glands flows in vessels they are called as duct glands. Where as the secretion of some glands does not flow in vessels, their secretion directly mixes in the blood, they are called ductless glands. The system formed by ductless glands is known as endocrine system.

Observe the endocrine glands and their location in the given fig.



Observe the various types of endocrine glands and the hormones secreted by them in the given table.

Name of the endocrine gland	Location	Hormone secreted	Response of body to Hormone
Pitutary gland (Master gland)	Floor of brain	Growth Hormone (or) Somatotrophin	Growth of bones
		Thyroid stimulating hormone (TSH)	Stimulates the secretion of Thyroxine
		Adreno cartico Trophic hormone (ACTH)	Stimulates the secretion of adrenal cortex
		Follical Stimulating hormone (FSH)	In female growth of graftian follicles, stimulates estrogen secretion.
		Lutenising Hormone (LH)	In females ovulation, development of corpus luteum; and stimulates secretion of progesterone.
		Prolactine	In females development of mammary glands, promotes milk production.
		Oxytocine	Controls the contraction of uterus muscles, while child birth.
		Vasopressin	Regulates the water reabsorption in kidney
Thyroid gland	Neck	Thyroxine	Effects in general growth rate and metabolical activity
Ovary	Below the abdomen	Progestron	Growth of the uterus development of mammary glands
		Estrogen	Growth of Skeleton of the pelvis, control of menstrual cycle in females
Testies	Scrotal sacs	Testosterone	Development of sex organs and secondary sexual characters in males. Sexual behaviour
Adrenal gland	above the kidney	Adrenalin	Increase in heart beat rate, Rise in blood Sugar, Dialation of coronary artery and pupil of the eye.
Pancreas	Near deudodenum	Insulin	Decrease of sugar levels in blood.
		Glucagon	Increase of Sugar levels in blood.

Pancreas: Pancreas is called as mixed gland. It acts as both duct and ductless glands. The juices secreted by pancrease helps in digesting the food. Pancreas secretes two types of hormones, they are insulin and glucagon. The diabetes milletus disease is caused due to the less secretion of insulin.

* How hormone influence metabolic activities in our body.

Hormones influence our metabolic activities in different ways, simple sight of snake makes us afraid and that itself increase our heartbeat, beathing rate, blood pressure suddenly then after some time we come back to normal position. These changes are due to the effects of adrenalin hormone which is secreted by adrenal gland.

In our body there is a relation between nervous system and endocrine system. With the coordination of these two systems only life processes will takes place in our body.

12.3.2 Coordination of life processes

Though the digestion is taking place in the alimentary canal but for it. Coordination of respiratory system, circulatory system and nervous system is essential. To get energy from the food it should be oxidised for that respiration has to take place. In respiration we breathe air by exhalation and inhalation. The blood circulation helps in transport of oxygen in to the cell. All these involuntary actions are controlled by medulla oblongata. In this way all life process will work with coordination.

CHECK YOUR PROGRESS.

- How endocrine system and nervous system work together give one example.
- Why we consider pituitary gland as a master gland?
- Write the parts of the hind brain and their functions?

12.4 Control and coordination in plants

In plants nervous system and endocrine system is absent but there is a controlling mechanism by hormones. These hormones are called phytohormones.

* How the seed less fruits are developed?
* What are the substances which play an important role in ripening of fruits in plants?

12.4.1 Phytohormones

Plants can sense the presence of stimuli like light, heat water, touch pressure, chemicals gravity etc. The hormones present in plants are called phytohormones which controls responses towards the stimuli mentioned above.

Phytohormones - Their uses

Phytohormones	Uses
Auxins	Cell elongation and differentiation of shoots and roots
Cytokinins	Promote cell division, development of sprouting of lateral buds, opening of stomata
Gibberellins	Germination of seed, sprouting of buds, elongation of stem development of seedless fruits. Breaking the dormancy
Abscicic acid	Closing of stomata, seed dormancy
Ethylene	Ripening of fruits

12.4.2 Tropic and Nastic movements in plants

- What happens if we touch the leaflets of *Mimosa pudica* (touch me not) plant?
- Why the tendrils of plants move towards support?

In plants there are two types of movements, they are tropic movement and nastic movement. Plant parts shows movement when they are subjected to external stimuli. In tropic movements the direction of stimuli determines the direction of movements but where as in nastic movement the direction of movement may not be determined by direction of stimuli.

When we touch the leaflets of 'touch me not' plant they shrink. This type of movement is nastic movement.

The response of plant to light and showing movement towards light is called 'phototropism'.

Tendrils are thin thread like growth they grow towards the support and wind around them. This type of response to make contact (or) touch is called 'thigmotropism'.

Roots always grows towards the earth which is called 'geotropism'.

The plants which grow near a rock or wall side they grow towards region containing water. Such type of movement is called 'hydrotropism'.

The chemical substance stimulates the pollen grain which falls on the stigma. This type of response to chemicals is called 'chemotropism'.

CHECK YOUR PROGRESS.

- What are the phytohormones which controlls growth of the plant?
- Give the examples for different types of topic movements in plants?
- Which hormone helps to ripe the fruit?

KEY POINTS

- Nervous system and endocrine system work together in a coordinated manner and send the information to various organs of the body
- Human Nervous system consists of central nervous system and peripheral nervous system.
- Central Nervous system consists of brain and spinal cord. Peripheral nervous system is formed by the cranial nerves and spinal nerves
- Nerve cell is the structural and functional unit of the nervous system.
- There are three types of nerves sensory nerves, motor nerves and mixed nerves
- Eye, Ear, Nose, Tongue and Skin all the five sense organs present in our body they work by the effect of nervous system.
- Endocrine glands are ductless glands which secretes hormones directly into the blood and play an important role in coordination of different activities in the body.
- In plants phytohormones regulate the plant growth. Auxins, Cytokinins, Gibberellins, Ethylene and abscibic acids are the phytohormones present in plant.
- External stimuli makes plant to show different types of movements. They are tropic movements and nastic movements

PRACTICE FOR LEARNING OUTCOMES

1. Why pancreas is called as mixed gland?
2. What are the differences between cerebrum and cerebellum?
3. Explain the effect of adrenalin with suitable examples?
4. Write the functions of sensory nerve and motor nerve?
5. Explain the structure of nerve cell with the help of diagram?
6. Mention the phytohormones present in plants and write their uses?
7. The location of pituitary gland is ( )

   A) Neck   B) Brain   C) stomach   D) Kidney
8. The number of cranial nerves present in man ( )

   A) 12 pairs   B) 10 pairs   C) 31 pairs   D) 4 pairs
9. Match the following

A)	Testosterone	( )	1.	Ovary
B)	Glucagon	( )	2.	Testies
C)	Estrogen	( )	3.	Thyroid
D)	Thyroxin	( )	4.	pancreas

CHAPTER

13

Growth, development and Reproduction

We find different living and non-living organisms.

- What are the characteristics that makes living things different from non-living things?

Living organisms exhibit unique characteristics like growth, reproduction etc. Growth is the process in which the mass of a body changes over time. If we observe a child during the process of growth her height and weight increases.

- In child, does height and weight changes?
- Have you ever seen a two months old baby having moustache?

When living organisms grow, there will be many other changes along with the change in size. New parts are formed. New processes emerge. They produce their offsprings (young ones) The changes that accompany the growth of any plant (or) animal is development.

- What will happen if production of offsprings in human is not controlled?

Growth, development and reproduction of living organisms help them in their survival and maintain their population. In this lesson we shall learn, growth, development and also reproductive parts in plants and humans, the process of reproduction and family planning.

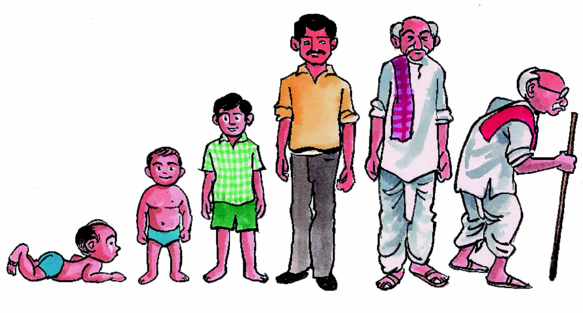
LEARNING OUTCOMES

The learner...

- Differentiates between growth and development.
- Explains the process of development from embryo to maturation in humans.
- Specifies the difference between sexual and asexual reproduction.
- Identifies the parts of a flower.
- Draws and explains the human male and female reproductive systems.
- Applies vegetative propagation methods in plants.
- Applies Family planning methods in daily life.

13.1 Growth, Development and Reproduction

- What is growth?
- Are you the same when you were six years old and now?



If you observe a newly born baby they have almost all the parts of an adult, but these parts are small in size. As the years pass the size of the parts increases to a certain size. The reason behind these physical changes is "growth".

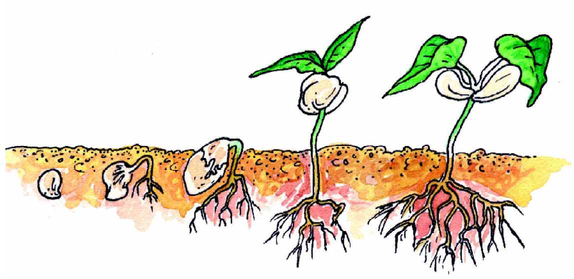
- How do organisms grow?

Living organisms grow by increase in size (or) mass of a cell, organ (or) organism and increase in cell number by cell division. Growth is an irreversible permanent change. Plants grow in height (or) length and circumference (girth). In plants growth continues throughout life where as in animals it is limited to certain time period. Growth is measurable. For example increase in height and weight for certain time period in living organisms can be measured.

- Are growth and development the same?

We notice growth of the plant from seedling, after sowing a seed.

- How a small seed grows into a big tree?
- How do roots, stems, leaves and flowers originate from a seed?



Multicellular organisms start their life with a single cell (zygote). Millions of cells produced by divisions from the fertilized egg forms body parts. For example roots, stem, leaves, flowers, fruits in plants and eyes, legs, hands, heart, brain etc. in animals, all originate from single cell.

- How do cells derived from a single cell form different parts?

Genes play vital role in cellular differentiation to produce different cells that are structurally and functionally different from each other. The differentiated cells contribute for the formation of different organs in the Embryo. Qualitative and quantitative change in embryo leads to development that involves the emergence of pattern, change in the form, cell differentiation and growth are also a part and parcel of development.

Development is a systematic process. For example, in the development of the hands, the upper arm, lower arm, palm and fingers are formed in an orderly sequence. In development process, there will be gradual change in the form (or) structure of organs; for example, in the formation of palm and feet. Sunlight, temperature, availability of food and water are the factors that influence growth and development. Growth and development are necessary for the survival and reproduction of living organisms.

Importance of reproduction

You might have noticed that the living organisms in your surroundings die. No organism lives forever. Death is inevitable. Every organism will live for a certain time period. But still life exists on earth when living organisms are dying. What can be the reason behind it? Reproduction is the process by which an organism reproduces similar organism. Their offsprings grow, mature and reproduces new offsprings.

k What happens if organisms of the specific species cannot reproduce?

Plants and animals reproduce to sustain their species by producing the next generation. If the organism of specific species fail to reproduce that species will go extinct.

13.2 Development in Plants and Animals

13.2.1 Development in Plants

Formation of leaves and flowers at specific areas in plants are responsible for growth. Those specific areas are called as 'meristems'. The meristems which are present in tips of roots and shoots are called "apical meristems" (root apical meristem, shoot apical meristem). Some cells in shoot apical meristem differentiates and forms axillary bud. This axillary buds are capable of forming leaves, branches (or) flowers. The growth of the roots and stems in length with the help of apical meristem is called the "primary growth". Increase in girth is called "secondary growth".

13.2.2 Development in Human beings

A) Development in womb

In women, egg reaches fallopian tube. Sperm reaches egg and fuses with egg. Fusion of egg and sperm is called fertilization. Fertilized egg is called Zygote. By the time zygote reaches uterus, it divides number of times and appears like a ball of cells. This attaches to the tissue in the uterus wall. This is called implantation of foetus. Foetus exists in the mother's womb for about 9 months. In these 9 months, development of foetus takes place. This development can be divided in to three trimesters.

First 3 months (or) first trimester

Foetus attaches to uterine wall. Amniotic sac, Placenta, Umbilical cord are formed to provide nutrition and protected to developing foetus. Many external and internal organs gradually develop.

3-6 months (or) second trimester

Foetus begins to show movement. Brain development is fast. Foetus increases in size.

6-9 months (or) third trimester

Increase in size continues. In this manner, development of foetus takes place till birth. At the end of nine months, the foetus usually turns in an upside down direction inorder to be released from the mother body.

B) Infancy to Adolescene

In the first 1½ years after the birth of a baby, the height and weight increases rapidly, decreases in childhood and again increases in adolescence. Motor changes like positioning of the head, sitting, standing, walking, running, holding and writing develops. Cognitive development like understanding, memory, knowledge etc improves. Language development develops from small sounds to babbling, then few repetitive words and then small sentences.

C) Adolescence to Puberty

Growth and development from 10-19 years is called Adolescence. Development in adolescence is rapid. The growth in the size of bones, muscles, height continues. In boys, the larynx develops and increases in size. Reproductive parts develop. Development of secondary sexual characters like hair growth under armpits, near genital organs, increase in breast size appears in females. Male develop moustache, beard.

In female reproductive phase ends at 45 to 50 years old. Females possess specific number of eggs even before the birth. These eggs mature at puberty. For every 28 to 30 days egg matures, releases from ovary and reaches to fallopian tube.

During this time, the wall of the uterus develop tissue and becomes thick in order to receive the fertilized egg. If fertilization does not occur, the newly formed tissue, blood vessels rupture and bleed. This is called mensuration. The cycle which takes place for every 28 to 30 days is called menstrual cycle.

CHECK YOUR PROGRESS.

- Which tissue differentiate in plants to form leaves and flowers?
- Write two changes occur in boys and girls during adolescence.

13.3 Asexual Vs Sexual Reproduction

Reproduction is of two types - Sexual and Asexual. In asexual reproduction single parent can produce its offsprings. Gametes are absent.

In sexual reproduction, male and female gametes belonging to opposite sex are formed. Fusion of these gametes may produce new individual. Sexual reproduction results in offsprings that are non identical to the parents (or) amongst themselves - where as offsprings that are produced in asexual reproduction are almost identical to their parents. Let us study methods of Asexual reproduction.

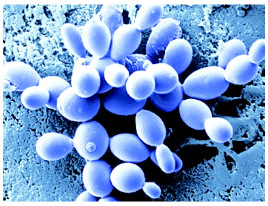
13.3.1 Fission

Single celled organisms such as *Paramecium* and bacteria reproduce by fission. If *Paramecium* divides into two it is binary fission, and if it divides into more than two cells it is called multiple fission.

Fission in paramoecium

13.3.2 Budding

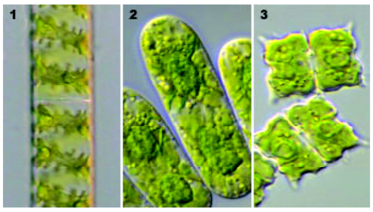
External growth that appears on the body of a parent is called as bud. This bud separates from the parent and survives independent. Example: Yeast.



Budding in yeast

13.3.3 Fragmentation

Some of the organisms can grow from a single piece of the parent organism. Fragmentation occurs in the simple organisms. Examples: Flatworms, Moulds, Lichens, Spirogyra.

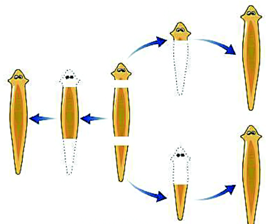


Fragmentation in Spirogyra

13.3.4 Regeneration

Lizards can regenerate their lost tail which is lost accidentally (or) to protect itself from enemies.

Few organisms are capable of regenerate their lost body parts (or) new individual may form from broken body pieces. Example: Planaria



Regeneration in Planaria

Parthenocarpy: In some plants, ovary directly develops into fruit without fertilization. This phenomenon is called as "Parthenocarpy". Artificial parthenocarpy is used to produce seedless fruits like Watermelon, Pomegranate, Papaya, Tomato

Seedless Watermelon

13.3.5 Natural Vegetative Propagation

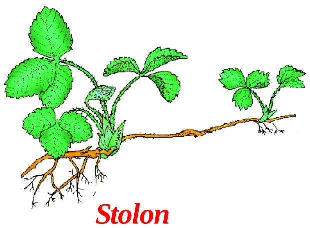
Usually, seeds are sown to produce plants.

k Have you ever observed seedless fruits. Recall.

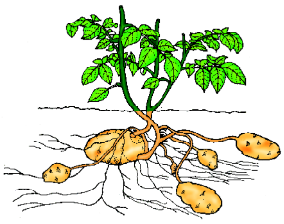
k Banana has no seeds, then how can it reproduce?

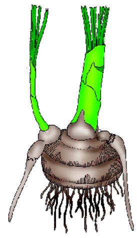
In plants reproduction also takes place by vegetative propagation. This is one type of asexual reproduction. The process by which new plants form from the vegetative parts of the plant, such as stems, roots, leaves is called vegetative propagation.

Stems: Aerial weak stems like runners and stolans, upon touching the ground, develop adventitious roots. When they get separated from the parent plant, the stem portion with the roots develops into new plant.


Stolon


Bulb


Tuber


Corms

Examples: **Jasmine, Mint** **Onion** **Potato** **Colacasia, Amorphophallus**

Roots: Root buds in plants such as Murraya, Guava, Millingtonia etc grow as new plants

Leaves: In Bryophyllum small plants grow from the edge of leaves


Root buds in Millingtonia


Bryophyllum

13.3.6 Artificial Vegetative Propagation in Plants

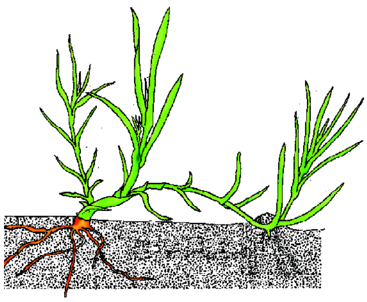
k If you want to start a kitchen garden, what type of plants do you want to grow? How do you grow them?

k Do all the trees grow only from seeds? Or else, Are there any other methods?

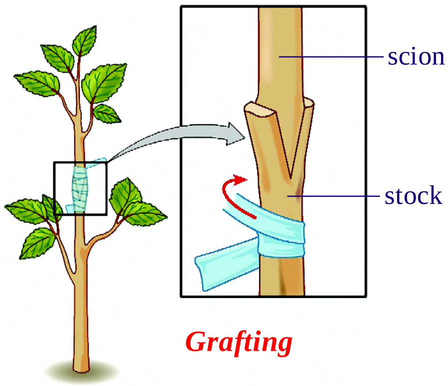
k Have you noticed the methods used to grow plants in orchards and flower gardens?

Cutting: Some plants can grow individually when a piece of the parent plant having a bud is cut off from the existing plant. **Examples:** Rose, *Hibiscus*

Layering: A branch of the plant with atleast one node is bent towards the ground and a part of it is covered with moist soil leaving the tip of the branch exposed above the ground. After a few days, new roots develop from the part. **Example:** Nerium, Jasmine.


Layering

Grafting: Grafting is a process in which two desired plants are selected and joined together in such a way that two stems join and grow as a single plant. One which is attached to soil is called stock and the cut stem of another plant without roots is called scion. Both are tied with the help of a twine thread and covered by a polythene cover.



Grafting

Examples: Mango, Citrus, apple, rose.

Sexual reproduction occurs through reproductive parts such as flowers (plants), testis, ovaries (animals)

k Have you ever observed that animals reproducing through somatic vegetative cells like plants?

In cloning, to give birth to a new organism, nucleus is removed from the ovum and nucleus from somatic cells of male (or) female is inserted in to the ovum from which nucleus is removed (enucleated). This ovum is cultured in culture medium and develops into infant. The first organism formed by this process is 'Dolly', the sheep.

CHECK YOUR PROGRESS.

D State one difference between asexual and sexual reproduction.

D Give two examples for artificial vegetative propagation.

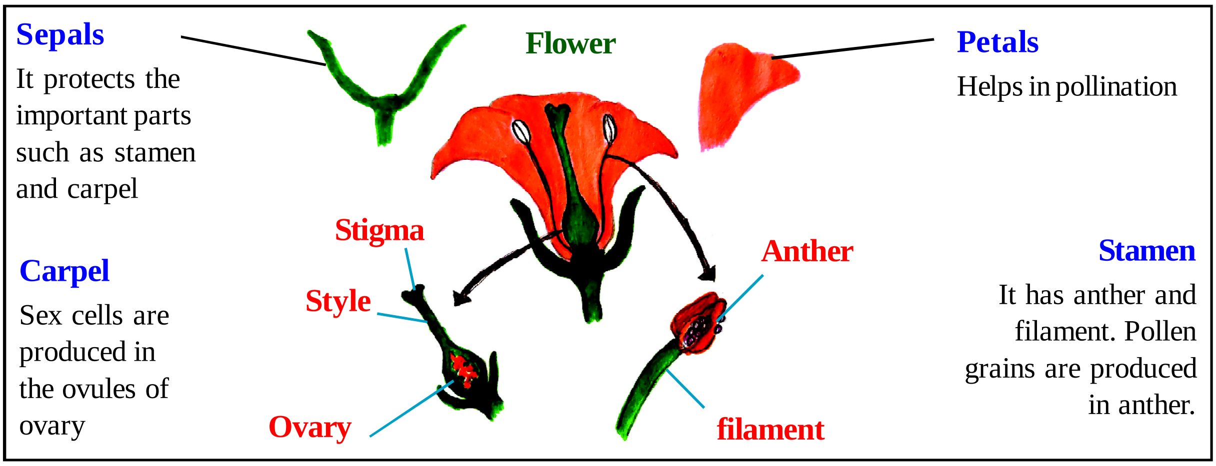
13.4 Reproductive parts in plants and humans

13.4.1 Reproductive parts in plants

k Do all the plants have flowers?

k Have you ever observed parts in a flower? Name the parts?

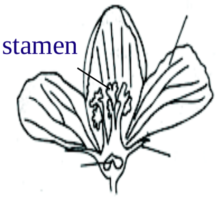
Flower is the reproductive part of plants. Collect any flower, identify the parts and differentiate between them. Draw the diagram of a flower.



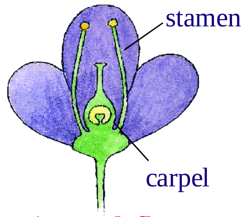
Flowers having either stamens (or) carpels are called unisexual flowers

Examples: Watermelon, Cucumber, Maize, Snake Gourd, Bitter gourd, Pumpkin

Flowers having both the stamen and carpel are bisexual. **Examples:** Lilly, Rose, Datura, Brinjal, *Hibiscus*, Tomato, Mango



Unisexual flower (male)



Bisexual flower

13.4.2 Reproductive parts in humans

Sexual mode of reproduction occur in humans. Sexes are separate and distinct. Specific organs are developed for sexual reproduction.

Male reproductive system - parts

Testis:

A pair of testes are located outside the abdominal cavity within a pouch called scrotum. In each testis highly coiled seminiferous tubules are present. Millions of sperms are produced in these tubules by meiosis. Testis produce male sex hormone testosterone

k Do you know why testes are located outside the abdominal cavity?

Scrotum has temperature about $2^{o}c$ - $2.5^{o}c$ temperature lower than the body temperature. Sperms cannot tolerate body temperature. So, testes are present outside the abdominal cavity in scrotum

Vasa Efferentia: The seminiferous tubules open into vasa Efferentia

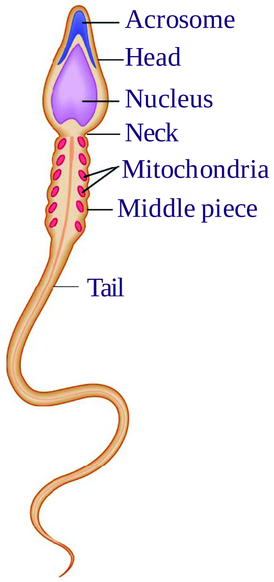
Epididymis: Vas efferentia open into epididymis which is highly coiled. Sperms are temporarily stored in them

Vasa deferentia: From each epididymis arises vas deferens which ascends into the abdominal cavity looping around the ureter.

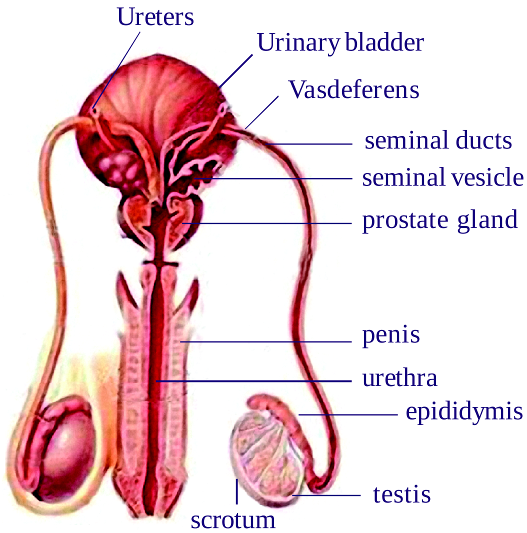
Seminal Vesicles: They open into the vas deferens. They produce seminal fluid. It is the source of energy for sperms when they are released outside the body.

Ejaculatory duct: A duct from seminal vesicles joins the vas deferens and continues as ejaculatory duct. Two ejaculatory ducts join the centre and open into urethra

Urethra: In males it sends both urine as well as sperms. So, it called as urinogenital tract. Male reproductive system has accessory glands such as cowper's and prostrate.



Sperm cell



Male reproductive system

The passage of sperms: Seminiferous tubules - vasa Efferentia - epididymis - vasa deferentia - ejaculatory duct - urethra

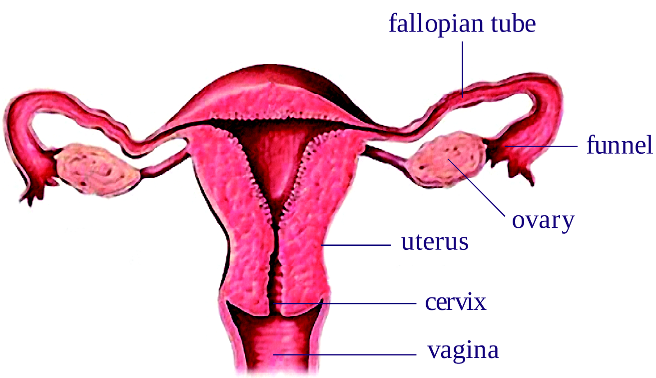
The sperm: The sperm has head, middle piece and tail. Head bears acrosome and nucleus. Acrosome helps in penetrating into ovum, mitochondria of middle piece produce energy for the movement of the sperm. The tail helps in movement.

Female reproductive system - parts:

Ovaries: Ovaries are the primary female reproductive organs which produces eggs (ovum). A pair of ovaries are present in the abdominal cavity. The eggs (ovum) develop in follicles, which at first look are like bubbles in the ovary. They are called "graffian follicles". Each follicle contains a single ovum which is formed after the process of meiosis. When an ovum matures, the follicle ruptures and ovum is flushed out.

Fallopian Tubes: A pair of fallopian tubes are present. Each tube extends from ovary. Fallopian tubes opens in to thick walled uterus. Fertilization occurs in fallopian tube.

Uterus: Uterus is a Muscular, inverted pear shaped structure. The inner layer of uterus is called endometrium. The thickness of these layers increases gradually soon after



Female reproductive system

menstruation. If fertilization does not occur, the endometrium disintegrates and flows out as menstrual fluid. If fertilization occurs the thickness of endometrium continues which provides nourishment to the developing.

Vagina: Vagina is widened, muscular tube. It opens outside through pore.

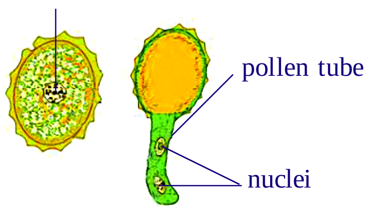
CHECK YOUR PROGRESS.

- What happens if petals are absent in flowers?
- What is the difference between unisexual and bisexual flowers. Give examples
- What are the male reproductive parts?

13.5 Facts about Reproduction

13.5.1 Facts about Reproduction in plants (Flower to seed)

You come to know that stamens and carpels are the male and female reproductive parts in the flower. Pollen grains are the male sex cells produced in the anther of stamens. Female sex cells are produced in the ovules present in the ovary of carpel. Pollen grains fertilize the female sex cells. For fertilization pollen grains must reach the female sex cells. Transfer of pollen grains from anther to stigma is called "pollination". Transfer of pollen grains from anther to stigma of the same flower is called "self pollination". When pollen grains of a flower are transferred to the stigma of a different flower on the same plant (or) different plant of the same species is called "Cross pollination". Pollen grains can be carried by air, water, insects, birds and animals to the stigma.

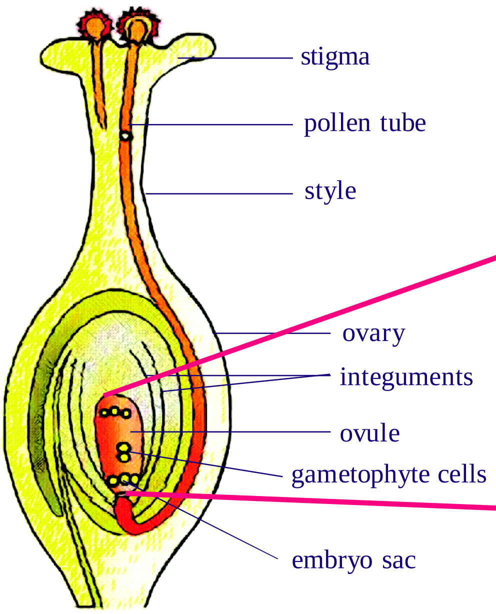


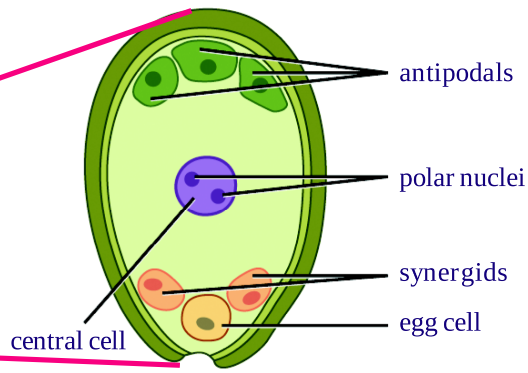
Pollen grain

Pollen grains after reaching stigma, germinates and forms pollen tube. Pollen tube reaches egg, fertilization takes place and zygote is formed. Pollen grains are microscopic male sex cells. Ovary is the lower part of the carpel. It has an ovule. Ovule is attached by a stalk to the inner side of the ovary. Depending upon the species of plant an ovary may have one, (or) several ovules. At center of ovule there is a Embryosac which has gametophyte cells. Embryosac consists of 7 cells. Three cells in top end are called antipodals. Three cells at micropylar end of which two are called synergids and central one is egg cell. One is large central cell contains two nuclei. It is secondary nuclei. You might have noticed that seeds germinate when they have favourable conditions. Then, what are the favourable conditions, do you think these conditions help the pollen grains to germinate upon reaching stigma?

Cells on the surface of the stigma secretes a sticky fluid which contains sugars. This will help the pollen grains to germinate and forms pollen tube. As soon as the tip of the pollen tube reaches the

Embryosac, the end of the tube ruptures and releases the two nuclei in to the Embryosac. One of the two nuclei fuses with the egg to form a zygote. It is called fertilization. Another nucleus fuses with the secondary nucleus which is present in the center of Embyosac and forms endosperm. In this way, fertilization that takes place two times is called “double fertilization”. The embryo consists of one or more cotyledons. Cotyledons develops by utilizing the food in endosperm. Ovule matures into seed. The ovary grows and ripens to form the fruit. Mean-while the other floral parts may shrivel and fall off. The seed produced after fertilization develops into seedling under favourable conditions. This process is called germination.





Female gametophyte

Fertilisation

13.5.2 Facts about reproduction in humans

Sperm, the male gamete, reaches fallopian tube through vagina. Ovum released from ovary enters fallopian tube through widened funnel. In this tube, sperm enters the ovum and fuses with nuclei of ovum. This fusion of sperm and ovum is called fertilization

k What happens if the sperm cell does not reach the egg?

In humans, fertilization takes place inside the body. This is called internal fertilization. If fertilization takes place outside the mother’s body it is called as external fertilization. External fertilization occurs in fishes and Amphibians (Example: Frog)

Some human beings may not have the ability to produce offspring.

k What methods do they follow to produce offsprings?

k What is "test tube baby?"

There may be several factors for infertility. Off spring can be produced through artificial insemination. If there are any complications in conception, they can go for advanced technique called, In vitro fertilization (IVF). In this procedure eggs are removed from mother and sperms are collected from father. Sperms are sent to the ovum in the test tube. Fertilization takes place resulting in an embryo. This type of fertilization is called "Invitro fertilization". If mother's egg and father's sperm are not healthy, they are collected from donors. Even though mother produces eggs but has difficulties in the development foetus then the fertilized eggs from the mother inserted into another woman's womb. This method is called "Surrogacy" and the woman is called "Surrogate mother" or Surrogate.

CHECK YOUR PROGRESS.

D What is Pollination?

D How does the endosperm form?

D What is fertilization?

13.6 Family planning

k Population increases if birth rate is not controlled. Do you know how it is controlled?

In our country, the government is conducting awareness programmes and also announcing incentives to reduce the birth rate. The prevention of pregnancy in women by preventing fertilization is called contraception. Any device (or) Chemical (drug) which prevents pregnancy in woman is called contraceptive.

Family Planning methods: Temporary methods:

Rhythm method: Calculating the optimal time for conception (ovum release time) and preventing fertilization

Condom: Physical devices such as condoms and diaphragm (cap) are used.

Contraceptive pills: Chemicals in the form of pills are taken either orally (or) inserted into female reproductive organ, vagina. It contain hormones which stop the ovaries from releasing ovum in to the oviducts.

Loop: The use of intra - uterine device called Copper-T, loop etc are very effective in preventing pregnancy.

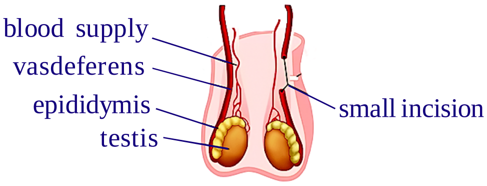
Copper-T

Permanent methods:

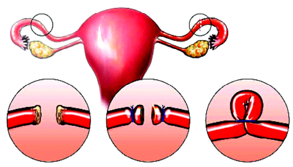
Surgical methods of birth control are available for males as well as females.

Vasectomy: In male a small portion of vas deferens is removed by surgical operation and both ends are tied properly. This prevents the release of sperms.

Tubectomy: In females, a small portion of oviducts is removed by surgical operation and the cut ends are tied. This prevents the ovum from entering into the oviduct.



vasectomy - cut ends of vas deferens are sealed



tubectomy - cut ends of follopian tubes are sealed

Birth control methods

Project: Write the family planning measures taken by the government of India and their implementation. Suggest few methods to improve.

CHECK YOUR PROGRESS.

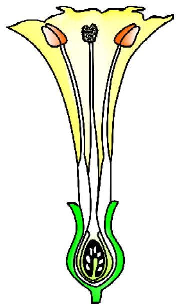
- What is 'Contraception'?
- Give examples of temporary contraception methods

KEY POINTS

- Growth, development and reproduction are necessary for the survival and continuity of the race.
- Increase in size of an organ (or) organism (or) cell and increase is number of cells is called growth.
- Growth is physical and quantitative, development is qualitative.
- Organs are formed in living organisms due to cellular differentiation.
- Single parent is involved in asexual reproduction, gametes are not formed. But, in sexual reproduction organisms of opposite sex are involved and gametes are formed.
- Flower is a reproductive part in plants. Stamens, carpels, petals, sepals are the parts in a flower.
- In human male reproductive system, testis, vas deferens, epididymis, vas efterens, seminal vesicles, ejaculatory duct, urethra, cowper's gland, prostrate gland are present
- Ovaries, fallopian tubes, uterus are present is human female reproductive system.
- There are temporary and permanent birth control methods, to control population growth

PRACTICE FOR LEARNING OUTCOMES

1. Write two advantages of vegetative propagation.
2. Why do organisms reproduce?
3. What are the artificial vegetative propagation methods that are followed to grow desirable plants in orchards? Why?
4. Explain permanent birth control methods:
5. What are the consequences if fertilization of ovum does not take place in fallopian tube?
6. Explain the process of reproduction is human beings.
7. Observe the diagram and sentences given below and identify the parts



   i) Part that produces pollen.

   ii) Part that receives pollen.

   iii) Part that contain ovules.

   iv) Part that holds the anther.

8. Vegetative propagation in Bryophyllum is through ( )

   A) Stem B) leaves C) roots D) flower

9. Why testis in males are located outside the body? ( )

   A) To produce sperms B) To release sperms

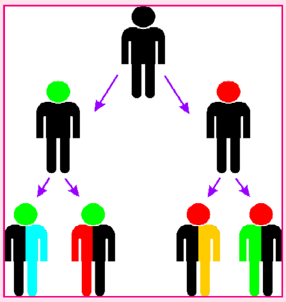
   C) Sperms to reach ova D) To provide favourable temperature for sperm

10. Match the following

A)	Hibiscus	( )	1.	Regeneration
B)	Cross pollination	( )	2.	Budding
C)	Stamen	( )	3.	Unisexual flower
D)	Planaria	( )	4.	Bisexual flower
E)	Yeast	( )	5.	Male reproductive part in a flower

CHAPTER

14 Evolution and Heredity



When we observe our world and its myriad forms of life, we are struck by two seemingly opposite observations, the fantastic variety of life and the similarity between them. As we shall see, we would need to understand these two characteristics of life in order to understand how life evolves. When we say evolution occurs, we not only mean that composition of population of species change, but also that there is come direction in that change. We will try to understand this in our chapter.

- Is it true that man evolved from monkeys?
- How does the composition of population change?
- Is evolution about change or producing something new and different?
- How are characters inherited?
- Are women responsible for producing female child?

In the chapter on reproduction we had studied that reproductive processes usually give rise to individuals that have some new characters in spite of the similarity that they share with their parents. Often such new characters give rise to observable changes in life forms.

Several theories about how populations of organisms changed from one form to the other. We shall discuss two such theories, one proposed by Lamarck and another by Darwin & Wallace.

LEARNING OUTCOMES

The learner...

- Observes the variations in different organisms.
- Explains the process of Evolution.
- Compares the important points of Lamarkism and Darwinism.
- Cites exapmles of evidences of evolution.
- Explains heredity.
- Appreciates Mendel's experiments on heredity.
- Differentiates between genotype, phenotype, dominant character and recessive character.
- Identifies the reason behind the sex of a baby.

14.1 Theories of Evolution

- How did the different forms of life come to be?
- How do new characters develop?
- Do such characters play a role in Evolution?

People who were trying to answer such questions proposed some ways to answer them. Here you get to read about those proposed by Lamarck, Darwin & Wallace.

14.1.1 Lamarkism

Jean Baptist Lamarck
(1774-1829)

According to Jean Baptist Lamarck, whenever the environment of certain organisms undergoes some changes, it forces the organisms to change accordingly. By use and dis use one could acquire a new character or lose it. Thus, organisms of today were formed from related organisms over time. It would be like saying.

Once deers are today's Girafee

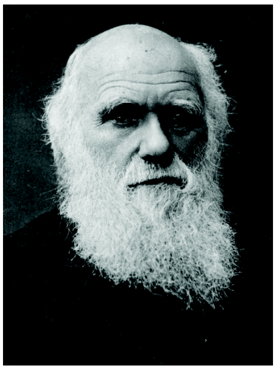
He thought that at some point of time in history the size of giraffe was equal to that of deer. Due to shortage of food material on the ground and to reach the upper branches of trees giraffes started stretching their necks. Because of continuous stretching of neck, after several generations developed long necks. Such characters that are developed during the lifetime of an organism are called 'acquired characters'. Lamark proposed that these acquired characters are passed on to its off springs i.e., to next generation and proposed the theory of **'Inheritance of acquired characters'.**

Giraffe

This theory was later on challenged by experiments done by Weismann. After is an account of it.

August Weismann, tested Lamark's theory by an experiment on rats. He removed tails of few parental rats. He observed that their off spring's are normal with tails. He has done it again and again for twenty generations but still off springs are normal with tails. He proved that the acquired characters are not inherited which were explained in Lamarkism.

14.1.2 Darwinism



Charles Darwin
(1809 - 1882)

Charles Robert Darwin, an English Naturalist went on voyage for 5 years on a world survey-ship of the British Government, H.M.S Beagle and explored the fauna and flora of a number of continents and islands. During his time, Darwin was much influenced by the publication of Alfred Russel Wallace and the paper titled **'On the tendency of varieties to depart from original types'.**

Darwin observed that each island in Galapagos had a different group of finches (birds similar to sparrows.) All the finches shared similar characters (with some variations) with the birds found on the mainland (Kinador in South America). Along with many other observations of this type, Darwin concluded that, species of organisms could change over time from one form to the other. With some variations organisms simply originated from pre-existing organisms. Darwin was aware of animal and plant breeding experiments that could produce new species of organisms. Breeding for selected characters was artificially done by man. This was artificial selection. A similar process was definitely, present in nature. Organisms tend to be selected over others and evolve into new forms. Variations in characters were always present in nature and most often naturally selected variations turned out to be advantageous. Darwin explained this concept in his book "The Origin of Species by Natural Selection". Alfred Russel Wallace also independently concluded that natural selection contributed to origin of new species.

CHECK YOUR PROGRESS.

- What are the salient features of Darwinism?
- How characters develop in organisms according to Lamark.

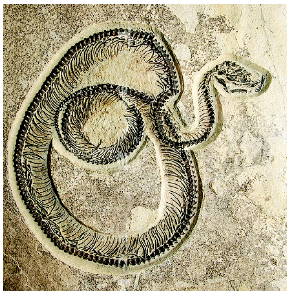
14.2 Evidences of Evolution

- Are there any evidences of proofs that evolution has occured?
- How scientists explained that new species have evolved during the course of evolution?

14.2.1 Evidences from Palaeontology

How do we come to know about organisms present on earth say about a million years ago?

Fossils are evidences of ancient life forms or ancient habitats which have been preserved by natural processes. Fossils are the remnants of plants or animals that were preserved in the layers of the earth and have been excavated from the soil.



Fossil

The study of fossils is called Palaeontology. Fossils can be actual remains of organisms that lived on earth long ago. Usually when organisms die, their bodies are decomposed and lost. Sometimes the body or some parts of the body do not decompose completely and get preserved in layer of soil. This gets compressed over time and transform into fossils. Geologists can determine the age of a fossil by using carbon dating method.

Dinosaur

A rare and magnificient fossil of the dinosaurs, ketosaurs belonging to the lower Jurassic age going back to about 160 million years were collected from Yamanapalli in Adilabad district of Telangana. This fossil is 14 metres long and 5 metres high. This fossil is preserved at BM Birla Science Centre in Hyderabad.

The biologists and palaeontologists have found the fossils of many transitional forms(connecting links) which link several major groups of vertebrates.

14.2.2 Evidences from embryology

k Observe the different developmental stages of organisms in the given image. Tadpole larva of frog resembles fish more than the frog. What does this indicates?

It indicated that amphibians(salamander/frog) have evolved from fishes.

Embryological evidences

There are remarkable similarities in the embryos of different animals from fish to man. The resemblance is so close that it is difficult to distinguish one embryo from the other at an early stage.

What does it indicates?

Archeopteryx has both avian and reptilian characters, hence it is considered as connecting link between these two groups.

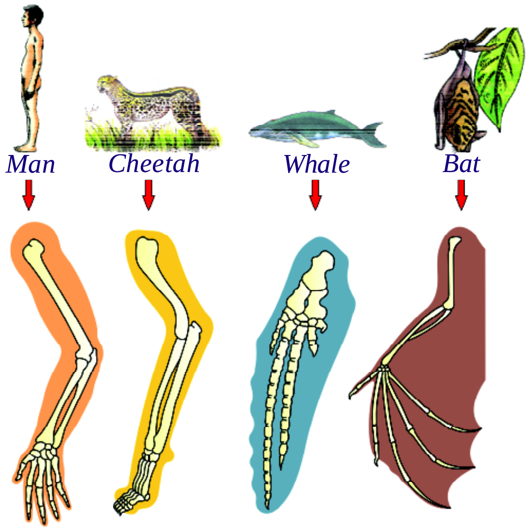
It indicates that the life history of every individual, exhibits the structural features of their ancestors. This strengthens the view of the existence of a common ancestor for closely related groups of organisms.

14.2.3 Homologous and Analogous organs

Man hand and cheetah paw are similar...!

Observe the given image carefully,

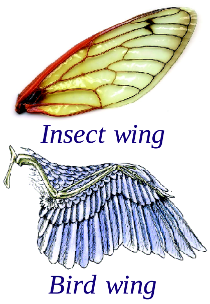
What do you understand after careful observation of forelimbs of Man, Cheetah, Whale and Bat?



Homologous organs

The internal structure of forelimb (flipper) of a whale (swimmer) wing of a bat (flyer), leg of a cheetah (runner) and hand of a man (grasping) The anatomy of all these animals show a common pattern in the arrangement of bones while their functions are different. Such organs are called homologous organs. It indicates that all these vertebrates have evolved from a common ancestor. This type of evolution is called divergent evolution.

Does the bat wing and insect wing have similar structure? Do they have similar function?



Analogous organs

When we observe carefully the bats are having a web of elastic fibers extending between the bones of fingers which help in stretching and contraction of wings this is called patagium. But the wings of insects neither have elastic fibres or bones. The designs of the two wings, their structure and components are different. These are structurally different but have the same function, flying. The organs which are structurally different but functionally similar are known as 'Analogous organs'. This type of evolution is called convergent evolution.

CHECK YOUR PROGRESS.

- What are fossils?
- What are the evidences of evolution?
- Give the examples of homologous organs.

14.3 Heredity: From Parents to Offsprings

The girl resembles her grandfather, the boy seems to be like his aunt, generally we hear such comments. These similarities are the result of inherited traits transmitted from parent to progeny. Transmission or passing of characters or traits from parent to offspring is called 'Heredity'. The process in which Traits are passed from one generation to another generation is called 'Inheritance'. Differences in characters within very closely related groups of organisms are referred to as variations. Often a new character in a group may lead to variations which also get inherited.

A detailed account of experimental evidence of heredity provided by Gregor Johann Mendel in the early 19th century. He was an Austrian Monk. He conducted a series of experiments on pea plants starting from the year 1856 in St. Thomas Church. He worked for over a decade after which he presented the conclusions from his experimental data in the form of a detailed research paper "On experiments with plant hybrids." As he was the first to do such experiments and propose laws of inheritance, Mendel is considered the 'Father of Genetics'. Genetics is the field of science in which we study the inheritance of characters and their causal elements, 'the genes'.

14.3.1 Experiments on pea plant

Mendel had chosen 7 pairs of contrasting characters for his study.

Sl.No.	Character	Description
1.	Colour of the flower	Purple or white
2.	Position of the flower	Either in axial or terminal in position. (If they are axial they are arranged in axial position throughout the length of the stem).
3.	Colour of the seed	The seeds are either yellow or green colour.
4.	Shape of the seed	The seeds are either round (smooth surface) or wrinkled.
5.	Shape of the pod	The completely developed pod is either smooth, full and constricted.
6.	Colour of the pod	All the ripe pods are yellow in colour. Unripe parts are either yellow or green in colour.
7.	Length of the stem	When the plants are grown in the same environment some stems are tall (6 to 7 feet) and some stems are dwarf (3/4 feet to 1½ feet).

Mendel has chosen pea plant for his experiments because it has the following advantages.

1. Well defined characters
2. Bisexual flowers
3. Predominantly self pollinating,
4. Suitable for cross pollination
5. It is an annual plant.

14.3.2 Monohybrid Cross

Cross pollinating a pure breed of yellow and green seeds gave all yellow coloured seeds. The first generation of cross was called first filial

Mendel called it progeny of first generation parents.

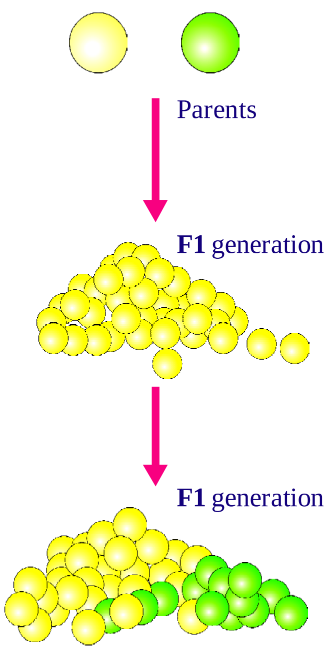
These pea plants on self pollination gave second generation or Filial 2 (F_2) generation.

k What might be the seed colour of F_2 generation?

F_2 generation had about 75% yellow (seeds) peas and about 25% green (seeds) peas.

According to such an observation it may be said that every pea plant has two 'factors' which are responsible for producing a particular character or trait. The determining agent responsible for each trait is called a factor. These factors are now called genes.

Monohybrid Cross

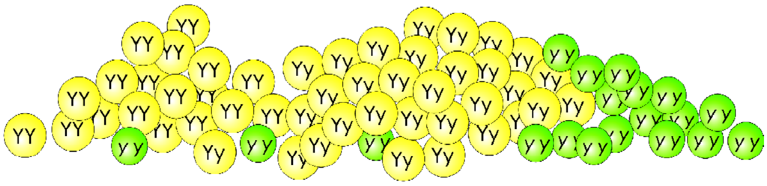


Mendel's experiments showed us that factors were present in pairs. So for the yellow seed we may assume the factors to be YY. Capital letter is taken to show that this is the seed colour in the first generation of cross between yellow and green variety. We would represent green by 'yy'.

During reproduction one 'factor' from each parent is observed to form a new pair in the progeny. One of these will always dominate the other if mixed together. In a cross of pure breeds, The trait expressed in F_1 generation is called dominant. While the other which is not expressed in F_1 is called recessive. The breed after cross pollination will have one factor from pure breed yellow (Y) and one from the pure breed green (y). That is, all the peas will have the paired factor 'Yy' and the seeds of these will be yellow in colour.

Self pollination in F_1-Generation:

On self pollinating these peas (ones with Yy factor), how the new breed have Combinations of ‘Y’ and ‘y’?



♀ \ ♂	Y	y
Y	**YY**	**Yy**
y	**yY**	**yy**

So in this heap we will get approximately equal numbers of YY, Yy, and yy peas. But any pea that has a Y factor will be yellow. Any pea that has both yy will be green.

1. YY will be approximately 25% and is yellow.
2. yy will be approximately 25% and is green.
3. yY will be approximately 25% and is yellow
4. Yy will be approximately 25 % and is yellow

Phenotype: In F_1 generation all seeds are yellow in colour. After cross pollination in F_2 generation we can clearly observe that 75 percent are yellow seed producing pea plants and 25 percent are green ones. This is known as ‘Phenotype’ (externally visible characters) and this ratio is called 'phenotypic ratio' or monohybrid phenotype ratio. It is 3:1.

Genotype: In 75 percent yellow seed producing pea plants of F_2 generation only 25 percent pea plants produce yellow seeds that are pure breeds (YY) and are ‘homozygous’ that is to have the same factors for representing a character. Remaining 50 percent yellow seed producing pea plants are (Yy) heterozygous . The remaining 25 percent green seed producing pea plants are pure (yy) homozygous type. Monohybrid genotype ratio is 1:2:1.

14.3.3 Mendel's Laws

After crossing of yellow and green seeds, all seeds produced in F_1 generation are yellow seeds only. Why this happened Mendel propounded that, among a pair of closely related factors for a character, only one is expressed itself in the first generation as one of them is dominant over the other. This is so evident that it came to be called Mendels’ **Law of Dominance.**

Each one of these factors is received from each parent. When this generation forms gametes, these factors separate and each one enters into a separate gamete randomly. This separation of factors at the time of formation of gametes is called the **law of Segregation.**

Mendel also explained the process of inheritance of more than one characters. For this, he proposed **law of Independent Assortment.**

14.4 Parents to Progeny

Where are factors present?

We had studied that factors are present in gametes or the sex cells of an organism. We know the cells have a nucleus and there are thread like structures called chromosomes present in them. We say that factors or genes are precent on then.

Let us take an example to understand this. If a book case is a mucleus, then the different books may represent chromosomes and the pages of the books 'factors'.

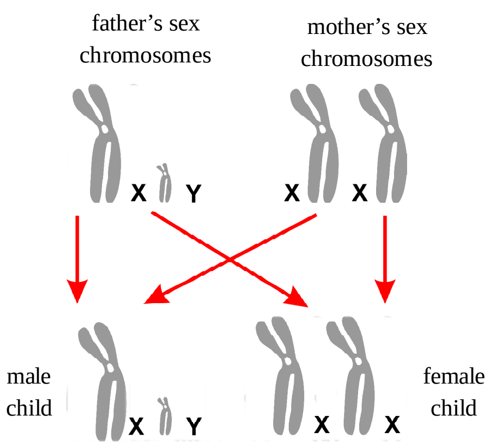
14.4.1 Human Chromosomes

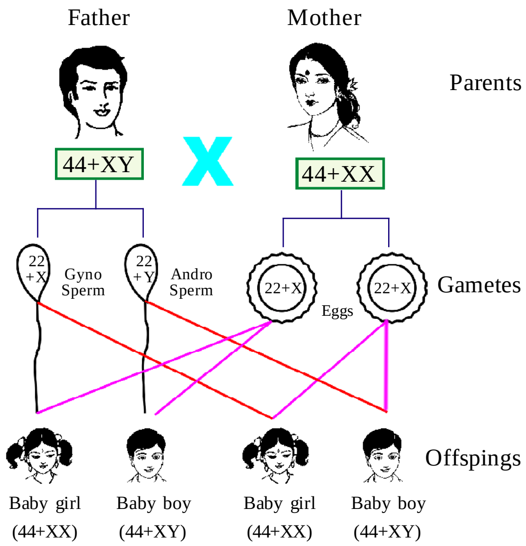
Every human cell contains 46 chromosomes. These chromosomes are present in the Mucleus. They are present in pairs. Thus we have 23 pairs of chromosomes.

Out of the 23 pairs of chromosomes, 22 pairs are termed autosomes. The 23rd pair, X and Y which determine the sex of an organism hence in are called sex chromosomes.

14.4.2 Sex determination in Human

Let us know who is responsible for the sex of a baby. The foetus develops from the zygote which is formed by the fusion of the two gametes, the male gamete or sperm and the female gamete or egg. Ova or eggs are of the same kind only. These contain 22 autosomes and a single X chromosome. Sperms are of two kinds (i) having 22 autosomes and one X chromosome, or (ii) having 22 autosomes and a Y chromosome. When X bearing sperm fuses with the egg, a female child results with 44 autosomes





and two X chromosomes. If Y bearing sperm fuses with the egg then a male child results with a chromosomal constitution of 44 autosomes and one X and one Y chromosome.

So the sex of an individual is purely due to chance and neither the mother nor the father can be blamed.

14.4.3 Hereditary Genetical Disorders

Chromosomes (also genes) pass from one generation to the next with some changes. The changes may affect the organism. Some such changes leading to disorders are discussed here.

- **Thallassemia:** Patients suffering from this disorders are unable to manufacture haemoglobin. This is because the pair of genes controlling haemoglobin production are defective. Thallasemics person suffering from Thallasemia require frequent blood transfusion in order to survive.
- **Haemophilia:** Those persons suffering from haemophilia have either a defective gene or lack genes,which control production of substance responsible for blood clotting. In the absence of such substance blood does not coagulate. Once bleeding starts, it does not stop easily.
- **Color Blindness:** The most common form of the disorder, a person is unable to distinguish the blue colour from the green. Again this is due to the presence of a defective gene or absence of the gene, responsible for the colour vision.

Thalassemia is an autosomal disorder. Haemophilia and Colour blindness are allosomal disorders or X linked disorders. In human beings pattern baldness is inherited from father to male child through Y chromosome, and even female child is inherited baldness which is a sex influenced character.

14.4.4 Sex chromosomal disorders

1. **Klinefelter's syndrome:** This genetic disorder is caused by trisomy 23rd pair in the chromosome. A klinefelter male possesses an additional X-Chromosome. The karyotype is 47 (44+XXY). They exhibit female secondary sexual characters. The principal effects include hypogonadism, and reduced fertility. Slight enlargement of breasts (gynecomastia) is common.
2. **Turner's syndrome:** They are underdeveloped females. The karyotype is 45, (44+X). It is due to the monosomy of 23rd pair. The symptoms are short stature, webbed neck, and broad shield like chest with widely spaced nipples and gonadal dysgenesis

CHECK YOUR PROGRESS.

D On which chromosomes the genes responsible for Haemophilia and Colourblindness present?

D Explain Sex determination in human beings.

D What is the number of autosomes and allososmes in human beings.

KEY POINTS

- Evolution is a continuous process of development of more complex organization from simple level.
- Jean Baptist Lamark was the first person to propose the theory of Evolution. Lamark explained the inheritance of acquired characters with examples.
- Charles Darwin proposed Natural selection theory. He observed a small group of related birds which are exhibiting diversity in the break structure in Galapagos islands.
- Organs which are similar in structure but dis similar in functions are called Homologous organs. And the organs which are dis similar in structure and similar in functions are called Analogous organs.
- The changes that occur among closely related group of organisms are called variations.
- Mendel was considered the father of Genetics. He did experiments in pea plant based on the 7 pairs of contrasting characters.
- Externally visible character is called phenotype and genetic makeup of a character is called genotype.
- Mendel proposed Law of Dominance, Law of segregation and Law of Independent assortment.
- Every cell of human being contains 46 chromosomes. Out of 46 (23 pairs), 22 pairs are termed autosomes. The 23rd pair, X and Y chromosomes are called Sex chromosomes.
- In human beings Thallassemia, Haemophilia and colourblindness are hereditary genetical disorders and klinefelters syndrome and Turners syndrome are sex chromosomal disorders.

PRACTICE FOR LEARNING OUTCOMES

1. What are the evidences that prove Darwinism.
2. Mention the names of two theories that explain evolution.
3. What is Palaeontology? Give two examples of fossils.
4. Write the differences between homologous and analogous orgnas.
5. How can you prove that father is responsible for the sex of a girl baby.
6. Write any two hereditary disorders, their symptoms and treatment.
7. Phenotypic and genotypic ratios of Monohybrid cross. ( )

   a) 1:2:1; 3;1 b) 3:1, 1:2:1 c) 23; 1:2:1 d) 3:1; 23

8. Scientist who explained the Inheritance of acquired characters. (   )

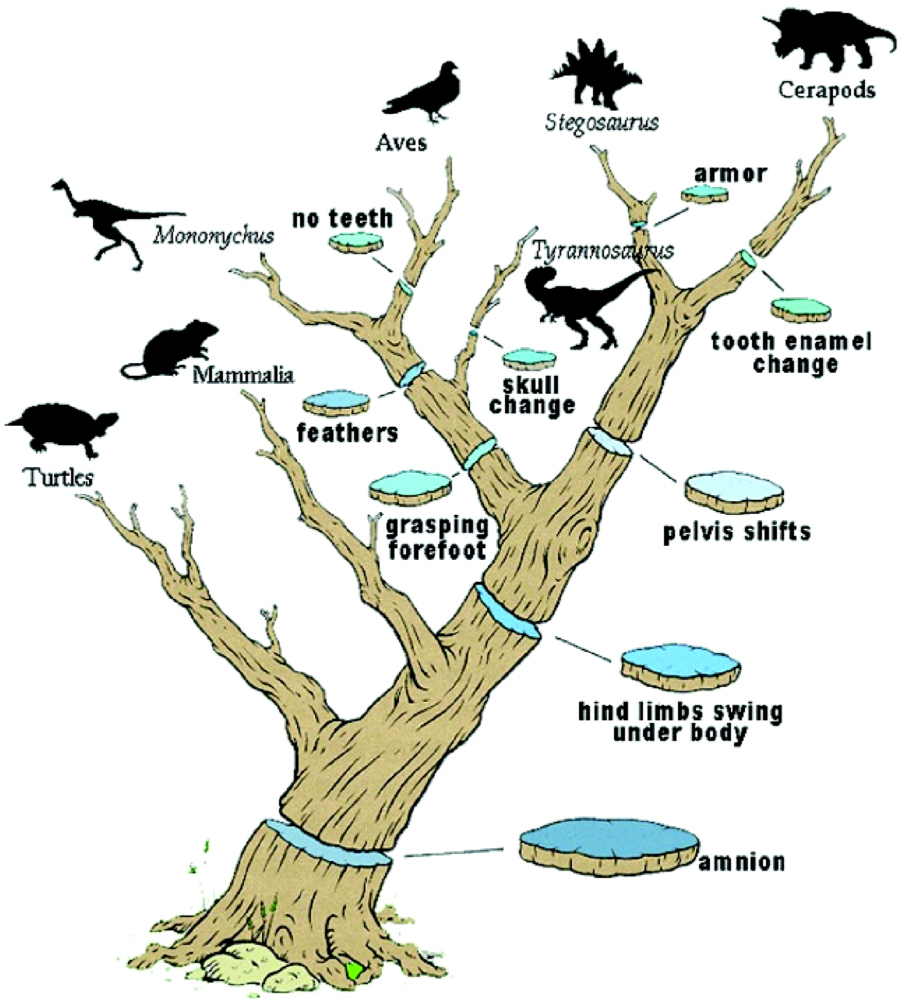
A) Darwin   B) Lamark   C) Sutton   D) Haeckel

9. Number of characters Mendel chosen for his experiments in peaplants. (   )

a) 10   b) 8   c) 7   d) 4

10. Match the following

A)	Number of chromosomes in Human beings	( )	1.	One pair
B)	XY choromosomes	( )	2.	22 pairs
C)	Number of autosomes	( )	3.	23 pairs
D)	Number of sexchromosomes	( )	4.	Sex chromosomes



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