Approved by Government of Nepal, Ministry of Education, Curriculum Development Centre, Sanothimi, Bhaktapur as an additional learning material

Green Science and Environment 8

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Preface

It gives me an immense pleasure in presenting this book- Green Science and Environment for class 8. This book is written specially to meet the requirements of the new syllabus introduced by the Government of Nepal, Ministry of Education, Curriculum Development Centre, Sanothimi, Bhaktapur, Nepal.

My aim and effort while writing this book has been to help students understand, enjoy and appreciate the fascinating subject of Science and Environment by making the process of learning enjoyable and stimulating. I have attempted to present the subject matter covering the entire prescribed syllabus in a simple language and interesting style with a large number of illustrative examples for easy understanding and application of the fundamental principles of science. Each unit of the book has been carefully planned to make it student-friendly and present the subject matter in an interesting, understandable and enjoyable manner. A **Structural Programme Learning Approach** (SPLA) has been followed and exhaustive exercises are given at the end of each unit to test knowledge, understanding and applications of concepts taught/learnt.

The text is supplemented with weighting distribution, learning objectives, word power, teaching instructions, sample test papers and a large number of well-labelled accurate pictures. I sincerely hope that this book will serve its intended purpose and be received enthusiastically by both the students and teachers concerned.

I wish to express my sincere gratitude to Green Books Team for publishing this book. My hearty thank goes to Focus Computer for excellent type setting and layout.

I also wish to acknowledge my great indebtedness to many teachers for their valuable suggestions and advice concerning the textbook. I am confident that as result of their suggestions this book will be more useful than any other textbooks. However, sympathetic criticisms and constructive suggestions for further improvement of the book, if any, will be welcomed and with warm regards incorporated in the subsequent editions.

Author
Kathmandu, Nepal
September 2016

Contents

Physics

UNIT 1

Measurement

Weighting Distribution (Approximate)	Teaching periods : 3	Marks (in %): 1

Before You Begin

Physics is a science of measurement. The word 'Science' comes from the Latin word '*Scientia*' which means to 'know'. The knowledge which man has gained through observations and experiments, when organized systematically is called science. In physics, we deal with a large number of physical quantities like length, mass, time, volume, pressure, velocity, force, etc. These quantities can give clear understanding only if we can measure them and express our conclusions into these measurements. Therefore, physics is also called the science of measurement. The comparison of an unknown physical quantity with a known standard quantity of the same kind is called measurement.

Learning Objectives

After completing the study of this unit, students will be able to:

i. define measurement and state its importance.

ii. introduce fundamental and derived units with examples.

iii. identify the measurement of mass, weight and time.

iv. solve simple numerical problems.

Syllabus

i. define measurement and state its importance.

ii. introduce fundamental and derived units with examples.

iii. identify the measurement of mass, weight and time.

iv. solve simple numerical problems.

Glossary: A dictionary of scientific/technical terms

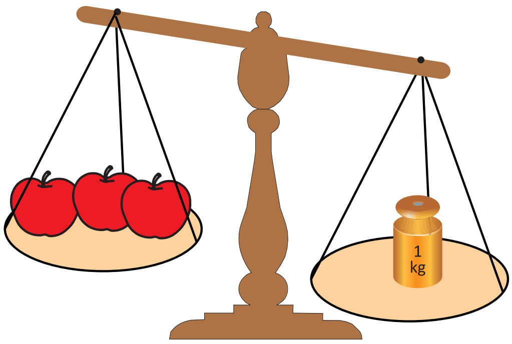
measurement	:	the comparison of an unknown physical quantity with a known standard quantity of the same kind
fundamental	:	basic, forming the source or base from which everything else is made
derived	:	something obtained from something else
mass	:	the total quantity of matter present in a body
weight	:	the force with which a body is pulled towards the surface of the earth
time	:	the duration between any two events

Measurement

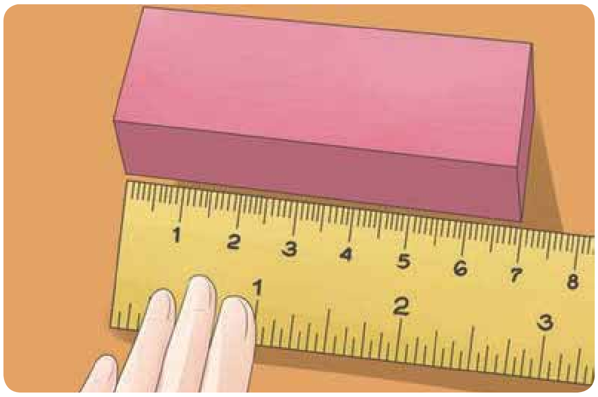
Measurement and Its Importance

We measure various quantities like length, mass, volume, time, temperature, speed, etc. in our day to day life. We measure things while buying and selling goods. We measure various quantities to do experiments in a science laboratory. To measure a physical quantity, we compare that physical quantity with a known standard quantity of the same kind. So, measurement is the comparison of an unknown physical quantity with a known standard quantity of the same kind. Different tools or instruments are used to measure different physical quantities. A beam balance is used to measure the mass of a body. A spring balance is used to measure the weight of a body. A watch is used to measure time and a metre rod or scale is used to measure the length of a body.

Fig. 1.1



Measuring mass



Measuring length

The importance of measurement in our daily life is given below:

1. Measurement makes buying and selling goods easier.
2. It helps to get the accurate amount of physical quantities.
3. It is important to perform experiments in a science laboratory.
4. It is important in laboratories for getting proper amount of medicines.
5. It is important in construction of roads, buildings, bridges, etc.

Physical quantities

The quantities like length, mass, time, area, volume, temperature, etc. can be measured. These quantities are known as physical quantities. Thus, those quantities which can be measured are called physical quantities. Some other examples of physical quantities are force, speed, pressure, acceleration, energy, power, electric current, etc. We cannot measure love, feeling, kindness, anger, beauty, desire, experience, happiness, etc. So they are not called physical quantities.

There are two types of physical quantities. They are:

1. Fundamental physical quantities
2. Derived physical quantities

1. Fundamental physical quantities

Those physical quantities which are independent of other physical quantities are called fundamental physical quantities. There are seven fundamental quantities in the SI system. They are length, mass, time, temperature, electric current, amount of substance and luminous intensity. Fundamental physical quantities are also called basic physical quantities.

Do You Know

A physical quantity is represented by a number followed by a unit. The number with a unit is known as the magnitude/size of the physical quantity. The number alone is meaningless. For example, 25 is a mathematical pure number but 25 kilogram is a physical quantity. Therefore, the unit must always be written while writing a physical quantity.

2. Derived physical quantities

Those physical quantities which are obtained by multiplying or dividing one fundamental physical quantity with another are called derived physical quantities. Area, volume, speed, velocity, acceleration, density, pressure, work, energy and power are some examples of derived physical quantities. These physical quantities depend on one or more fundamental physical quantities.

Do You Know

Velocity is called a derived physical quantity. Velocity is the distance travelled per unit time. So, velocity is obtained by dividing one basic physical quantity, i.e. length with another basic physical quantity, i.e. time. Therefore, velocity is called a derived unit.

Unit and Its Types

A unit is a standard quantity which is used to compare an unknown physical quantity. Similar physical quantities are measured in terms of units. Metre (m), kilogram (k), second (s), newton (N) and pascal (Pa) are some examples of units.

Units are of two types, viz. fundamental units and derived units.

1. Fundamental units

The units of fundamental physical quantities like metre (m), kilogram (kg), second (s), etc. are called fundamental or basic units. These units are independent of each other. So the units which are independent of each other are called fundamental or basic units.

There are seven fundamental units in the SI system which are as follows:

Fundamental units	Fundamental quantities	Symbols
1. metre	Length	m
2. kilogran	Mass	kg
3. second	Time	s
4. kelvin	Temperature	K
5. ampere	Electric current	A
6. candela	Luminous intensity	cd
7. mole	Amount of substance	mol

2. Derived units

The units of derived physical quantities like square metre (m^2), metre/second (m/s), newton (N), pascal (Pa), watt (W), etc. are formed by the combination of one or more physical quantities. These units are called derived units. So, the units which are formed by multiplying or dividing one or more fundamental units are called derived units. Derived units can be expressed in terms of fundamental units. In the SI system, there are so many derived units. Some of them are given below:

Physical quantities	Expression/ Formula	SI units	Symbol	Basic units involved
1. Area	length × breadth	metre × metre	m^2	m × m
2. Volume	length × breadth × height	metre × metre × metre	m^3	m × m × m
3. Speed/ velocity	distance/time	metre/second	m/s	m/s or ms^{-1}
4. Acceleration	change in velocity/time	metre/second^2	m/s^2	m/s^2 or ms^{-2}
5. Force	mass × acceleration	$\frac{\text{kilogram × metre}}{(\text{second})^2}$	kg × m/s^2	$kgms^{-2}$
6. Density	mass/volume	kilogram/(metre)^3	kg/m^3	kgm^{-3}
7. Work/ energy	force × displacement	newton×metre	J or Nm	$\frac{kg \times m \times m}{s \times s}$
8. Power	$\frac{\text{work done}}{\text{time}}$	watt or joule/second	W or J/s	$\frac{kg \times m \times m}{(s \times s \times s)}$
9. Pressure	force/area	pascal or newton/ (metre)^2	Pa or N/m^2	$\frac{kg}{(m \times s \times s)}$

Differences between Fundamental physical quantities and Derived physical quantities

Fundamental physical quantities	Derived physical quantities
1. Those physical quantities which are independent of each other are called fundamental physical quantities.	1. Those physical quantities which are derived from the fundamental physical quantities are called derived physical quantities.
2. In SI system, there are seven fundamental physical quantities.	2. The number of derived physical quantities is not fixed.

Differences between fundamental (basic) units and derived units

Fundamental/basic units	Derived units
1. The units which are independent of one another are called fundamental or basic units.	1. The units which are formed by multiplying or dividing one or more fundamental units are called derived units.
2. They are the units of fundamental physical quantities.	2. They are the units of derived physical quantities.

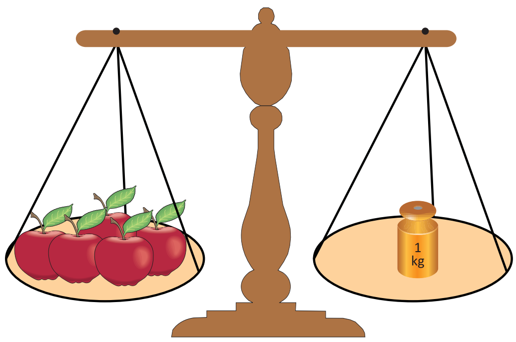
Mass and Its Measurement

The total quantity of matter present in a body is called the mass of the body. The mass of a body depends on the number of atoms and the mass of each atom of that body. The SI unit of mass (m) is kilogram (kg). Mass is also measured in gram (g), milligram (mg), etc. The mass of a body does not change from place to place. So it is called a constant quantity. The mass of a body is measured by a beam balance or physical balance.

The object whose mass is to be measured is placed in the left-hand pan and the weights or standard masses are added to the right hand pan until the beam attains equilibrium. In this position, the total mass of 'weights' on the right hand pan gives the mass of the object.

Fig. 1.2

Measuring masses



Measuring the mass of apples

One standard kilogram

One standard kilogram is defined as the mass of a platinum-iridium cylinder kept at 0°C at the International Bureau of Weights and Measures, Severs near Paris in France. All other measuring masses throughout the world are compared to the standard kilogram kept in the International Bureau of Weights and Measures.

The mass of light objects is measured in milligram (mg), gram (g) and kilogram (kg). Similarly, the mass of heavy objects is measured in quintal, metric ton, etc. The sub-multiples and multiples of a kilogram are as follows:

SI unit	Sub-multiples	Multiples
1 kilogram (kg)	1 milligram (mg) = $\frac{1}{1000000}$ kg	1 quintal = 100 kg
	1 gram (g) = $\frac{1}{1000}$ kg	1 ton = 1000 kg

Worked out Numerical: 1

Convert 25 kilogram into gram.

Solution:

25 kg

= 25 × 1000 g [∵ 1kg = 1000 g]

= 25000 g

Worked out Numerical: 2

Convert 7000 gram into kilogram.

Solution:

7000 g

= $\frac{7000}{1000}$ kg [∵ 1kg = 1000 g]

= 7 kg

Worked out Numerical: 3

Convert 60 kilogram into milligram.

Solution:

60 kg

= 60 × 1000 g [∵ 1kg = 1000 g]

= 60 ×1000 × 1000 mg [∵ 1g = 1000 mg]

= 60000000 mg

Weight and Its Measurement

The earth pulls every object towards its centre with a force. This force is called gravity. Fruits of a tree fall down due to the gravity of the earth. So, gravity is the force with which a body is pulled towards the centre of the earth. The weight of a body is the gravity acting on the body. The direction of weight is towards the centre of the earth/planet. Weight is a variable quantity. It depends on the mass of a body (m) and the value of acceleration due to gravity (g) at a place. The weight of a body is measured by a spring balance. The SI unit of weight is newton (N).

Fig. 1.3

Spring balance

Do You Know ?

The weight of body differs from place to place because weight depends on the value of acceleration due to gravity (g) and the value of acceleration due to gravity (g) changes from place to place on the earth's surface.
[$\because W = m \times g$]

Worked out Numerical: 4

The mass of a box is 25 kg. Calculate its weight [Given, g = 9.8 m/s^2].

Solution:

Mass of a box (m) = 25 kg

Acceleration due to gravity (g) = 9.8 m/s^2

Weight of the box (W) = ?

We know,

$W = m \times g$

$= 25 \times 9.8$ N

$= 245$ N

$\therefore$ The weight of the box is 245 N.

Worked out Numerical: 5

The weight of a body is 550 N and value of acceleration due to gravity is 9.8 m/s^2. Calculate the mass of the body.

Solution:

Weight of a body (W) = 550 N

Acceleration due to gravity (g) = 9.8 m/s^2

Mass of a body (m) = ?

According to the formula,

We know,

$$W = m \times g$$

or, $550 = m \times 9.8$

or, $m = \frac{550}{9.8}$

$= 56.12$ kg

Activity 1

- Take a beam balance and some standard weights of milligram, gram and kilogram.
- Now, measure the mass of your school bag, science book, pen, calculator, pencil, eraser, etc. by using a beam balance.
- Take a spring balance and measure the weight of these objects.

Differences between Mass and Weight

Mass	Weight
1. The mass of a body is the total amount of matter contained by the body.	1. The weight of a body is the measure of gravity acting on the body.
2. A beam balance is used to measure the mass of a body.	2. A spring balance is used to measure the weight of a body.
3. It is a constant quantity.	3. It is a variable quantity.

Time and Its Measurement

Time is defined as the duration between any two events. The SI unit of time is second (s). It is determined on the basis of time taken by the earth to rotate in its own axis. A watch or clock is used to measure time.

Fig. 1.4

Quartz watch

Mechanical watch

Digital watch

One mean solar day is defined as the time taken by the earth to complete one rotation around the sun about its axis. This time duration is divided into 24 intervals. One interval out of 24 intervals of a mean solar day is called one hour. The duration of one hour is divided into 60 equal intervals, one interval of which is called one minute. One minute time is divided into 60 equal intervals, one interval of which is called one second.

One second is defined as $\frac{1}{86400}$ th parts of a mean solar day.

Conversion of one day into seconds

One day = 1 × 24 hours
= 1 × 24 × 60 minutes
= 1 × 24 × 60 × 60 seconds
= 86400 seconds
∴ One day = 86400 seconds

Worked out Numerical: 6

Convert 86400 seconds into days.

Solution:

86400 seconds

$= \frac{86400}{60}$ min [∵ 1 m = 60 sec]

$= \frac{86400}{60 \times 60}$ [∵ 1 hour = 60 mins]

$= \frac{86400}{60 \times 60 \times 24}$ day[∵ 1 day = 24 hours]

= 1 day.

Worked out Numerical: 7

Convert 1 year into seconds.

Solution:

1 year

= 1 × 365 days [∵ 1 year = 365 days]

= 1 × 365 × 24 hours [∵ 1 day = 24 hours]

= 1 × 365 × 24 × 60 minutes [∵ 1 hour = 60 mins]

= 1 × 365 × 40 × 60 × 60 seconds [∵ 1 m = 60 sec]

= 31536000 seconds

A variety of clocks like mechanical clock (pendulum clock), quartz clock and atomic clock are used to measure time.

A mechanical clock or pendulum clock works on the basis of the oscillation of a simple pendulum. This type of clock cannot measure time accurately. A quartz clock works due to vibration of quartz crystal. It is more accurate than a mechanical clock. Similarly, an atomic clock works due to emission of radiation by Cs-133 isotopes. It measures time most accurately.

Activity 2

- Listen to the 'Radio Nepal or Nepal Television' and adjust the time in your clock according the Radio Nepal or Nepal Television. Observe the difference in time in your clock and that in the Radio Nepal after one month. What can you conclude from this activity?

Key Concepts

1. Measurement is the comparison of an unknown physical quantity with a known standard quantity of the same kind.
2. Those quantities which can be measured are called physical quantities.
3. Fundamental physical quantities are also called basic physical quantities.
4. The units which are independent of each other are called fundamental or basic units.
5. The total quantity of matter contained by a body is called the mass of the body.
6. One standard kilogram is defined as the mass of a platinum-iridium cylinder kept at 0°C at the International Bureau of Weights and Measures, Severs near Paris in France.
7. Time is defined as the duration between any two events. The SI unit of time is second.
8. One mean solar day is defined as the time taken by the earth to complete one rotation around the sun about its axis.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Measurement is very important in our daily life. ☐

b. Physical quantities cannot be measured. ☐

c. Metre and kilogram are derived units. ☐

d. Mass is a constant quantity. ☐

2. Fill in the blanks using appropriate words.

a. .... is the comparison of an unknown physical quantity with a known standard quantity of the same kind.

b. Derived quantities depend on .... physical quantities.

c. Mass is measured by using ....

d. An .... watch gives the most accurate time.

3. Tick (√) the most appropriate answer from the given alternatives.

a. Which of the following is a fundamental quantity?

☐ area ☐ mass ☐ force ☐ speed

b. Which of the following is a derived unit?

☐ pascal ☐ metre ☐ kilogram ☐ kelvin

c. Which physical quantity is measured by a spring balance?

☐ mass ☐ weight ☐ volume ☐ time

d. What is the SI unit of weight?

☐ newton ☐ kilogram ☐ metre ☐ pascal

4. Answer the following questions.

a. What is measurement? Write down the importance of measurement.

b. What are physical quantities? Give any two examples.

c. Name the two types of physical quantities.

d. What are fundamental physical quantities? Give any three examples.

e. Define derived units with any five examples.

f. What is mass? Write down its SI unit.

g. How is the mass of a body measured? Write in brief.

h. What is one standard kilogram?

i. What is weight? Write its SI unit.

j. What is time? Write its SI unit.

k. What is one solar day? Define one second time.

5. Given reason.

a. Mass and length are called fundamental physical quantities.
b. Density is called a derived physical quantity.
c. Kilogram and second are called fundamental units.
d. The unit of velocity is called a derived unit.
e. Measurement is very important in our daily life.

6. Find out the basic units involved in the units of:

a. velocity
b. acceleration
c. force
d. density
e. power
f. pressure
g. work

7. Differentiate between:

a. Fundamental units and derived units
b. Mass and weight
c. Mechanical clock and atomic clock

Numerical Problems

1. The mass of a body is 60 kg and the value of acceleration due to gravity is 9.8 m/s^2. Calculate the weight of the body. (Ans: 588 N)
2. The weight of a body is 1176 N and the value of acceleration due to gravity is 9.8 m/s^2. Calculate the mass of the body. (Ans: 120kg)
3. Convert one solar day into seconds. (Ans: 86400 s)
4. Convert 25000 gram into kilogram. (Ans: 25 kg)
5. Convert 123000000 milligram into kilogram. (Ans: 123 kg)
6. Convert the following:
   a. 8.5 hour into seconds [Ans: 30,600 s]
   b. 3.7 kilogram into gram [Ans: 37000 g]

UNIT 2

Velocity and Acceleration

Weighting Distribution (Approximate)	Teaching periods : 4	Marks (in %): 1

Before You Begin

We see many things around us. All these things do not appear to move. The things that do not move from one place to another are called things at rest. The things that change their position with respect to other objects in their surroundings are called the things in motion. A book kept on a table is an example of a body at rest and a flying bird is an example of a body in motion. In this unit, we will study rest and motion, speed and velocity, acceleration and retardation and equations of motion based on velocity and acceleration.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce average velocity and relative velocity and explain them.
ii. introduce acceleration and retardation.
iii. write and apply equations related to velocity and acceleration.
iv. solve numerical problems related to velocity and acceleration.

Syllabus

- Average velocity and relative velocity
- Acceleration and retardation
- Equations of motion based on velocity and acceleration
- Simple numerical problems based on velocity and acceleration

Glossary: A dictionary of scientific/technical terms

velocity	:	the rate of change in displacement of a moving body
acceleration	:	the rate of increase in the velocity of a moving body
motion	:	if the position of a body changes with respect to other objects in its surroundings
reference	:	a standard by which something can be compared
displacement	:	the distance travelled by a moving body in a certain direction
retardation	:	the rate of decrease in velocity of a moving body

Velocity and Acceleration

Concept of Rest and Motion

If we look around in the classroom, we see a variety of things. All these things do not move, they are said to be at rest. A body is said to be at rest, if it does not change its position with respect to a fixed point taken as reference point in its surroundings. A book lying on a table, walls of a house, blackboard and desk are some examples of body at rest.

Do You Know

A reference point is a body at rest with respect to which the state of another body is compared. Reference point may be a certain point, object or place about which the state, i.e. rest or motion, of a body is studied.

Human beings, animals, birds, insects, etc. move from one place to another. A man running on a road, a bus plying on a road, a bird flying in the sky, etc. keep on changing their position continuously. These are some examples of things in motion. A body is said to be in motion, if it changes its position with respect to a fixed point taken as reference point in its surroundings. However, rest and motion are relative terms.


Fig. 2.1
Book at rest


Bird in motion

Rest and motion are relative terms

Let us consider that we are sitting in a moving train. We are in motion with respect to the trees or buildings outside the train because our position is changing with respect to them. However, if we compare our position with respect to the things inside the train, i.e. other passengers, seats, fan of the train, walls and roof of the train, etc. They are at rest. Thus, an


Fig. 2.2
Moving train

object can be at rest in relation to one object while it can be in motion in relation to another object at the same instant of time. Therefore, we can say that rest and motion are relative terms.

Uniform motion and Non-uniform motion

When a moving body covers an equal distance in an equal interval of time, it is called a uniform motion. In the given figure, a motorcycle covers 25 m in every one second. So, the motion of the motor cycle is called uniform motion.

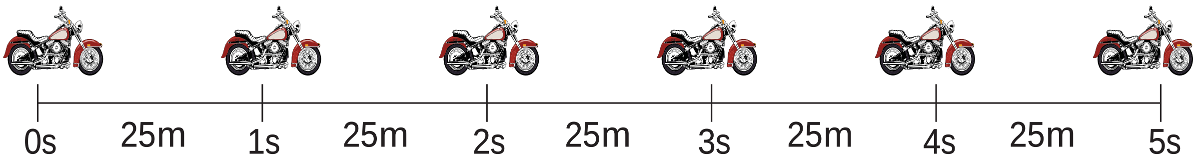


Fig. 2.3

When a moving body does not cover an equal distance in an equal interval of time, it is called a non-uniform motion. In practice, most objects have non-uniform motion. Motion of a moving bus, motion of a flying bird, motion of an aeroplane, motion of a motorcycle, etc. are some examples of non-uniform motion. However, planets, natural satellites and machines have uniform motion.

In the given figure, a motorcycle does not cover an equal distance in an equal interval of time. So, it is called a non-uniform motion.

Fig. 2.4

Scalar and Vector Quantities

A physical quantity which is described completely by its magnitude only is called a scalar quantity. Thus, a scalar quantity has only magnitude but no direction. Length, distance, time, area, temperature, speed, mass, energy, power and volume are some examples of scalar quantities.

A physical quantity which requires both magnitude and direction for its complete description is called a vector quantity. Thus, a vector quantity has both magnitude and direction. Displacement, velocity, force, acceleration and weight are some examples of vectors quantities.

Do You Know

- The sum of scalar is always positive but the sum of vectors may be positive, zero or negative.
- Scalars are added by the rules of simple algebra but vectors are added by the rules of vector algebra.
- Scalars are not written in a special way but vectors are written in a special way, e.g. vector PQ is denoted by $\overrightarrow{PQ}$.

Differences between Scalars and Vectors

	Scalars		Vectors
1.	Scalars have magnitude but no direction.	1.	Vectors have both magnitude and direction.
2.	The sum of scalars is always positive.	2.	The sum of vectors may be positive, zero or negative.
3.	They are added by the rules of simple algebra.	3.	They are added by the rules of vector algebra.

Distance and Displacement

A distance is the actual length of the path covered by a moving body irrespective of its direction. In the SI system, distance is measured in metre (m).

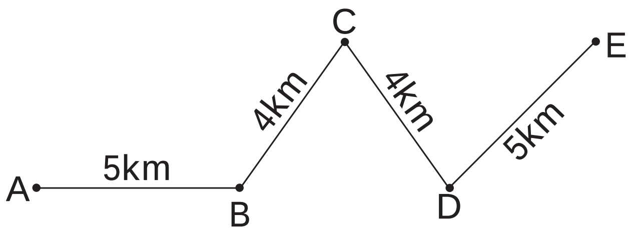


Fig. 2.5

In the given figure, the total distance covered by a moving body from A to E is

Distance covered (s) = AB + BC + CD + DE = 5km + 4km + 4km + 5km = 18 km

During the calculation of distance covered, the direction in which a body is moving is not considered. So, the distance covered by a body is a scalar quantity.

Displacement is the shortest distance between the initial and the final position of a moving body in a certain direction. It is a vector quantity. It can be positive, zero or negative.

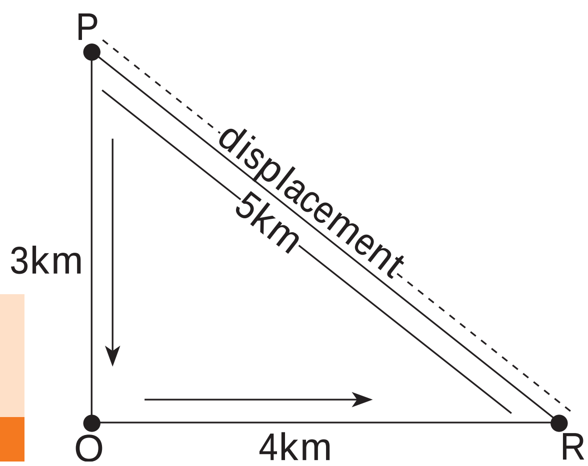
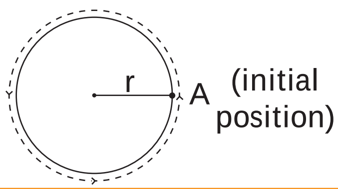


Fig. 2.6

Do You Know

- The sum of scalar is always positive but the sum of vectors may be positive, zero or negative.
- Scalars are added by the rules of simple algebra but vectors are added by the rules of vector algebra.
- Scalars are not written in a special way but vectors are written in a special way, e.g. vector PQ is denoted by $\overrightarrow{PQ}$.



Distance covered from P to R (s) = (3 + 4) km

= 7 km

Displacement (s) = 5 km

Suppose a bus moves from P to Q (3km) towards south and Q to R (4km) towards east.

Then the distance covered by the bus is PQ + QR = 3km + 4km = 7km

But the displacement of the bus PR from P to R is given by

$$PR = \sqrt{PQ^2 + QR^2}$$

$$= \sqrt{3^2 + 4^2}$$

$$= \sqrt{25}$$

$$= 5$$

∴ The displacement of the bus is 5 km.

Speed and Velocity

The speed of a moving body is defined as the distance covered by it per unit time, i.e.

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

The SI unit of speed is metre per second (m/s) and CGS unit is centimetre per second (cm/s). Speed is a scalar quantity. The speed of fast moving bodies like car, bus, motorcycle, aeroplane, etc. is expressed in kilometre/hour (km/h). The speed of a moving body may be uniform or non-uniform.

The velocity of a moving body is defined as the distance covered by a body per unit time in a fixed direction. It is also called the rate of change of displacement.

$$\text{Velocity (v)} = \frac{\text{Displacement (s)}}{\text{Time taken (t)}}$$

The SI unit of velocity is metre per second (m/s). Velocity is a vector quantity.

Differences between Speed and Velocity

Speed	Velocity
1. The rate of change of distance of a moving body is called speed.	1. The rate of change of displacement of a moving body is called velocity.
2. Its magnitude is always positive.	2. Its magnitude can be negative, zero or positive.
3. It is a scalar quantity.	3. It is a vector quantity.

Worked out Numerical: 1

A motorcycle travels 48 km in 40 minutes towards west. Calculate the velocity of the motorcycle.

Solution:

Given,

Displacement (s) = 48 km

= 48 × 1000 m [$\because$ 1km = 1000 m]

= 48000 m

Time taken (t) = 40 minutes

= 40 × 60 seconds [$\because$ 1 min. = 60 s]

= 2400 s

Velocity (v) = ?

We know,

$$\text{Velocity (v)} = \frac{\text{Displacement (s)}}{\text{Time taken (t)}}$$

$$= \frac{48000}{2400}$$

= 20 m/s

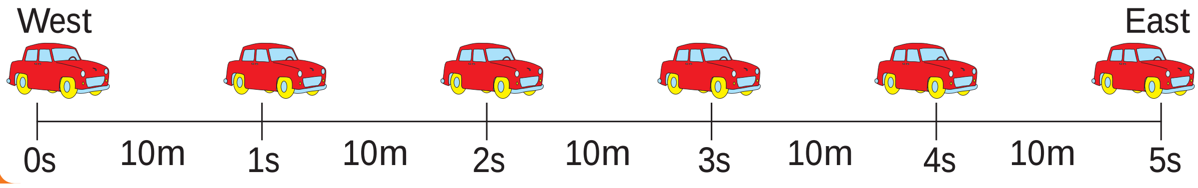
$\therefore$ The velocity of the motorcycle is 20 m/s.

Uniform velocity and Non-uniform velocity

A body is said to be moving with uniform velocity if it covers equal distance in equal intervals of time in a fixed direction.

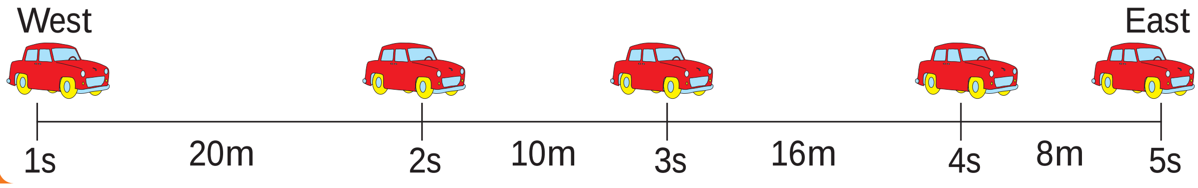
The velocity of a car in the given figure 2.7 is called uniform or constant because the car covers equal distance in every one second.

Fig. 2.7



A body is said to be moving with non-uniform or variable velocity if it covers unequal distance in equal intervals of time in a certain direction. In the given figure 2.8, the velocity of the car is called non-uniform or variable velocity as it covers unequal distance in every one second.

Fig. 2.8



Worked out Numerical: 2

A motorcycle covers 20 m in 5 seconds and 60 m in 11 seconds. Calculate the average velocity of the motorcycle.

Solution:

Given,

Total distance covered (s) = 20 m + 60 m

= 80 m

Total time taken (t) = 5 s + 11 s

= 16 s

Average velocity (v) = ?

We know,

$$\text{Average velocity (v)} = \frac{\text{Total distance covered (s)}}{\text{Total time taken (t)}}$$

$$= \frac{80}{16}$$

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

∴ The average velocity (v) of the motorcycle is 5 m/s.

Average velocity

An average velocity of a moving body is defined as the arithmetic mean of the initial and the final velocity over a given period of time.

If 'u' is the initial velocity and 'v' is the final velocity of a body moving in a certain direction, then,

$$\text{Average velocity (v)} = \frac{u + v}{2}$$

Relative velocity

The relative velocity is defined as the velocity of a moving body with respect to another moving body in a certain direction.

i. When two bodies move in the opposite direction

Let us consider two cars x and y are moving in the opposite direction. Let the velocity of the car x be v_x and that of the car y be v_y. Since the direction is opposite velocity of car x with respect to car y = v_{xy}, i.e.

v_{xy} = Velocity of car x – Velocity of car y

= $v_x - (-v_y)$ [$\because v_y$ is negative as it moves in opposite direction]

$\therefore \quad v_{xy} = v_x + v_y$

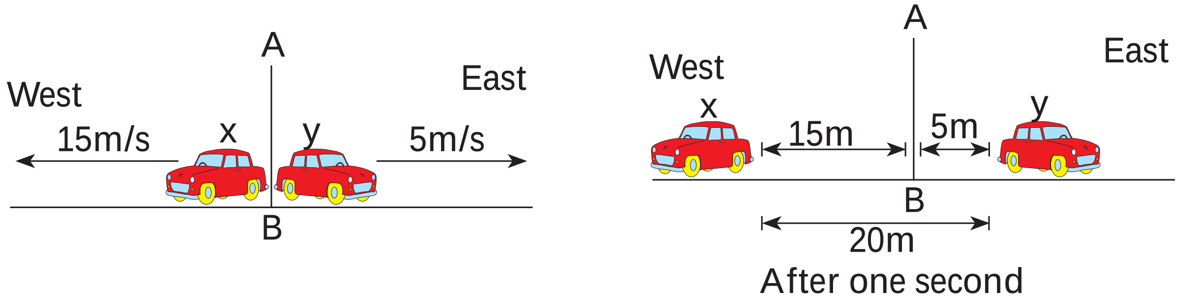


Fig. 2.9

Thus, when two vehicles are moving in the opposite direction, they appear to move with higher velocity.

ii. When two bodies move in the same direction

Let us consider two cars x and y moving along a straight road in the same direction. Let velocity of the car x be v_x and that of the car y be v_y. Since they are moving in the same direction.

Velocity of car x with respect to car y (v_{xy}) = Velocity of car (v_x) – Velocity of car y (v_y)

$$v_{xy} = v_x - v_y$$

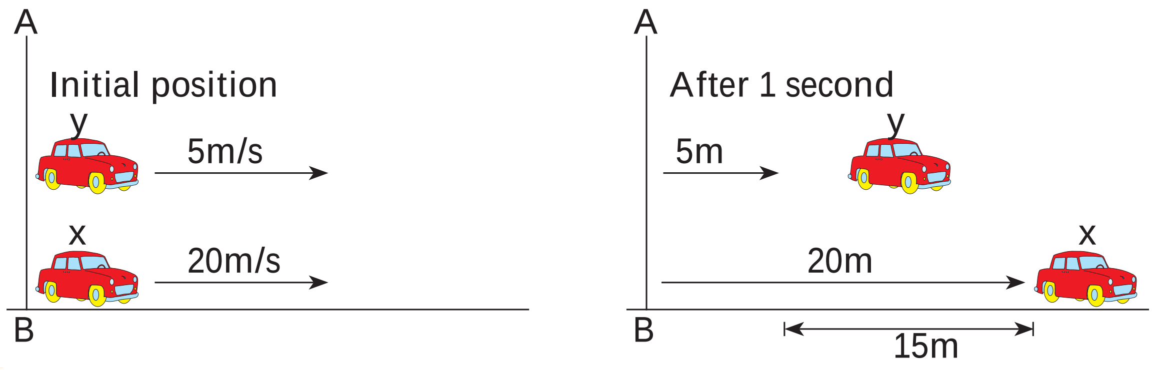


Fig. 2.10

Differences between Average velocity and Relative velocity

Average velocity	Relative velocity
1. It is the arithmetic mean of the initial velocity and final velocity of a moving body.	1. It is the velocity of a moving body with respect to another.
2. Reference point is not necessary to express average velocity.	2. Reference point is necessary to express relative velocity.

Worked out Numerical: 3

Two trucks A and B are moving in the opposite direction with the velocity of 20m/s and 10 m/s respectively. Calculate the relative velocity of truck A with respect to truck B. Also calculate the distance between them after 5 minutes if they start from the same place.

Solution:

Given,

Velocity of truck A (v_A) = 20 m/s

Velocity of truck B (v_B) = 10 m/s

When they are moving in the opposite direction,

Relative velocity (v_{AB}) = $v_A - (-v_B)$

= 20 – (–10)

= 20 + 10

= 30 m/s

Now, Time taken (t) = 5 × 60

= 300 s [∵ 1 minute = 60 seconds]

Distance covered by truck A after 5 minutes,

$s_A = V_A \times t$
$= 20 \times 300$
$= 6000$ m

Distance covered by truck B after 5 minutes,

$s_B = v_B \times t \quad = 10 \times 300$
$= 3000$ m

$\therefore$ Distance between two trucks after 5 minutes,

$s = s_A + s_B$ [$\because$ they move in the opposite direction.)
$= 6000 + 3000$
$= 9000$ m

Worked out Numerical: 4

Two cars A and B are moving in the same direction from the same point with the velocity of 25 m/s and 15 m/s respectively. Calculate the relative velocity of the car A with respect to B. Also find out the distance between them after 2 minutes.

Solution,

Given, Velocity of car A (v_A) = 25 m/s

Velocity of car B (v_B) = 15 m/s

Relative velocity of car A with respect to car B

$v_{AB} = v_A - v_B$ [$\because$ Rhey are moving in the same direction.]
$= 25 - 15$
$= 10$ m/s

Now, time taken (t) = 2 min.
$= 2 \times 60$s [$\because$ 1 minute = 60 seconds]
$= 120$ s

Distance covered by car A in 2 minutes,

$s_A = v_A \times t$
$= 25 \times 120$
$= 3000$ m

Distance covered by car B in 2 minutes,

$s_B = v_B \times t$
$= 15 \times 120 \quad = 1800$ m

∴ Distance between car A and Car B after 2 minutes (s) = $s_A - s_B$

$= 3000 - 1800$

$= 1200$ m

Concept of Acceleration

Let us consider a body moving in a straight line with a non-uniform velocity. Let a school bus start from rest at "Stop A". When it starts moving, its velocity increases and after a certain time it gains a constant velocity. As "Stop B" approaches, its velocity gradually decreases and finally becomes zero at the "Stop B". These changes in the velocity of a moving body are described in terms of acceleration.

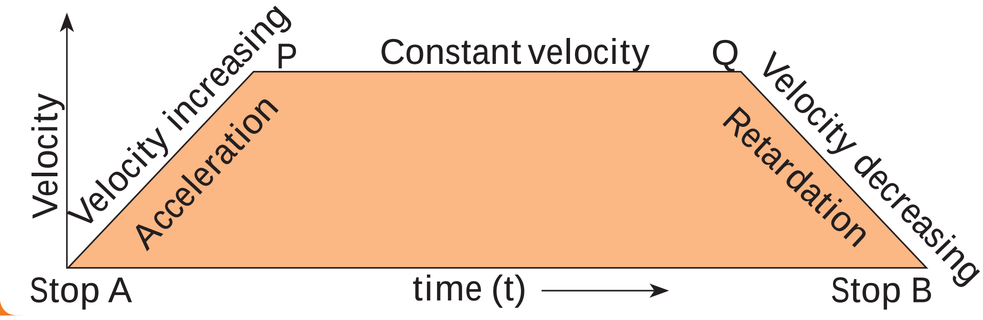


Fig. 2.11

The rate of change of velocity of a moving body is called its acceleration, i.e.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time interval}}$$

We know,

Change in velocity = Final velocity (v) – Initial velocity (u)

$$\text{Thus, Acceleration (a)} = \frac{\text{Final velocity (v)} - \text{Initial velocity (u)}}{\text{Time interval (t)}}$$

$$\therefore a = \frac{v - u}{t}$$

SI unit of acceleration

We know,

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time interval}}$$

In the SI system, the unit of velocity is 'm/s' and that of time is 's'.

∴ The SI unit of acceleration is $\frac{m/s}{s}$ or m/s^2 or ms^{-2}.

So, in SI system, the unit of acceleration is metre per second square (m/s^2 or ms^{-2}).

Positive acceleration and Negative acceleration

If the final velocity of a moving body is greater than the initial velocity, i.e. $v > u$, then,

$$\text{Acceleration (a)} = \frac{v - u}{t} = \text{Positive quantity}$$

In other words, when the velocity of a body increases with time, its acceleration is positive. In common practice, positive acceleration is simply called acceleration.

> **Do You Know**
>
> When a ball is thrown vertically downwards, its velocity increases with time. So the acceleration of a ball thrown vertically downwards is always positive.

If the final velocity of a moving body is less than the initial velocity, i.e. $v < u$ then,

$$\text{Acceleration (a)} = \frac{v - u}{t} = \text{Negative quantity}$$

In other words, when the velocity of a body decreases with time, its acceleration is negative. The negative acceleration is also called retardation.

If a body has an acceleration of $-2\ m/s^2$, then the retardation of the body is $+ 2\ m/s^2$. The SI unit of retardation is m/s^2 or ms^{-2}. In fact, retardation is the acceleration with a negative sign.

> **Do You Know**
>
> When a ball is thrown vertically upwards, its velocity decreases with time. So, the acceleration of a ball thrown vertically upwards is negative (a case of retardation).

Differences between Acceleration and Retardation

Acceleration	Retardation
1. The rate of increase in velocity of a moving body is called acceleration.	1. The rate of decrease in velocity of a moving body is called retardation.
2. It is positive.	2. It is negative.

Worked out Numerical: 5

A car starts to move from rest and gains a velocity of 72 km/h after 10 seconds. Calculate the acceleration of the car.

Solution:

Given,

Initial velocity (u) = 0 [∵ The car starts to move from rest.]

Final velocity (v) = 72 km/h

$$= \frac{72 \times 1000}{60 \times 60} = 20\ m/s$$

Time taken (t) = 10 s

Acceleration (a) = ?

We know,

$$a = \frac{v - u}{t} = \frac{20 - 0}{10} = 2\ m/s^2$$

∴ Acceleration of the car = 2 m/s^2.

Equations of Motion

When a body travels in a straight line with a uniform acceleration, the relationship among the initial velocity (u), final velocity (v), distance covered (s), acceleration (a) and the time taken (t) are called the equations of motion. There are three equations of motion which are as follows:

i. $v = u + at$ ii. $s = ut + \frac{1}{2}at^2$ iii. $v^2 = u^2 + 2as$

i. Derivation of equation v = u + at

Let us consider a body having initial velocity 'u' is moving with a uniform acceleration 'a'. If after time 't', its velocity is 'v', then from the definition of acceleration 'a', we get,

$$\text{Acceleration (a)} = \frac{\text{Final velocity (v)} - \text{Initial velocity (u)}}{\text{Time taken (t)}}$$

or, $a = \frac{v - u}{t}$

$at = v - u$

or, $v = u + at$ .... (1)

This equation helps us to find the velocity gained by a moving body in time 't'.

ii. Derivation of equation $s = ut + \frac{1}{2}at^2$

Let us consider a body having initial velocity 'u' is moving with a uniform acceleration 'a'. If after time 't', its velocity is 'v'. For a body moving in a straight line under uniform acceleration, the distance covered (s) in time (t) is given by,

Distance covered (s) = Average velocity × Time taken

or, $s = \frac{u + v}{2} \times t$ q∵ Average velocity = $\frac{u + v}{2}$ r

or, $s = \frac{u + (u + at)}{2} \times t$ [∵ $v = u + at$]

or, $s = \frac{2u + at}{2} \times t$

$$\text{or,} \quad s = \frac{2ut}{2} + \frac{at^2}{2}$$

$$\text{or,} \quad s = ut + \frac{1}{2}at^2 \quad \text{..........................} \quad (2)$$

iii. Derivation of equation $v^2 = u^2 + 2as$

Let us consider a body having initial velocity 'u' is moving with a uniform acceleration 'a'. If after time 't', its velocity is 'v'. For a body moving in a straight line under uniform acceleration, the distance covered (s) in time (t) is given by,

Distance covered (s) = Average velocity × time taken

Do You Know

- If a body starts from rest, its initial velocity (u) is zero.
- If a body comes to rest, its final velocity (v) is zero.
- If a body moves with a uniform velocity, its acceleration (a) is zero.

$$\text{or,} \quad s = \frac{u+v}{2} \times t$$

$$\text{or,} \quad s = \frac{v+u}{2} \times \frac{v-u}{a} \qquad q\because a = \frac{v-u}{t},\ t = \frac{v-u}{a}r$$

$$\text{or,} \quad s = \frac{v^2-u^2}{2a}$$

$$\text{or,} \quad 2as = v^2 - u^2$$

$$\text{or,} \quad \boxed{v^2 = u^2 + 2as} \quad \text{......................} \quad (3)$$

Worked out Numerical: 6

A car starts to move from rest and gains an acceleration of 2 m/s^2. Calculate the final velocity of the car after 10 seconds. Also, calculate the distance covered by the car within that time.

Solution:

Given,

Initial velocity (u) = 0 [∴ The car starts from rest.]

Acceleration (a) = 2 m/s^2

Time (t) = 10 s

Final velocity (v) = ?

Distance covered (s) = ?

We know,

$$v = u + at$$
$$= 0 + 2 \times 10$$
$$= 20 \text{ m/s}$$

$\therefore$ The final velocity of the car is 20 m/s.

Again,

$$s = ut + \frac{1}{2}at^2$$
$$= 0 \times 10 + \frac{1}{2} \times 2 \times 10^2$$
$$= \frac{1}{2} \times 2 \times 100$$
$$= 100 \text{ m}$$

$\therefore$ The distance covered by the car = 100 m.

Worked out Numerical: 7

A car starts from rest and covers a distance of 100 m after 10 seconds. If the acceleration is 2 m/s^2, calculate the final velocity of the car.

Given,

Initial velocity (u) = 0 [$\therefore$ The car starts from rest]

Distance covered (s) = 100 m

Time taken (t) = 10 s

Acceleration (a) = 2 m/s^2

Final velocity (v) = ?

We know,

$$v^2 = u^2 + 2as$$

or, $v^2 = 0 + 2 \times 2 \times 100$

or, $v^2 = 400$

or, $v = \sqrt{400}$

$\therefore$ $v = 20$ m/s

$\therefore$ The final velocity of the car (v) = 20 m/s.

Key Concepts

1. A body is said to be at rest if it does not change its position with respect to a fixed point taken as reference point in its surroundings.
2. When a moving body covers an equal distance in an equal interval of time, it is called a uniform motion.
3. When a moving body does not cover an equal distance in an equal interval of time, it is called a non-uniform motion.
4. A physical quantity which is described completely by its magnitude only is called a scalar quantity.
5. A physical quantity which requires both magnitude and direction for its complete description is called a vector quantity.
6. A distance is the actual length of the path covered by a moving body irrespective of its direction.
7. Displacement is the shortest distance between the initial and the final position of a moving body in a certain direction.
8. A relative velocity is defined as the velocity of a moving body with respect to another moving body in a certain direction.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Distance is a scalar quantity. ☐

b. The SI unit of speed is m/s^2. ☐

c. An average velocity is the mean of initial velocity and final velocity. ☐

d. The rate of change of velocity is called acceleration. ☐

e. Retardation is a scalar quantity. ☐

2. Fill in the blanks using appropriate words.

a. Rest and .... are relative terms.

b. Vector quantities have both .... and ....

c. The rate of change of displacement is called ....

d. .... is the acceleration with negative sign.

e. The SI unit of .... is m/s^2.

3. Tick (√) the most appropriate answer from the given alternatives.

a. Which of the given objects has uniform motion?

☐ moving bus ☐ flying bird ☐ moving car ☐ planet

b. Which of the following is a scalar quantity?

☐ force ☐ velocity ☐ speed ☐ weight

c. Which of the following is a vector quantity?

☐ time ☐ energy ☐ power ☐ displacement

d. Which of the following is the unit of retardation?

☐ m/s^2 ☐ ms^2 ☐ m/s ☐ ms^{-1}

4. Answer the following questions.

a. What is meant by rest and motion? Give one example of each.

b. Rest and motion are relative terms. Justify this statement.

c. What is meant by uniform motion and non-uniform motion? Write with examples.

d. Define scalar quantities with any three examples.

e. Define vector quantities with any three examples.

f. What is displacement? Write its SI unit.

g. What is meant by speed and velocity? Write down SI unit of velocity.

h. Define average velocity and relative velocity.

i. What is acceleration? Write down its formula and SI unit.

j. What is retardation? Write down its SI unit.

k. What are the equations of motion?

5. Given reason.

a. Speed is called a scalar quantity.

b. Velocity is called a vector quantity.

c. The acceleration of a body moving with uniform velocity is zero.

6. **Differentiate between:**

a. Rest and Motion
b. Distance and Displacement
c. Scalars and Vectors
d. Speed and Velocity
e. Acceleration and Retardation

7. **Prove that:**

a. v = u + at
b. $s = ut + \frac{1}{2} at2$
c. v2 = u2 + 2as

Numerical Problems

1. A motorcycle covers 500 metres in 25 seconds. Calculate the average velocity. [Ans: 20 m/s]

2. A car covers a distance of 1.5 km in 1 minute and 5 km in 4 minutes. Calculate the average velocity of the car. [Ans: 21.66 m/s]

3. Two vehicles P and Q are moving towards the west with the velocity of 25 m/s and 15 m/s respectively. Calculate the relative velocity of P with respect to Q. [Ans: 10 m/s]

4. A truck is moving towards east with the velocity of 20 m/s and another is moving towards west with the velocity of 15 m/s. Calculate the relative velocity. If those trucks move at the same time from the same place, calculate the distance between them after 2 minutes. [Ans: 35 m/s, 4200 m]

5. A vehicle starts to move from rest and its final velocity becomes 20 m/s after 10 seconds. Calculate the acceleration of the vehicle. [Ans: 2 m/s^2]

6. A car is moving with the velocity of 90 km/h. If the car comes to rest after 10 seconds, calculate the retardation of the car. [Ans: 2.5 m/s^2]

7. A vehicle starts to move from rest and attains an acceleration of 0.8 m/s^2 in 10 seconds. Calculate the final velocity and distance covered by the vehicle within that time. [Ans: 8 m/s, 40 m]

8. A truck is moving with the velocity of 72 km/h. When the driver applies brakes, the truck comes to rest in 2 seconds. Calculate the retardation and distance covered by the truck. [Ans: 10 m/s^2, 20m]

9. A bus is moving with the velocity of 90 km/h. If the bus covers a distance of 625 m before coming to rest, calculate the retardation of the bus. [Ans: 0.5 m/s^2]

UNIT 3

Simple Machine

Weighting Distribution (Approximate)	Teaching periods : 4	Marks (in %): 1

Before You Begin

We use a variety of machines like knife, scissors, pulley, screw, axe, beam balance, crow-bar, etc. to make our work easier and faster. These machines have simple structure. So they are called simple machines. Simple machines help us to work more efficiently. They help us to perform mechanical work using our muscular energy. Simple machines help to multiply force, change the direction of the force and increase the speed of work. We can make our life easier by using a variety of simple machines.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce simple machines with examples.

ii. explain types of lever with examples.

iii. introduce mechanical advantage (MA), velocity ratio (VR) and efficiency (h) of simple machines.

iv. calculate MA, VR and h of lever.

Syllabus

- Introduction to simple machines
- Lever, its types and working principle
- Mechanical advantage (MA), velocity ratio (VR) and Efficiency (h) of lever
- Simple numerical problems

Glossary: A dictionary of scientific/technical terms

machine	:	a piece of equipment with moving parts that is designed to do a particular work
load	:	the force exerted by a machine after application of effort
effort	:	the force applied on a machine while doing work
efficiency	:	the ratio of output work to input work of a machine
convenient	:	easy or quick to do
input work	:	the work done on a machine
output work	:	the work done by a machine
ideal	:	perfect, most suitable
fulcrum	:	the point on which a lever turns or is supported

Simple Machine

A simple machine is a mechanical device which is simple in structure and makes our work easier and faster. Scissors, knife, door knob, beam balance, fire tongs, screw, axe, wheel-barrow and crow bar are some examples of simple machines that we use in our daily life. These machines help us to work more efficiently, travel faster and perform certain task more accurately.

Fig. 3.1

Wheel barrow *Scissors* *Knife* *Screw driver*

Simple machines are very useful to us. The major advantages of simple machines are as follows:

1. Simple machines help to multiply the effort applied.
2. They help to apply force in convenient direction by changing the direction of force applied.
3. They help to increase the speed of work.
4. They help to do the work safely and easily.

Terminology Related to Simple Machines

1. **Effort:** Effort is the force applied to a machine to do work.

2. **Load:** Load is the force applied by the machine on the body on which work is done.

Mechanical advantage: The ratio of the load to the effort applied is called mechanical advantage. It is denoted by MA.

$$\text{Mechanical advantage (MA)} = \frac{\text{Load (L)}}{\text{Effort (E)}}$$

Mechanical advantage (MA) has no unit as it is the ratio of two forces.

Do You Know

- If the load lifted by a machine is greater than the effort applied, the MA is greater than 1.
- If the load lifted is less than the effort applied, the MA is less than 1.
- MA depends on friction and weight of the machine. If friction increases, MA decreases and vice-versa.
- No machine is frictionless and weightless. So, large amount of effort is wasted to overcome friction and lift the machine. Therefore, MA of a machine becomes less.

4. Velocity ratio: The ratio of the distance travelled by effort to the distance travelled by load is called velocity ratio. It is denoted by VR. It has no unit as it is the ratio of two distances.

$$\text{Velocity Ratio (VR)} = \frac{\text{Distance travelled by effort}}{\text{Distance travelled by load}} = \frac{\text{Effort arm}}{\text{Load arm}}$$

$$\therefore \quad \text{VR} = \frac{\text{Effort arm}}{\text{Load arm}}$$

5. Efficiency: The efficiency of a machine is defined as the percentage ratio of output work to input work. It is expressed in percentage and denoted by letter eta (η).

$$\text{Efficiency } (\eta) = \frac{\text{Output work}}{\text{Input work}} \times 100\%$$

The work done by a machine is called output work. It is the product of load and distance travelled by load. Similarly, the work done on a machine is called input work. It is the product of effort and the distance travelled by effort.

In short, Output work = load × distance travelled by load

Input work = Effort × distance travelled by effort

Relation among MA, VR and η of a machine

We know,

$$\text{Efficiency } (\eta) = \frac{\text{Output work}}{\text{Input work}} \times 100\%$$

$$= \frac{\text{Load} \times \text{load distance}}{\text{Effort} \times \text{effort distance}} \times 100\%$$

$$= \frac{\frac{\text{Load}}{\text{Effort}}}{\frac{\text{Effort distance}}{\text{Load distance}}} \times 100\%$$

$$= \frac{\text{MA}}{\text{VR}} \times 100\%$$

$$\therefore \quad \eta = \frac{\text{MA}}{\text{VR}} \times 100\%$$

Do You Know

- MA and η of a machine are affected by friction but not the VR. So, MA is always less than VR.
- The efficiency of a machine can be increased by reducing friction. Some of the ways to reduce friction are applying oil or grease, using ball-bearings and making the surface smooth.

Efficiency of a machine can also be defined as the percentage ratio of mechanical advantage (MA) and velocity ratio (VR) of a machine. It has no unit as it is the ratio of two similar physical quantities, i.e. work done.

Differences between Mechanical advantage and Velocity ratio

Mechanical advantage (MA)	Velocity ratio (VR)
1. It is the ratio of load and effort.	1. It is the ratio of distance moved by effort to distance moved by load.
2. It is affected by friction.	2. It is not affected by friction.

Differences between Input work and Output work

Input work	Output work
1. The work done on a machine is called input work.	1. The work done by a machine is called output work.
2. The product of effort and distance travelled by effort is input work.	2. The product of load and distance travelled by load is output work.

Perfect machine or Ideal machine

The machine in which the output work is equal to the input work is called perfect machine or ideal machine. It is the machine without friction. The efficiency of an ideal machine is 100%. However, in practice, no machine is 100% efficient. The output work is always less than input work because:

i. a part of input work is wasted in overcoming friction and

ii. a part of input work is wasted in moving the parts of the machine.

Therefore, the efficiency of a practical machine is always less than 100%.

Do You Know

The efficiency of a machine is 90% means that 90% of the input work is converted into useful output work and 10% of the input work is wasted to overcome the friction and to move the parts of the machine.

Do You Know

The efficiency of a machine is always less than 100%, why?
Mechanical advantage is affected by friction and weight of a machine but velocity ratio is not affected by the friction. So, mechanical advantage is always less than velocity ratio. Therefore, the efficiency of a machine is always less than 100%.

Worked out Numerical: 1

A load of 1800 N is lifted by a machine applying 450 N effort. Calculate the MA, VR and η of the machine. The load distance and effort distance are12 cm and 60 cm respectively.

Given,

Load = 1800 N

Effort = 450 N

Load distance = 12 cm

Effort distance = 60 cm

We know,

$$MA = \frac{\text{Load}}{\text{Effort}} = \frac{1800N}{450N} = 4$$

$$VR = \frac{\text{Effort distance}}{\text{Load distance}} = \frac{60 \text{ cm}}{12 \text{ cm}} = 5$$

$$\eta = \frac{MA}{VR} \times 100\% = \frac{4}{5} \times 100\% = 80\%$$

∴ The MA, VR and η of the machine are 4, 5 and 80% respectively.

Types of Simple Machine

There are six types of simple machines which are as follows:

1. Lever
2. Pulley
3. Wheel and axle
4. Inclined plane
5. Screw
6. Wedge

In this unit, we will study lever and its types with examples.

1. Lever

A lever is a rigid, straight or bent bar which is capable of turning about a fixed point or an axis called its fulcrum. A lever consists of fulcrum, effort arm and load arm. See-saw, scissors, beam balance, wheel-barrow, bottle-opener, fire-tongs and nut-cracker are some examples of lever.

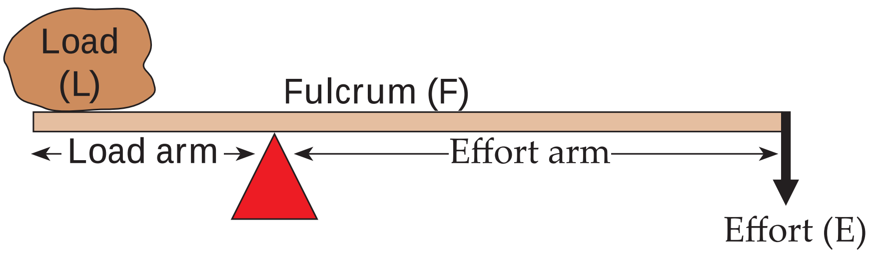


Fig. 3.2

The fixed point about which a lever can rotate freely is called fulcrum. The perpendicular distance of the load from the fulcrum is called the load arm and the perpendicular distance of the effort from the fulcrum is called the effort arm.

Principle of lever

When a lever is in equilibrium, the input work is always equal to the output work. In other words, the product of load and load arm is equal to the product of effort and effort arm.

In short, Input work = Output work

or, $\boxed{\text{Effort} \times \text{Effort arm} = \text{Load} \times \text{Load arm}}$

Classification of lever

There are three classes of levers on the basis of the location of the fulcrum, load and effort. They are as follows:

a. First class lever
b. Second class lever
c. Third class lever

a. First class lever

The lever in which fulcrum is located in between load and effort is called first class lever. Scissors, beam balance, crow-bar, nail-cutter, handle of water pump and pliers are some common examples of first class levers used in our daily life.

Fig. 3.3

Scissors *Pliers* *Beam balance* *Handle of water pump*

First class levers are used to increase the rate of doing work, change the direction of force and multiply the effort. The MA of first class lever may be more than one, one or less than one.

b. Second class lever

The lever in which load is located in between fulcrum and effort is called second class lever. Nut-cracker, wheel-barrow, oar of a boat, bottle-opener, lemon-squeezer and mango-cutter are some examples of second class lever.

Fig. 3.4

Wheel-barrow *Lemon-squeezer* *Nut-cracker* *Bottle-opener*

Since the load lies in between the effort and fulcrum, the effort arm is always longer than the load arm in a second class lever. So, the MA of a second class lever is always more than 1. By applying less effort, a large load is lifted by using these levers. Thus, second class levers always act as force multipliers.

c. Third class lever

The lever in which effort is located in between fulcrum and load is called third class lever. Fire tongs, human arm, fishing rod, shovel and broom are some examples of third class lever.

Fig. 3.5

Fire tongs *Fishing rod* *Shovel* *Human arm*

In third class lever, as effort lies in between the fulcrum and load, the effort arm is always smaller than the load arm. So the MA of third class lever is always less than 1. Third class levers act as speed multipliers, e.g. a bread knife cuts the entire bread slice by moving less effort distance.

Fig. 3.6

Activity 1

- Name any six levers that are used at your home.
- Study the structure of each of them and identify the position of load, effort and fulcrum in each of them.
- Classify these levers on the basis of the position of fulcrum, load and effort.

Worked out Numerical: 2

A load of 800 N is lifted by applying 200 N effort. If the distance between fulcrum and load is 25 cm, calculate the effort distance.

Given,

Load = 800 N

Effort = 200 N

Load distance = 25 cm

Effort distance = ?

We know,

Effort × Effort distance = Load × load distance

$$\text{or,}\quad \text{Effort distance} = \frac{\text{Load} \times \text{Load distance}}{\text{Effort}}$$

$$= \frac{800 \times 25}{200}$$

$$= 4 \times 25$$

$$= 100 \text{ cm}$$

∴ Effort distance = 100 cm

Worked out Numerical: 3

One metre long lever is used to lift a load of 1200 by applying 400 N effort. If the load arm is 20 cm, calculate MA, VR and η of the lever.

Given,

Length of lever = 1 m = 100 cm

Load arm = 20 cm

∴ Effort arm = (100 – 20) cm = 80 cm

Load = 1200 N

Effort = 400 N

We know,

$$MA = \frac{\text{Load}}{\text{Effort}} = \frac{1200}{400} = 3$$

$$VR = \frac{\text{Effort arm}}{\text{Load arm}} = \frac{80}{20} = 4$$

$$\eta = \frac{MA}{VR} \times 100\% = \frac{3}{4} \times 100\% = 75\%$$

∴ The MA, VR and η of the machine is 3, 4 and 75% respectively.

Do You Know

The cutting edges of metal-cutting scissors are made shorter but those of cloth-cutting scissors are made longer, why?
Metal is harder than the cloth. So, we have to apply greater effort to cut metal than the cloth. If the cutting edges of metal-cutting scissors are made shorter then the load distance is shorter. As a result of which greater effort is created on that edge and it is easy to cut the metal piece. But it is easy to cut cloth even the cutting edges of cloth cutting scissors are made longer. Therefore, cutting edges of metal cutting scissors are made shorter but those of cloth-cutting scissors are made longer.

Key Concepts

1. A simple machine is a mechanical device which is simple in structure and makes our work easier and faster.
2. The ratio of the load to the effort applied is called mechanical advantage. It is denoted by MA.
3. The ratio of the distance travelled by effort to the distance travelled by load is called velocity ratio.
4. The efficiency of a machine is defined as the percentage ratio of output work to input work.
5. The machine in which the output work is equal to the input work is called perfect machine or ideal machine.
6. A lever is a rigid, straight or bent bar which is capable of turning about a fixed point or an axis called its fulcrum.
7. When a lever is in equilibrium, the input work is always equal to the output work. In other words, the product of load and load arm is equal to the product of effort and effort arm.
8. The lever in which fulcrum is located in between load and effort is called first class lever.
9. The lever in which load is located in between fulcrum and effort is called second class lever.
10. The lever in which effort is located in between fulcrum and load is called third class lever.

Exercise

1. Put tick a (√) for the correct statement and a cross (×) for the incorrect one.

a. Simple machines make our work easier and faster. ☐

b. The force applied to a machine is called load. ☐

c. The work done by a machine is called output work. ☐

d. In practice, no machine is 100% efficient. ☐

2. Fill in the blanks using appropriate words.

a. .... is the ratio of load to the effort.

b. The ratio of effort distance to the load distance is called ....

c. An ideal machine has .... efficiency.

d. In first class lever, ...lies in between .... and effort.

3. Tick (√) the most appropriate answer from the given alternatives.

a. Which of the following is not a simple machine?

☐ crow-bar ☐ pliers ☐ scissors ☐ motorcycle

b. Which of the following is a first class lever?

☐ broom ☐ pliers ☐ wheelbarrow ☐ bottle-opener

c. The distance between effort and fulcrum is called ....

☐ load arm ☐ load ☐ effort ☐ effort arm

d. The efficiency of an ideal machine is ....

☐ 60% ☐ 80% ☐ 90% ☐ 100%

4. Answer the following questions.

a. Define simple machine with any five examples.

b. Write any three advantages of simple machines.

c. What is meant by effort and load?

d. What is mechanical advantage? Write its formula.

e. What is velocity ratio of a machine? Write its formula.

f. What is efficiency of a machine? Write its formula.

g. Write down the relation among MA, VR and η of a machine.

h. What is an ideal machine?

i. Name the six types of simple machines.

j. What is meant by the MA of a machine is 2?

k. What is meant by the VR of a machine is 3?

l. What is meant by the statement that the efficiency of a simple machine is 75%?

m. What is lever? Give any five examples.

n. Define first class lever with any three examples.

o. Define second class lever with any three examples.

p. Define third class lever with any three examples.

q. State the principle of lever.

5. Given reason.

a. Scissors and forceps are called simple machines.

b. Simple machines are widely used in our daily life.

c. A beam balance is called first class lever.

d. MA of a machine is always less than VR.

e. MA of third class lever is always less than 1.

f. The efficiency of a machine is always less than 100%.

6. Differentiate between:

a. Load and Effort

b. MA and VR

c. Input work and Output work

d. Ideal machine and Practical machine

7. Classify the given levers.

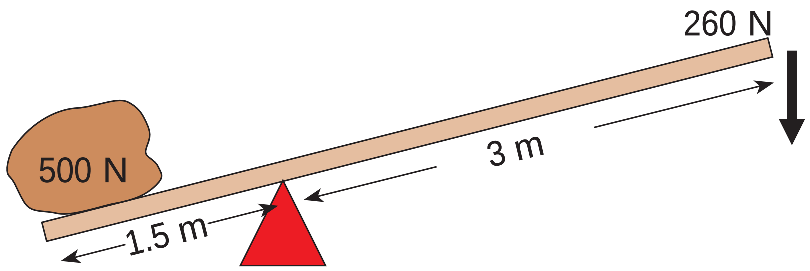
a.

b.

c.

Numerical Problems

1. If the load distance of a lever is 30 cm and effort distance is 60 cm, calculate the amount of effort required to lift a load of 200 N. [Ans: 100 N]
2. Ram of weight 500 N and Hari of weight 400 N are playing see-saw. If Ram is sitting 1.5 m away from the fulcrum, how far should Hari sit from the fulcrum to balance Ram? [Ans: 1.87 m]
3. Calculate the MA if a load of 1200 N is lifted using a simple machine by applying an effort of 400 N. [Ans: 3]
4. How much effort should be applied to lift a load of 2400 N using a simple machine of MA 3? [Ans: 800 N]
5. In a simple machine, if the load arm is 25 cm and effort arm is 100 cm, calculate the VR of the machine. [Ans: 4]
6. Study the given figure and calculate the input work, output work and efficiency. [Ans: 780 Nm, 750 Nm, 96.15%]



7. A load of 600 N is lifted using a lever of 4m effort arm applying an effort of 200 N. If load arm is 1 m, calculate MA, VR and η of the lever. [Ans: MA = 3, VR = 4, η = 75%]

UNIT 4

Pressure

Weighting Distribution (Approximate) | Teaching periods : 4 | Marks (in %): 1

Before You Begin

When a body is placed on a surface, the body exerts a force equal to its weight on the surface. The total perpendicular force acting on the surface of contact is called thrust. The effect of thrust depends on the area of the surface over which the thrust is applied. The thrust per unit area of the surface is called pressure. The SI unit of pressure is pascal (Pa) or N/m^2. Pressure is a scalar quantity.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce atmospheric pressure and explain its importance.
ii. introduce liquid pressure.
iii. derive formula to calculate liquid pressure.
iv. solve some simple numerical problems related to pressure.
v. introduce density, relative density, floating and sinking of substances.

Syllabus

- Atmospheric pressure and its importance
- Liquid pressure and its measurement
- Simple numerical problems
- Density and relative density
- Floating and sinking of objects
- Simple numerical problems

Glossary: A dictionary of scientific/technical terms

pressure	:	the thrust acting per unit area of the surface
thrust	:	the total perpendicular force acting on the surface in contact
atmospheric	:	related to atmosphere
density	:	the mass per unit volume of a substance
blunt	:	without a sharp edge or point
barometer	:	a device which is used to measure the atmospheric pressure

Pressure

Pressure is defined as the thrust acting per unit area of the surface. If 'F' is the thrust, i.e. perpendicular force acting on a surface area 'A', then the pressure (P) acting on the surface is given by: Pressure (P) = $\frac{\text{Thrust (F)}}{\text{Area (A)}}$

$$\therefore \quad \boxed{P = \frac{F}{A}}$$

SI Unit of Pressure

The SI unit of thrust (F) is N and that of area (A) is m^2. So, the unit of pressure (P) is N/m^2 (newton per square metre) or Pa (pascal).

Factors affecting Pressure

1. Thrust or force acting perpendicularly on a surface.
2. Area over which the force acts

   Pressure is directly proportional to the thrust applied and inversely proportional to the area that receives the thrust. Therefore, the same thrust can produce different pressures depending on the area over which it acts. When the thrust acts over a large area of a surface, it produces small pressure. But if the same force acts over a small area, it produces a large pressure. Therefore, we prefer a sharp knife than a blunt one to chop vegetables. A sharp knife cuts vegetables better due to its sharp edge. The force of our hand falls on less area and produces more pressure. It makes cutting of vegetables easier. When the thrust acting on a surface increases, the pressure also increases.

Differences between Force and Pressure

Force	Pressure
1. Force is the push or pull which changes or tries to change the position of an object.	1. The force acting perpendicularly on a unit area of a surface is called pressure.
2. Its SI unit is N.	2. Its SI unit is N/m^2, or Pa.

Worked out Numerical: 1

The weight of a box is 2400 N and its base area is 2m^2. Calculate the pressure exerted by the box.

Given,

Weight of the box (W) = 2400 N

∴ Thrust (F) = 2400 N

Surface area (A) = 2m^2

Pressure (P) = ?

We know,

$$P = \frac{F}{A} = \frac{2400}{2} = 1200\ N/m^2$$

∴ Pressure exerted by the box is 1200 Pa.

Do You Know

One pascal pressure is the pressure exerted on a surface area of 1m2 by a thrust of 1 N.

In short, $\boxed{1\ Pa = \frac{1N}{1m^2}}$

Atmospheric Pressure

The gaseous envelope surrounding the earth is called the atmosphere. It extends upto a height of 1000 km from the surface of the earth. Atmosphere has weight. So it exerts pressure. The pressure exerted by atmosphere due to its weight is called atmospheric pressure.

The atmospheric pressure varies in different parts of the earth. At the sea level, the atmospheric pressure is about 101300 N/m^2 or 760 mmHg. Different altitude have different atmospheric pressure. Due to this, air blows from one place to another. The atmospheric pressure decreases as the altitude increases. Therefore, atmospheric pressure is maximum at the sea level and minimum at the top of Mt. Everest.

Fig. 4.1

Barometer

Do You Know

- Barometer is used to measure the atmospheric pressure.
- Simple barometer was designed by Torricelli in 1643 AD.

Experiment: 1

To demonstrate atmospheric pressure

- Take a tin can and keep some water into it. Heat the tin can until steam issues (forms) freely, driving out the air from the can.
- Remove the flame and cork up the can quickly. Hold it under the cold water tap. The steam inside will condense and the can will collapse under the external pressure of the atmosphere.

When the water in the can boils, steam is formed in the tin can. The steam pushes most of the air out of the can. When the corked up can is cooled by pouring cold water, the steam inside it condenses and creates a partial vacuum in the can. As a result, the atmospheric pressure crushes the can inwards.

This experiment shows the presence of large atmospheric pressure around us.

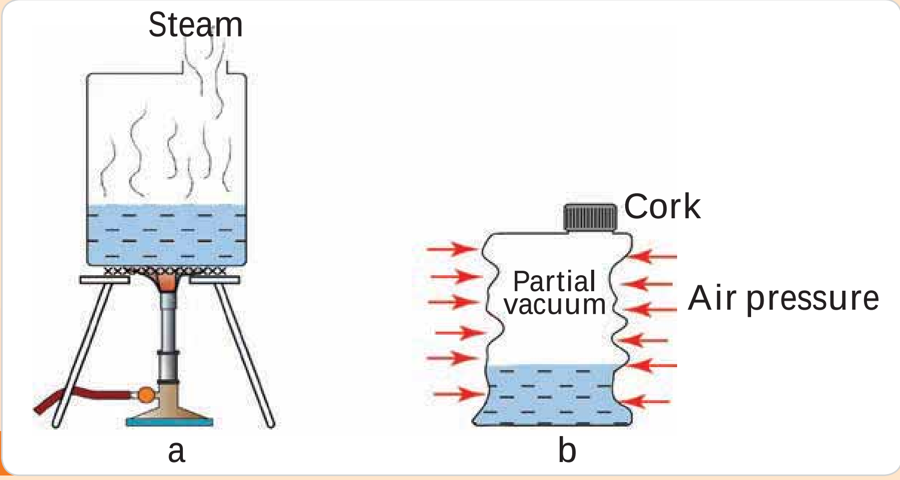


Fig. 4.2

Activity 1

- Take an empty glass and fill it completely with water in such a way that there is no space for air.

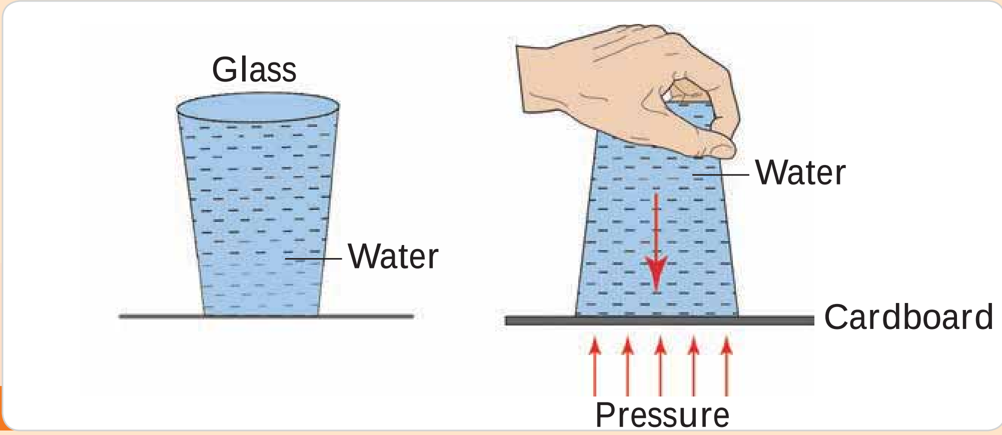


Fig. 4.3

- Take a thick cardboard and cover the glass gently and press the cardboard. Now, invert the glass pressing the cardboard with your hand.
- Now, remove the hand from the cardboard gently and observe it carefully.

The cardboard does not fall down for a while because the atmospheric pressure holds the water in the glass by pressing the cardboard upward. This activity shows the presence of atmospheric pressure.

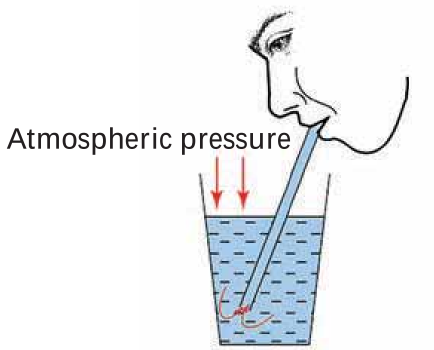
Importance of Atmospheric Pressure

We can do various works and use various equipment due to the presence of atmospheric pressure. The importance of atmospheric pressure is given below.

1. Atmospheric pressure helps to fill ink in the ink pen.
2. It helps to fill medicine in the syringe.
3. It helps to fill air in the tube of vehicles.
4. It helps to lift water using a water pump.
5. It helps to drink soft drinks using a straw.

Fig. 4.4

Medicine is being filled in a syringe



Drawing soft drinks through straw

The working of fountain pen, syringe, suction pad, straw, water pump, etc. is based on atmospheric pressure. These equipment cannot be used in the absence of atmospheric pressure. Therefore, atmospheric pressure is very important for human beings.

Liquid Pressure

Any substance that has weight exerts pressure. Liquids also have weight and exert pressure on the walls and bottom of the vessel in which they are stored. The thrust exerted by a liquid per unit area of the surface is called liquid pressure. The SI unit of liquid pressure is Pa or Nm^{-2}.

Fig. 4.5

Bursting of water pipe due to high pressure

Measurement of Liquid Pressure or Measurement of Pressure Exerted by a Liquid Column

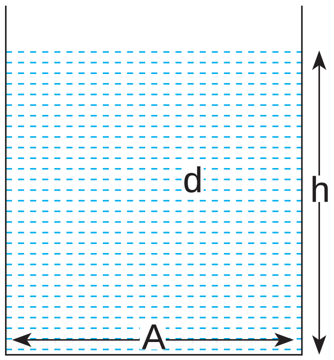


Fig. 4.6

Consider a horizontal cylindrical vessel of base area 'A' filled with a liquid of density 'd' upto the height of the vessel 'h'.

The liquid exerts pressure (P) at the bottom of the vessel due to its weight which is given by:

$$\text{Pressure (P)} = \frac{\text{Thrust (F)}}{\text{Area (A)}}$$

$$\text{or,} \quad P = \frac{F}{A}$$

$$\text{or,} \quad P = \frac{m \times g}{A} \qquad \left\{ \begin{array}{l} \because F = m \times g, \text{ where } m = \text{mass and} \\ g = \text{acceleration due to gravity} \end{array} \right\}$$

$$\text{or.} \quad P = \frac{d \times V \times g}{A} \qquad \left\{ \because d = \frac{m}{V} \text{ and } m = d \times V \right\}$$

$$\text{or,} \quad P = \frac{d \times A \times h \times g}{A} \qquad \left\{ \begin{array}{l} \because V = l \times b \times h \\ \text{or,} \quad V = A \times h \end{array} \right\}$$

$$\text{or,} \quad P = dhg$$

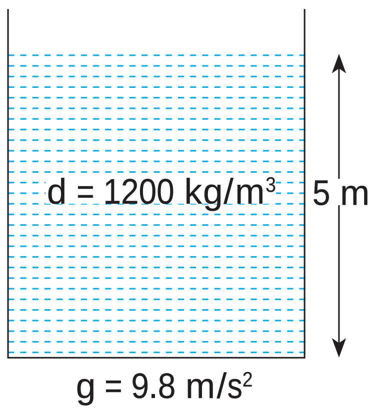
$$\therefore \quad \boxed{P = hdg} \quad \text{Proved.}$$

The above relation shows that the pressure exerted by a liquid depends on the following three factors.

1. Height of the liquid column or depth of the liquid column (h)
2. Density of the liquid (d)
3. Acceleration due to gravity (g)

Worked out Numerical: 2

Study the given figure and calculate the pressure exerted by the liquid at the bottom of the vessel.



Given,

Height (h) = 5 m

Density (d) = 1200 kg/m^3

Acceleration due to gravity (g) = 9.8 m/s^2

Liquid pressure (P) = ?

We know,

$$P = hdg$$
$$= 5 \times 1200 \times 9.8$$
$$= 58800 \text{ Pa}$$

$\therefore$ Pressure exerted by liquid (P) = 58800 Pa.

Worked out Numerical: 3

The dimension of a water tank is 10 m × 8 m × 6m. Calculate the pressure exerted at the bottom of the tank when it is half-filled with water. [Take g = 9.8 m/s^2]

Given,

Height of water column (h) = $\frac{6}{2}$ [$\because$ The tank is half-filled.]

= 3 m

Acceleration due to gravity (g) = 9.8 m/s^2

Liquid pressure (P) = ?

We know,

$$P = hdg$$
$$= 3 \times 1000 \times 9.8 \quad [\because \text{Density of water (d)} = 1000 \text{ kg/m}^3]$$
$$= 29400 \text{ Pa}$$

$\therefore$ The pressure exerted by water at the bottom of the tank (P) = 29400 Pa.

Properties of liquid Pressure

1. Liquid pressure increases with increase in the height of liquid column or depth

The pressure exerted by a liquid increases when the depth of the liquid or the height of the liquid column increases and vice-versa. In other words, liquid pressure is directly proportional to the height of the liquid column ($\therefore P \propto h$). Due to this, the force of water in the tap of the ground floor is maximum and that in the tap of the uppermost floor in minimum. The wall of water dam is made thicker at the base so that the bottom of the wall can withstand more pressure. Similarly, deep sea divers wear special protective suits to prevent their body from crushing.

Activity 2

- Take a plastic bottle and make three holes at different heights as shown in the figure.
- Close the holes with corks.
- Fill the bottle completely with water.
- Open all the holes simultaneously and observe the speed of water in each hole.

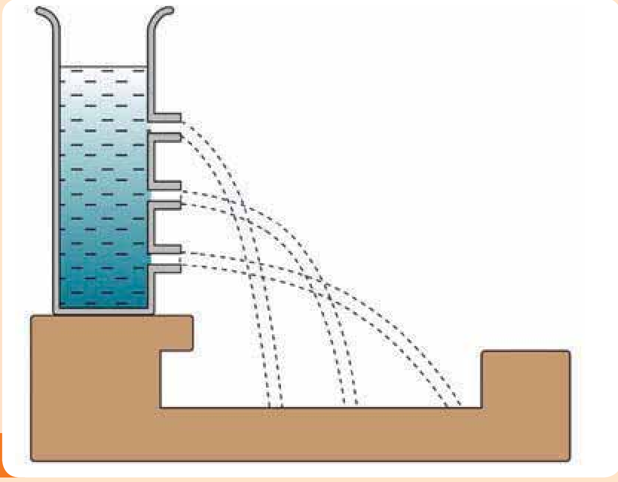


Fig. 4.7

Observation

The speed of flow of water is seen maximum at the lowermost hole and it decreases gradually in upper holes.

Conclusion

It proves that liquid pressure increases with depth.

2. Liquid pressure is transmitted equally in all directions when pressure is applied in the liquid kept in a closed container

Activity 3

- Take a balloon and fill it with water.
- Take a needle and make holes on all sides of the balloon. Now, press the balloon and observe the flow of the water through these holes.

Fig. 4.8

We can observe that the force of water coming out through all the holes will be the same. This activity proves that liquid pressure is transmitted equally in all directions when pressure is applied in the liquid kept in a closed container. This law of liquid pressure is called Pascal's law as this law was propounded by Blaise Pascal.

3. Liquid pressure is directly proportional to the density of liquid

Liquids having more density exert more pressure and vise-versa. The density of mercury is 13.6 times more than that of water. So, mercury exerts 13.6 times more pressure than that exerted by water when both liquids are kept in two similar vessels upto the same height.

4. Liquid determines its own level

Activity 4

- Take a Pascal's tube and fill it with water.
- Observe the level of water in all the tubes of different shapes and sizes.

We can see that water maintains same height in all the tubes.

This activity proves that liquid maintains its own level.

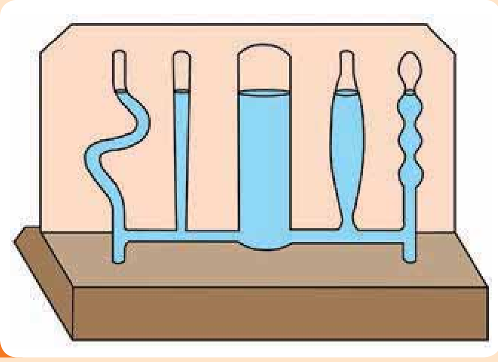


Fig. 4.9

Density

An iron block is felt heavier than the wooden block of the same shape and size. Similarly, sand is felt heavier than soil. It means that the density of iron is more than that of the wood. Similarly, the density of sand is more than that of the soil. The density of a substance can be defined as the mass per unit volume of the substance.

Formula of density,

$$\text{Density (d)} = \frac{\text{Mass (m)}}{\text{Volume (V)}}$$

$$\therefore \quad \boxed{d = \frac{m}{V}}$$

Units of density

The SI unit of mass is kilogram (kg) and that of volume is cubic metre (m^3). Therefore, the SI unit of density is kilogram per cubic metre (kg/m^3).

The CGS unit of density is gram per cubic centimetre (g/cm^3).

Activity 5

To calculate the density of soil and water

- Take a cuboid of a tin and fill it completely with soil. Measure the mass of the soil filled in the cuboid.
- Remove the soil from the cuboid and fill it completely with water. Measure the mass of the water.
- Now, measure the length, breadth and height of the cuboid and calculate its volume.
- Now, calculate the density of soil and water by using the given formula.

$$d = \frac{m}{V}$$

Relative Density

The relative density of a substance is the ratio of the density of substance to the density of pure water. It is calculated by the given formula.

$$\text{Relative density (R.D.)} = \frac{\text{Density of a substance}}{\text{Density of pure water}}$$

Since relative density is the ratio of two densities, it has no unit. The concept of relative density is used to compare the density of a given substance to the density of pure water. The substances whose relative density is less than that of water, float on water. Similarly, the substances whose relative density is more than that of water, sink in water.

Differences between Density and Relative density

Density	Relative density
1. It is the mass per unit volume of a substance.	1. It is the ratio of the density of a substance to the density of pure water.
2. Its SI unit is kg/m^3.	2. It has no unit.

Worked out Numerical: 4

The mass of a wooden block is 1600 kg and its volume is $2m^3$. Calculate the density of the wooden block.

Given,

Mass of wood (m) = 1600 kg

Volume of wood (V) = $2m^3$

Density (d) = ?

We know,

$$d = \frac{m}{V}$$

$$= \frac{1600}{2}$$

$$= 800\ kg/m^3$$

∴ The density of wooden block is $800\ kg/m^3$.

Worked out Numerical: 5

The density of gold is 19300 kg/m^3 and that of water is 1000 kg/m^3. Calculate the relative density.

Given,

Density of gold = 19300 kg/m^3

Density of water = 1000 kg/m^3

Relative density = ?

We know,

$$\text{Relative density} = \frac{\text{Density of gold}}{\text{Density of water}} = \frac{19300}{1000} = 19.3$$

$\therefore$ Relative density = 19.3

Floating and Sinking

A piece of ice floats on water but an iron nail sinks. Similarly, a piece of dry wood floats in water but a piece of stone sinks. The density of ice and wood are less than that of water. So they float in water. The density of iron and stone is more that of water. So they sink. It shows that the substances whose density is less than that of water float in water and the substances whose density is more than that of water sink.

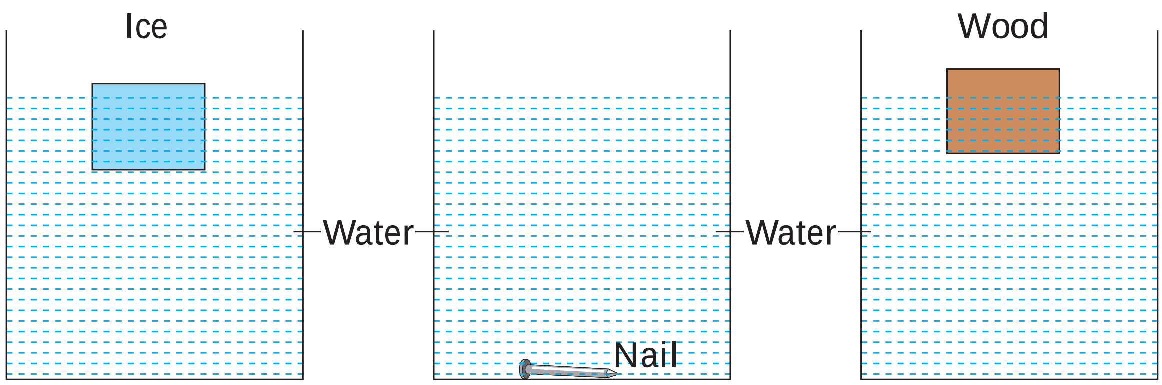


Fig. 4.10

Activity 6

Take a beaker and fill it with fresh water. Now, keep an egg in the beaker. The egg sinks in water because the density of egg is more than that of water. Now, dissolve some salt in water. Add some more salt and dissolve in water till the egg floats. In this case the density of salt solution becomes more than that of the egg. So the egg floats.

Do You Know

The floating and sinking of a substance depends on the density of the object and the density of liquid in which the body is kept.

Do You Know

An egg sinks in pure water but floats on concentrated salt solution, why?

The density of egg is more than that of water. So, an egg sinks in pure water but the density of egg is less than that of concentrated salt solution. So, an egg floats on concentrated salt solution.

Key Concepts

1. Pressure is defined as the thrust acting per unit area of the surface.
2. The gaseous envelope surrounding the earth is called the atmosphere.
3. The pressure exerted by atmosphere due to its weight is called the atmospheric pressure.
4. The thrust exerted by a liquid per unit area of the surface is called the liquid pressure.
5. The density of a substance can be defined as the mass per unit volume of the substance.
6. The substances whose density is less than that of water float in water and the substances whose density is more than that of water sink.

Exercise

1. Put tick a (√) for the correct statement and a cross (×) for the incorrect one.

a. The thrust acting per unit area of a surface is called pressure. ☐

b. Air does not exert pressure. ☐

c. The atmospheric pressure helps to fill ink in the pen. ☐

d. Liquid pressure decreases with the increase in height of liquid column. ☐

e. Relative density has no unit. ☐

2. Fill in the blanks using appropriate words.

a. The SI unit of pressure is ....

b. Pressure depends on thrust and ....

c. Mass per unit volume of a substance is called ....

d. The object whose density is less than water .... in water.

e. The density of mercury is .... times more than that of water.

3. Tick (√) the most appropriate answer from the given alternatives.

a. The force acting perpendicularly on a surface is called ....

☐ thrust ☐ pressure ☐ density ☐ volume

b. Pressure is measured in ....

☐ N/m^2 ☐ Nm^2 ☐ Nm ☐ N/m

c. The SI unit of density is ....

☐ kg/m^3 ☐ g/cm^3 ☐ kg/cm^3 ☐ g/m^3

d. The floating and sinking of a body depends on ....

☐ pressure ☐ thrust ☐ density ☐ mass

4. Answer the following questions.

a. What is thrust? Write down its SI unit.

b. Define pressure and write down the formula of pressure.

c. Name the factors that affect pressure exerted by a body.

d. What is liquid pressure? Prove that: P = hdg.

e. Write down the factors that affect liquid pressure.

f. State the properties of liquid pressure.

g. What is density? Write down its SI unit.

h. What is relative density?

i. What types of objects float in water?

j. What types of objects sink in water?

5. Differentiate between:

a. Thrust and Pressure

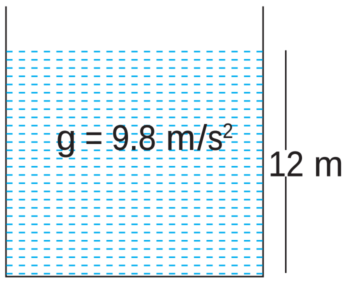
b. Density and Relative density

6. **Give reason.**
   a. We feel easier to cut vegetables with a sharp knife than a blunt one.
   b. The speed of flow of water from the tap is more at the ground floor than in the first floor.
   c. Ice floats on water but an iron nail sinks.
   d. Relative density has no unit.

7. **Describe an activity to prove that liquid pressure increases with the increase in height.**

Numerical Problems

1. The weight of a body is 600 N and its base area is 2m^2. Calculate the pressure exerted. [Ans: 300 Pa]
2. The mass of a wooden block is 50 kg and its base area is 100 cm^2. Calculate the pressure exerted by it. [Ans: 49000 Pa]
3. The depth of water in a pond is 5 m and the pressure exerted by water at the bottom of the pond is 49000 Pa. Calculate the acceleration due to gravity at that place. [Ans: 9.8 m/s^2]
4. The depth of water in a pond is 15 m. The density of water is 1000 kg/m^3 and acceleration due to gravity is 9.8 m/s^2. Calculate the pressure exerted by water. [Ans: 147000 Pa]
5. Study the given figure and calculate the pressure exerted by water at the bottom of the tank. [Ans: 117600 Pa]



6. The volume of a water tank is 5 m × 4 m × 2 m. If the tank is half-filled with water, calculate the pressure exerted at the bottom of the tank. [Ans: 19600 Pa]
7. The mass of an ice block is 500 kg and its density is 920 kg/m^3. Calculate the volume of the ice block. [Ans: 0.54 m^3]
8. The density of mercury is 13600 kg/m^3 and that of water is 1000 kg/m^3. Calculate the relative density. [Ans: 13.6]
9. The density of ice is 920 kg/m^3 and that of water is 1000 kg/m^3. Calculate the relative density. [Ans: 0.92]

Energy, Work and Power

Weighting Distribution (Approximate)	Teaching periods : 3	Marks (in %): 0

Before You Begin

Energy of a body is the capacity or ability of a body to work. Living beings cannot survive in the absence of energy. Similarly, energy is required to operate machines in industries, to run automobiles and so on. Work is said to be done when the force acting on a body produces motion in it in the direction of the force. In the SI system, work is measured in joule (J). The rate of doing work is called power. Its SI unit is watt (W). Energy, work and power are interrelated to each other.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce energy, work and power and explain the relationship among them.

ii. explain the transformation of energy and demonstrate it.

iii. write the formula to calculate energy, work and power.

iv. solve simple numerical problems related to energy, work and power.

Syllabus

- Introduction to energy, work and power
- Relationship among energy, work and power
- Transformation of energy
- Simple numerical problems related to energy, work and power

Glossary: A dictionary of scientific/technical terms

energy	:	the capacity of doing work
work	:	the product of force and displacement
power	:	the rate of doing work
potential energy	:	the form of energy that an object gains when it is lifted
kinetic energy	:	the form of energy that an object gains when it moves
transformation	:	conversion of one form of a substance into another
nuclear	:	related to nucleus of an atom
gravity	:	the force with which a body is pulled towards the surface of the earth or a planet

Energy

We need energy to do different types of works. The capacity or ability of a body to do work is called energy. In SI system, energy is measured in joule (J) Energy is a scalar quantity. Energy provides force to do work. The object having no energy cannot do work. Whenever work is done, energy is consumed.

Fig. 5.1

Forms of Energy

1. Mechanical energy

Mechanical energy is the energy possessed by a body due to its state of motion or of position. It is of two types:

a. Kinetic energy (KE) b. Potential energy (PE)

a. Kinetic energy

The energy possessed by a body by virtue of its motion is called kinetic energy. Running water, blowing air, the bullet fired from a gun, moving vehicle, rolling ball, etc. possess kinetic energy.

Formula for Kinetic Energy (KE = $\frac{1}{2}$ mv^2)

Let us consider a body of mass 'm' at rest (u = 0) is moving with an acceleration 'a'. Let 'v' be the final velocity of the body in moving the distance 's'.

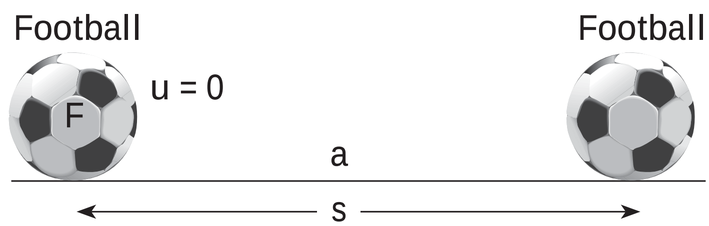


Fig. 5.2

According to the equation of motion,

$v^2 = u^2 + 2as$

or, $v^2 = 0 + 2as$ $[\because u = 0]$

or, $s = \frac{v^2}{2a}$ .... (1)

Now, Kinetic energy (KE) = Work done (W)

$KE = F \times s$ $[\because W = F \times s]$

$$KE = m\cancel{a} \times \frac{v^2}{2\cancel{a}} \qquad \left(\because F = m \times a,\quad s = \frac{v^2}{2a} \right)$$

$$KE = \frac{mv^2}{2}$$

$$\therefore \quad \boxed{KE = \frac{1}{2}mv^2}$$

From the above relation, it becomes clear that the kinetic energy (KE) of the body is directly proportional to the mass and square of the velocity of the moving body.

In short,

$KE \propto m$ .... (1)

$KE \propto v^2$ .... (2)

Activity 1

- Take a football. Throw it slowly and ask your friend to catch the ball. Repeat this activity by increasing the speed of the ball while throwing. Ask your friend to say the difference while catching the ball in both cases. More force is required to catch the ball thrown at a high speed than that in a low speed.
- Repeat the above activity with a cricket ball. The mass of a volleyball is more than that of a cricket ball. So less force is required to catch a tennis ball than that to catch a volleyball thrown at the same speed.

This activity proves that kinetic energy increases with increase in mass and velocity of the moving body and vice-versa.

Worked out Numerical: 1

A bullet of mass 10g is moving with the velocity of 250 km/h. Calculate the kinetic energy.

Given,

Mass of bullet (m) = 10 g

$$= \frac{10}{1000} \text{ kg} \qquad [\because 1\text{kg} = 1000 \text{ g}]$$

$$= 0.01 \text{ kg}$$

Velocity (v) = 250 km/h

$$= \frac{250 \times 1000}{60 \times 60} \text{ m/s} \qquad \left(\because \begin{array}{l} 1 \text{ km} = 1000 \text{ m} \\ 1 \text{ hr.} = 60 \text{ min.} \\ 1 \text{ min.} = 60 \text{ sec.} \end{array} \right)$$

$$= 69.44 \text{ m/s}$$

$\therefore$ Kinetic energy (KE) = ?

$$KE = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 0.01 \times (69.44)^2$$

$$= 24.10 \text{ J}$$

$\therefore$ Kinetic energy (KE) = 24.1 J

b. Potential energy

The potential energy of a body is defined as the energy possessed by the body by virtue of its position or configuration (change in shape or size). The energy stored in the stone lifted from the ground, stored water in a dam, stretched spring, stretched elastic, etc. are some examples of the objects having potential energy.

Formula of Potential Energy (PE = mgh)

Let us consider a body of mass 'm' is lifted to a height of 'h' from the surface of the ground.

Then,

Potential energy (PE) = work done (W)

or, $PE = F \times s$ $[\because W = F \times s]$

or, $PE = mg \times h$ $[\because F = mg, s = h]$

or, $PE = mgh$

$\therefore$ $\boxed{PE = mgh}$

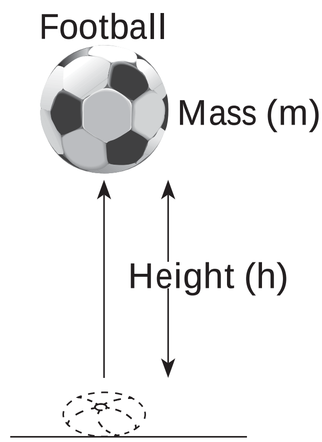


Fig. 5.3

Difference between Potential energy and Kinetic energy

Potential energy	Kinetic energy
1. Potential energy is the energy possessed by a body by virtue of its position or configuration.	1. Kinetic energy is the energy possessed by a body by virtue of its motion.
2. Potential energy is given by PE = mgh.	2. Kinetic energy is given by $KE = \frac{1}{2}mv^2$

Worked out Numerical: 2

A pumpkin of mass 8 kg is located at a height of 12 m from the ground. Calculate the potential energy stored in the pumpkin. [Take g = 9.8 m/s^2.]

Given,

Mass (m) = 8 kg

Height (h) = 12 m

Acceleration due to gravity (g) = 9.8 m/s^2

Potential energy (PE) = ?

We know,

PE = mgh = 8 × 9.8 × 12 = 940.8 J

∴ Potential energy (PE) = 940.8 J

Worked out Numerical: 3

How much potential energy is stored in 1m^3 water in a tank at the height of 18m from the earth's surface?

Given,

Mass of water in tank (m) = 1m^3

= 1000 litre

= 1000 kg (∴ 1*l* water = 1 kg water)

Height (h) = 18 m

Acceleration due to gravity (g) = 10 m/s^2

Potential energy (PE) = ?

We know,

PE = mgh

= 1000 × 10 × 18

= 180000 J

∴ Potential energy (PE) = 180000 J

Activity 2

- Take a catapult. Stretch the elastic of the catapult and throw a pebble in an open place. Be careful while throwing the pebble as it may hit birds, animals or people. Which energy helps to throw the pebble? Name the type of energy present in the stretched elastic of the catapult.

2. Chemical energy

We get energy stored in the food we eat. When petrol is burnt in the engine of a car, the chemical energy stored in petrol is used to run the car. The energy stored in a matter is called chemical energy. Bread, coal, petrol, diesel, battery, wood, oil, etc. have chemical energy stored in them. The chemical energy is released when chemical change takes place. Some sources of chemical energy are given below:

Fig. 5.4

Bread

Kerosene

Cell

3. Sound energy

Sound energy is the form of energy which is produced due to the vibration of a material medium. A vibrating body possesses sound energy. Loudspeaker, radio, television, horn of vehicles, temple bell, etc. are some sources of sound energy.

Sound can be experienced as of form a energy when the window panes shatter due to an explosion or when loud sound is produced by a low-flying aeroplane.

Fig. 5.5

Loudspeaker produces sound

4. Light energy

Light is a form of energy which makes things visible. Light is produced by extremely hot objects. The sun, lantern, torch light, electric bulb, kerosene lamp, etc. are some sources of light energy. The sun is the main source of light energy for the earth.

Fig. 5.6

The sun

5. Electrical energy

The form of energy which is produced due to continuous flow of electrons is called electrical energy. A cell, photocell, battery, generator, etc. are the sources of electrical energy. Electrical energy is used to rotate fans, drive trains, light bulbs, operate equipment like television, computer, camera and mobile phone.

Fig. 5.7

Lighting CFL

Do You Know

Modern life is not possible without electrical energy. Electrical energy is used to run machines in factories. It is used to operate electric trains, trolley buses, lift, fans in summer and heater in winter, motor to pump water from a well, etc. Since, electrical energy has more advantages than other forms of energy, electrical energy is widely used among the various types of energy.

6. Heat energy

The form of energy which gives the sensation of warmth is called heat energy. Electric heater, sun, burning coal, etc. are some sources of heat energy. The burning of diesel in a truck engine provides the energy needed to run the truck. Similarly, the heat energy produced from burning fire is used to cook food.

Fig. 5.8

Burning coal

Differences between Electrical energy and Heat energy

Electrical energy	Heat energy
1. Electrical energy is produced due to the continuous flow of electrons through a conductor.	1. The energy produced due to the vibration of molecules of a body is called heat energy.
2. It is mainly produced due to the flow of electrons.	2. It is mainly produced due to the molecular vibration of atoms or molecules.

7. Magnetic energy

The energy obtained from a magnet is called magnetic energy. It is used in electric bell, loudspeaker, mobile phone, television, radio, etc. Similarly, magnetic energy is used to generate electricity.

Fig. 5.9

Magnet attracting iron nails

8. Nuclear energy

The energy obtained from the nucleus of a atom is called nuclear energy. This energy can produce a large amount of heat and light energy. Nuclear energy is used in atomic power plants to produce electricity. Similarly, nuclear energy is used for making atom bomb, hydrogen bomb, etc.

Fig. 5.10 *Bomb explosion*

Work Done

Work is said to be done when the force acting on a body produces motion in it in the direction of the force. In other words, work done is defined as the product of force and displacement. In the SI system, work is measured in joule (J) or newton-metre (Nm).

Formula of work done

Work done (W) = Force (F) × Displacement (s) $\therefore$ $W = F \times s$

No mechanical work is done when a student studies for 2-3 hours sitting on a chair. Similarly, no work is done by a teacher teaching a class. Work is said to be done only if the force applied to a body succeeds in moving it. When a person pushes a wall, no work is done because the wall does not cover distance. But work is done when a person pushes a cart because the cart covers some distance.

Fig. 5.11 *A man pushing a wall (No work is done)*

A man pushing a cart (Some work is done)

Therefore, the work done by a body depends on:

a. The magnitude of force applied (F)

b. The distance covered in the direction of the force (s) applied

Differences between Work and Energy

Work	Energy
1. Work is the product of force and displacement in the direction of force.	1. The capacity or ability of a body to do work is called energy.
2. It is usually of two types.	2. It is of various types.

One joule work

When one newton force displaces a body through a distance of one metre, the work done is called one joule.

In short,

1 joule = 1 newton × 1 metre   [∵ W = F × s]

Types of Work

There are two types of work. They are:

a. Work done against friction

b. Work done against gravity

Do You Know

No work is done when a person is standing by carrying a load of 100 kg for one hour because for the work to be done by a person there should be some distance covered by the person because work done is the product of force and displacement.

a. Work done against friction

The work done by pushing or pulling an object on a surface is called work done against friction. For example, work done by pulling a wooden log on the road, work done by pushing a cart, etc.

b. Work done against gravity

The work done by lifting a body vertically upward from the earth's surface is called work done against gravity. For example, work done by a crane by lifting a wooden log vertically upward from the ground.

Do You Know

Friction is the force which opposes the motion of a body moving on other body when they are in contact.

Formula of work done against gravity

Work done against gravity (W) = Force × displacement

or, W = Weight × height   [∵ Force = Weight (mg, Displacement = Height (h)]

∴ $\boxed{W = mgh}$

Difference between Work against gravity and Work against friction

Work against gravity	Work against friction
1. It is the work done by lifting a body from the earth's surface.	1. It is the work done by dragging a body over the surface of another body.
2. This work can be done by lifting an object.	2. This work can be done by dragging a body over a surface of another body.

Worked out Numerical: 3

A force of 600 N displaces a body through 50 m. Calculate the work done.

Given,

Force (F) = 600 N

Displacement (s) = 50 m

Work done (W) = ?

We know,

W = F × s

= (600 × 50) Nm

= 30000 J

∴ Work done (W) = 30,000 J.

Worked out Numerical: 4

A crane lifts a wooden log of 200 kg upto a height of 25 m from the earth's surface. Calculate the work done against gravity. [Take g = 9.8 m/s^2.]

Given,

Mass of wooden log (m) = 200 kg

height (h) = 25 m

Acceleration due to gravity (g) = 9.8 m/s^2

Work done (W) = ?

We know,

W = mgh

= 200 × 9.8 × 25

= 49000 J

∴ The work done against gravity (W) =- 49,000 J.

Transformation of Energy

The process in which one form of energy is converted into another is called transformation of energy. An electric bulb converts electrical energy into light and heat energy, a solar cell converts light energy into electrical energy and a loudspeaker converts electrical energy into sound energy. These are some examples of transformation of energy.

Fig. 5.12

Some examples of energy transformation and the devices required are as follows:

S.N.	Devices	Energy transformation
1.	Electric bulb	Electrical energy → Light energy and heat energy
2.	Cell or battery	Chemical energy → Electrical energy
3.	Loud speaker	Electrical energy → Sound energy
4.	Microphone	Sound energy → Electrical energy
5.	Television	Electrical energy → Light and sound energy
6.	Electric motor	Electrical energy → Mechanical energy
7.	Dynamo or generator	Mechanical energy → Electrical energy
8.	Electromagnet	Electrical energy → Magnetic energy
9.	Solar cell / panel	Light energy → Electrical energy
10.	Heater	Electrical energy → Heat energy

Law of conservation of energy

According to law of conservation of energy, "Energy can neither be created nor be destroyed. Energy can only be changed from one form to another."

Activity 2

- Take a cell, two pieces of copper wire, a bulb and a bulb holder.
- Connect these materials to light the bulb.
- What type of transformation of energy occurs here? Discuss in your class.

Power

Power can be defined as the rate of doing work. The SI unit of work done is joule (J) and that of time is second (s). So the SI unit of power is J/s or W (watt). Power is also measured in kilowatt (kW), megawatt (MW), horsepower (h.p.), etc.

Formula to calculate power (P)

$$\text{Power (P)} = \frac{\text{Work done (W)}}{\text{Time taken (t)}}$$

$$\therefore \quad P = \frac{W}{t}$$

From the above relation, it becomes clear that power (P) depends on two factors, viz. amount of work done (W) and time taken (t).

Two machines that do the same amount of work can have different power. For example, machine A completes 100 J work in 10 seconds. But machine B completes 100 J work in 5 seconds.

$$\text{Power of machine A } (P_A) = \frac{W}{t} = \frac{100}{10} = 10 \text{ W}$$

$$\text{Power of machine B } (P_B) = \frac{W}{t} = \frac{100}{5} = 20 \text{ W}$$

From the above calculation, it becomes clear that when a body takes lesser time to do a particular work, the power is said to be greater and vice-versa.

One watt power

One watt power can be defined as the rate of doing one joule work in a time of one second.

In short, $1 \text{ watt} = \frac{1 \text{ joule}}{1 \text{ second}}$

Meaning of 1200 W written on an electric heater: It means that the electric heater converts 1200 J of electrical energy into heat energy in 1 second.

$$\therefore \quad 1200 \text{ W} = \frac{1200 \text{ J}}{1\text{s}}$$

The relation among watt (W), kilowatt (kW), megawatt (MW) and horse power (h.p.):

1000 W	= 1 KW
1000 kW	= 1 MW
746 W	= 1 h.p.

Worked out Numerical: 5

A man pulls a cart of 60 kg and covers a distance of 20 m in 5 seconds. Calculate the power of the man.

Given,

Mass (m) = 60 kg

∴ Weight or Force (F) = m × g

or, Force (F) = 60 × 9.8 [∵ g = 9.8 m/s^2]

= 588 N

Distance (s) = 20 m

time (t) = 5 s

We know,

$$P = \frac{W}{t} = \frac{F \times s}{t} = \frac{588 \times 20}{5} = 2352\ W$$

∴ Power of the person (P) = 2352 W

Worked out Numerical: 6

A crane lifts a load of 50000 N upto a height of 50 m in 10 seconds. Calculate the power of the crane in horsepower.

Given,

Load (F) = 50000 N

Height (h) = 50 m

Time (t) = 10 s

Power (P) = ?

We know,

$$P = \frac{W}{t} = \frac{F \times h}{t} \quad [\because W = F \times h]$$

$$= \frac{50000 \times 50}{10} = 250000\ W = \frac{250000}{746}\ \text{h.p.} \quad [\because 1\ \text{h.p.} = 746\ W]$$

$$= 335.12\ \text{h.p.}$$

∴ Power of the crane (P) = 335.12 h.p.

Relation Among Energy, Work and Power

There is a close relationship among energy, work and power. Energy is the capacity of a body to do work. A person or object cannot do work without energy. Human beings cannot do work without energy and they eat food to get energy. After digestion, the chemical energy present in food changes into muscular energy. We use muscular energy to do various types of work. Work is the product of force and displacement. It is the effect of energy.

Power is the rate of doing work. It is the rate of transformation of energy. Work done does not depend on the time taken but the time taken to do a particular work determines the power. Two machines or person that perform the same amount of work can have different power. The capacity of a body to do work is called energy and the rate of doing work is called power. Therefore, energy, work and power are interrelated to each other.

Differences between Work, Energy and Power

Work	Energy	Power
1. Work is the product of force and displacement in the direction of force.	1. The capacity or ability of a body to do work is called energy.	1. Power is the rate of doing work.
2. It is usually of two types.	2. It is of various types.	2. It is also of various types.
3. Its SI unit is joule (J).	3. Its SI unit is also joule (J)	3. Its SI unit is watt (W).

Key Concepts

1. The capacity or ability of a body to do work is called energy.
2. There are different forms of energy. They are mechanical energy, heat energy, light energy, sound energy, chemical energy, electrical energy and magnetic energy.
3. Mechanical energy is the energy possessed by a body due to its state of motion or of position. It is of two types, viz. kinetic energy and potential energy.
4. The energy possessed by a body by virtue of its motion is called kinetic energy.
5. The potential energy of a body is defined as the energy possessed by the body by virtue of its position or configuration (change in shape or size).
6. The work done by pushing or pulling an object on a surface is called work done against friction.

7. The work done by lifting a body vertically upward from the earth's surface is called work done against gravity.
8. The rate of doing work is called power. Its SI unit is watt (W).
9. According to law of conservation of energy, "Energy can neither be created nor be destroyed. Energy can only be changed from one form to another."
10. One watt power can be defined as the rate of doing one joule work in a time of one second.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. The capacity of a body to do work is called energy. ☐

b. The PE of a body kept on the earth's surface is zero. ☐

c. The SI unit of work done is watt. ☐

d. Loud speaker converts sound energy into electrical energy. ☐

e. Energy can neither be created nor destroyed. ☐

2. Fill in the blanks using appropriate words.

a. The SI unit of energy is ....

b. The formula to calculate kinetic energy is ....

c. Electric bulb converts .... into ....

d. Solar cell converts .... into ....

e. The rate of doing work is called ....

3. Tick (√) the most appropriate answer from the given alternatives.

a. Which of the following is the main source of light energy?

☐ sun ☐ moon ☐ bulb ☐ candle

b. .... energy is produced due to vibration of material medium.

☐ heat ☐ light ☐ sound ☐ chemical

c. Which of the given devices converts electrical energy into heat energy?

☐ television ☐ battery ☐ heater ☐ bulb

d. The SI unit of power is ....

☐ J ☐ Nm ☐ W ☐ Js

4. Answer the following questions.

a. What is energy? Write down its SI unit.
b. Name any five forms of energy.
c. Define mechanical energy with any two examples.
d. What is potential energy? Write down the formula to calculate potential energy.
e. Define kinetic energy with any two examples.
f. What is chemical energy? Name any three objects having chemical energy.
g. Define heat energy and light energy.
h. What is nuclear energy? Write its one use.
i. What is meant by work done? Define one joule work.
j. What is meant by work done against gravity? Give one example of work done against friction.
k. What is meant by transformation of energy? Give any two examples.
l. What is power? Write its SI unit.
m. Define one watt power.

5. Name the devices that convert the following.

a. Electrical energy into mechanical energy
b. Light energy into electrical energy
c. Mechanical energy into sound energy
d. Electrical energy into heat energy
e. Sound energy into electrical energy

6. Prove that:

a. $PE = mgh$ b. $KE = \frac{1}{2}mv^2$

7. Differentiate between:

a. Kinetic energy and Potential energy
b. Work and Power

c. Heat energy and Sound energy
d. Energy and Power

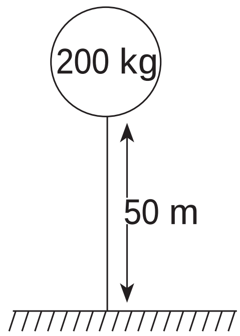
8. **Name the form of energy present in the given objects/devices.**

a. Battery
b. Bread
c. Running water
d. Water stored in a dam
e. Stretched catapult
f. Bullet fired from a gun
g. Lighting bulb
h. Ringing bell
i. Tuning radio

Numerical Problems

1. Calculate the potential energy stored in a metal ball of a mass of 80 kg kept at a height of 15 m from the earth's surface. What will be the potential energy when the metal ball is kept on the earth's surface. [Take $g = 9.8\ m/s^2$] [Ans: 11760 J, 0J]

2. Study the given figure and calculate the potential energy. [Take $g = 9.8\ m/s^2$] [Ans: 98000 J]



3. A bullet of mass of 50 g is moving with the velocity of 200 km/h. Calculate the kinetic energy of the bullet. [Ans: 77.16 J]

4. A bullet moving with the velocity of 200 km/h has the kinetic energy of 77.16 J. Calculate the mass of the bullet. [Ans: 50 g]

5. Sanu carries an object 20 m away by applying 500 N force. Calculate the work done. [Ans: 10000 J]

6. How much work is done while pushing a box of mass of 35 kg at a distance of 20 m? [Ans: 6860 J]

7. A crane lifts a load of 6000 N at the height of 20 m in 5 seconds. Calculate the power of the crane in horse power. [Ans: 32.17 h.p.]

8. Suman with a mass of 45 kg climbs a 3m high ladder in 10 seconds. Calculate her power. [Ans: 132.3W]

UNIT 6

Heat

Weighting Distribution (Approximate)	Teaching periods : 4	Marks (in %): 1

Before You Begin

When we touch a burning candle, we feel hot and when we touch ice, we feel cold. How do we get such a sensation? It is due to the flow of heat from a hot object to a cold one. When we touch a burning candle, heat flows from the flame of candle to our body and we feel hot. When we touch ice, heat flows from our body to the ice and we feel cold. Heat is a form of energy which gives us the sensation of warmth, i.e. hotness or coldness. The degree of hotness or coldness of a body is called its temperature.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce heat and temperature and differentiate between them.

ii. explain the determination of units of temperature and show the relationship between them.

iii. explain the structure and working mechanism of simple and clinical thermometer.

Syllabus

- Heat and temperature
- Differences between heat and temperature
- Thermometer and its structure
- Thermometric liquids
- Upper fixed point and lower fixed point
- Transformation of unit of temperature
- Types of thermometer (Laboratory and clinical thermometer)

Glossary: A dictionary of scientific/technical terms

heat	:	the form of energy which produces sensation of warmth
temperature	:	the degree of hotness or coldness of a body
calorimeter	:	the device which is used to measure the heat of a body
thermometer	:	the device which is used to measure the temperature of a body
sensation	:	a feeling that we get when we touch something or something affects our body
expansion	:	the process of becoming larger or increasing in volume
contraction	:	the process of becoming smaller or decreasing in volume

Heat

Concept of Heat

If we touch boiling water, we feel hot. When we touch an ice cube, we feel cold. Heat gives us the sensation of hotness or coldness. So, heat is a form of energy which produces the sensation of warmth. Heat is the energy that is transferred from one object to another because of temperature difference between them. Heat always flows from a hot body to a cold body. Heat can also be defined as the sum of kinetic energy of the molecules present in a body. Heat is measured by using calorimeter.

Units of heat

The SI unit of heat is joule (J). The CGS unit of heat is calorie (Cal.). The bigger units of heat are kilojoule (kJ), kilocalorie (kcal), etc.

Concept of Temperature

The temperature of a body is defined as the degree of hotness or coldness of a body. It can also be defined as the average kinetic energy of the molecules present in a body. Temperature of a body is the measure of the average kinetic energy or thermal energy of its molecules. Temperature is the property of a substance which determines the direction of flow of heat. Temperature is measured by using thermometer.

Do You Know

Heat always flows from the body at higher temperature to the body at lower temperature.

Units of temperature

The SI unit of temperature is kelvin (K). But temperature is commonly measured in degree Celsius (°C) and degree Fahrenheit (°F).

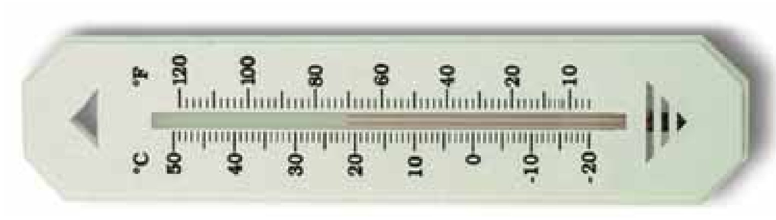
Differences between Heat and temperature

Heat	Temperature
1. Heat is the sum of kinetic energy present in the molecules of a body.	1. Temperature is the average kinetic energy present in the molecules of a body.
2. It is measured by using calorimeter.	2. It is measure by using thermometer.
3. Its SI unit is joule (J).	3. Its SI unit is kelvin (K).

Thermometer

We can feel hotness or coldness of a body by touching it. But we cannot measure the temperature of that body just by touching. A device that is used to measure the temperature of a body is called thermometer. So, thermometer is the device which is used to measure the temperature of a body.

Fig. 6.1



Thermometer

Principle of construction of thermometer

When a body is heated, it expands and when it is cooled, it contracts. This is the working principle of a thermometer. Thermometer can be made by using liquid or gas as they expand more than the solids. However, we commonly use liquid thermometers.

Types of Thermometer

There are different types of thermometers. But in this unit, we will study two types of thermometers, viz. laboratory thermometer and clinical thermometer.

1. Laboratory thermometer

The thermometer which is used to measure the temperature of various objects in a laboratory is called the laboratory thermometer. It consists of a capillary tube made of glass in which one end is closed and another end is connected to a cylindrical bulb.

Fig. 6.2

Laboratory thermometer

The cylindrical bulb has a small portion of the capillary tube filled with mercury or coloured alcohol. The air from the capillary tube is completely taken out before closing the open end of the capillary tube. The scale in the laboratory thermometer ranges from – 10° C to 110° C.

While measuring the temperature of a body, the bulb of the thermometer is kept in close contact of the body. As the bulb comes in contact with the hot body, the thermometric liquid inside the bulb expands and rises upwards in the capillary tube. Finally the liquid gives a constant level, which is the temperature of the body. When the bulb of the thermometer is kept in a cold body, the thermometric liquid contracts upto a constant level which shows the temperature of the cold body.

2. Clinical thermometer

The thermometer which is used to measure the temperature of the human body is called clinical thermometer. It consists of a prismatic glass tube having a constriction in the capillary tube near the bulb. The constriction allows the mercury to rise up in the capillary tube while measuring the temperature. But it does not let mercury to fall back immediately when removed from the body. It helps to take accurate reading of the body temperature.

Fig. 6.3

Clinical thermometer

In a clinical thermometer, the temperature scale ranges from 35°C to 42°C because the average human body temperature is 37°C.

While measuring temperature of the human body, the bulb of the clinical thermometer is kept in the mouth or armpit of the person for a while. The mercury remains at the original level due to contraction after its removal from the body. It helps to take accurate measurement of the body temperature.

Differences between Clinical thermometer and Simple thermometer

Clinical thermometer	Simple thermometer
1. It is constructed for measuring the temperature of human body.	1. It is constructed for measuring the temperature of different bodies in laboratory.
2. It has constriction near the bulb.	2. It has no constriction near the bulb.
3. In this thermometer, the scale ranges from 36°C – 42° C.	3. In this thermometer, the scale ranges from –10°C to 110°C.

Thermometric Liquids

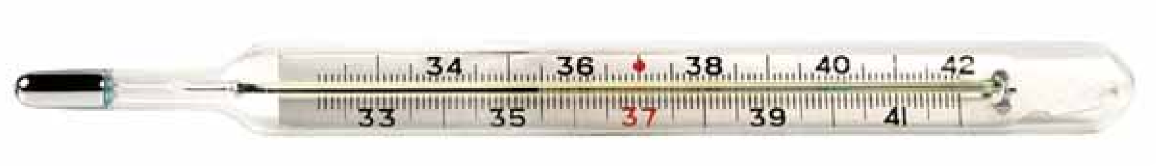
Two liquids, i.e. mercury and alcohol are used in a thermometer. These liquids are called thermometric liquids. The liquids which are used in a thermometer are called thermometric liquids.

Advantages of mercury as a thermometric liquid

1. Mercury can be seen clearly in the capillary tube as it is a silvery white liquid.
2. It has a uniform rate of expansion and contraction.
3. It is a good conductor of heat as it is a liquid metal.

4. It can measure a wide range of temperature because the freezing point of mercury is –39°C and boiling point is 357°C.
5. Mercury does not stick to the inner wall of capillary tube.

Fig. 6.4



Mercury thermometer

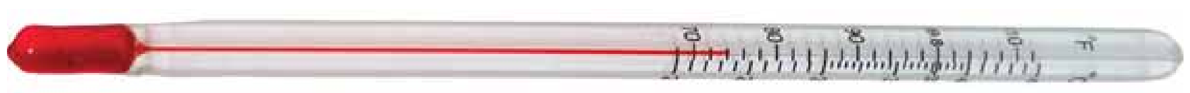
Disadvantage of mercury as a thermometric liquid

A mercury thermometer cannot measure very cold temperature as the freezing point of mercury is –39°C. Therefore, mercury thermometer is not suitable to measure very low temperature in cold countries.

Advantages of alcohol as a thermometric liquid

1. Alcohol is suitable to measure very low temperature in cold countries as its freezing point is –115°C.
2. It can measure accurate temperature as its rate of expansion is six times more than that of mercury.
3. It is not very expensive.

Fig. 6.5



Alcohol thermometer

Disadvantages of alcohol as a thermometric liquid

1. Alcohol is not suitable to measure the temperature above 78°C because its boiling point is 78°C.
2. It is a bad conductor of heat. So, it has no uniform rate of expansion and contraction.
3. It cannot give accurate measurement of temperature because it sticks to the inner wall of the capillary tube.

Differences between Mercury and Alcohol

Mercury	Alcohol
1. Its boiling point is 357°C and freezing point is –39°C.	1. Its boiling point is 78°C and freezing point is –117°C.
2. It is metal.	2. It is non-metal.

Calibration of Thermometer

Calibration of thermometer is the process of determining the scale in a thermometer. For this process, two fixed points, viz. lower fixed point and upper fixed point are determined.

a. Lower fixed point

The temperature of pure melting ice at the standard temperature and pressure is called the lower fixed point. It is 0°C or 273 K at standard atmospheric pressure, i.e. 760 mmHg.

b. Upper fixed point

The temperature of pure boiling water at the standard temperature and pressure is called the upper fixed point. It is 100°C or 373 K at standard atmospheric pressure, i.e 760 mm Hg.

During calibration of a thermometer, first of all, the upper fixed point and the lower fixed point are determined. Then the distance between these two points is divided into 100 equal divisions in Celsius and Kelvin scale and into 180 equal divisions in Fahrenheit scale.

Activity 1

To determine the lower fixed point of the thermometer, i.e. ice point

- Take a glass funnel and keep some ice cubes into it.
- Take a thermometer and insert its bulb into ice cubes.
- As the bulb is inserted in the ice cube, the level of mercury drops down in the capillary tube and shows a constant reading after sometime.

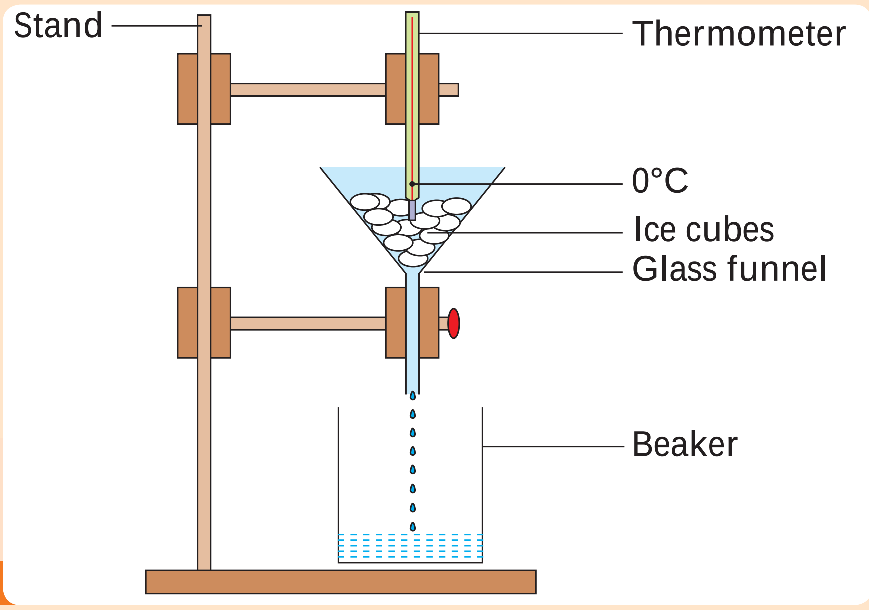


Fig. 6.6

The constant temperature is the melting point of ice. It is called the lower fixed point or ice point. Its value is 0°C or 32°F or 273 K.

Activity 2

To determine the upper fixed point of the thermometer, i.e. steam point

- Take a round bottom flask and keep some pure water into it.
- Insert a thermometer and a glass tube with the help of cork as shown in the figure.

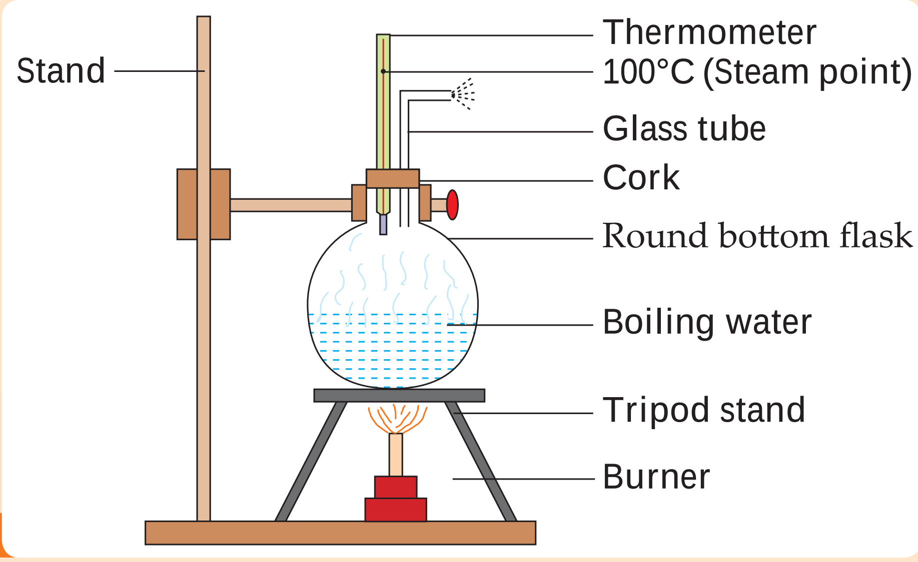


Fig. 6.7

Please note that the bulb of the thermometer should not touch water in the flask.

- Take a bunsen burner and boil the water in the flask for a while. Observe the level of mercury in the thermometer.

When water is heated, the level of mercury rises up in the capillary tube.

When water boils, the thermometer shows a constant reading which is known as the upper fixed point or steam point. Its value is 100°C or 212°F or 373 K.

Temperature Scales

There are three temperature scales for measuring temperature by thermometer. They are as follows:

1. Celsius scale
2. Fahrenheit scale
3. Kelvin scale

1. Celsius scale

In Celsius scale, the melting point of ice, i.e. 0°C is taken as the lower fixed point and the boiling point of water,

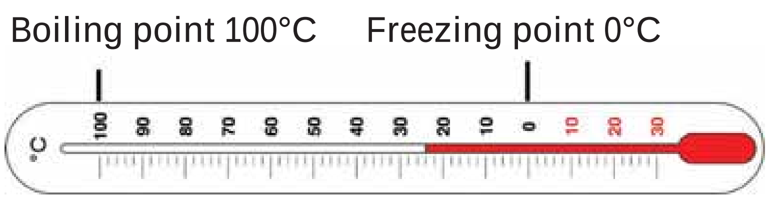


Fig. 6.8

Celsius scale

i.e. 100°C is taken as the upper fixed point. There are 100 equal division between 0°C and 100°C in this scale. Each division is called 1°C.

2. Fahrenheit scale

In Fahrenheit scale, the temperature of melting ice, i.e. 32°F is taken as the lower fixed point and the boiling point of water, i.e. 212°F is taken as the upper fixed point. In this scale, there are 180 equal divisions between 32°F and 180°F. Each division is called 1°F.

3. Kelvin scale

In Kelvin scale, the melting point of ice, i.e. 273 K is taken as the lower fixed point and the boiling point of water, i.e. 373 K is taken as the upper fixed point. There are 100 equal divisions between 273 K and 373 K. Each division is called 1 K.

Temperature scales	Melting point of ice	Boiling point of water
Celsius scale	0°C	100°C
Fahrenheit scale	32°F	212°F
Kelvin scale	273 K	373 K

Relation among Celsius, Fahrenheit and Kelvin scales

$$\frac{C-0}{100-0} = \frac{F-32}{212-32} = \frac{K-273}{373-273} \text{ q} \because \frac{\text{Scale} - \text{Lower fixed point}}{\text{Upper fixed point} - \text{Lower fixed point}} \text{ r}$$

$$\therefore \boxed{\frac{C-0}{100} = \frac{F-32}{180} = \frac{K-273}{100}}$$

Relation between Celsius scale and Fahrenheit scale

$$\frac{C-0}{100} = \frac{F-32}{180}$$

Relation between Celsius scale and Kelvin scale

$$\frac{C-0}{100} = \frac{K-273}{100}$$

Do You Know

The boiling temperature of alcohol is only 78°C. So, very high temperature cannot be measured by alcohol thermometer.

Relation between Fahrenheit scale and Kelvin scale

$$\frac{F-32}{180} = \frac{K-273}{100}$$

Worked out Numerical: 1

Convert 98.6°F in °C.

We know,

$$\frac{C-0}{100} = \frac{F-32}{180}$$

or, $\frac{C}{100} = \frac{98.6-32}{180}$

or, $C = \frac{66.6}{180} \times 100$

or, $C = 37$

$\therefore$ 98.6°F = 37°C

Worked out Numerical: 2

Convert –40°F into °C.

We know,

$$\frac{C-0}{100} = \frac{F-32}{180}$$

or, $\frac{C}{100} = \frac{-40-32}{180}$

or, $\frac{C}{100} = \frac{-72}{180}$

or, $180 \times C = -72 \times 100$

or, $C = \frac{-7200}{180}$

or, $C = -40$

$\therefore$ 40°F = –40°C

Worked out Numerical: 3

Convert 100°C into °F.

We know,

$$\frac{C-0}{100} = \frac{F-32}{180}$$

or, $$\frac{100-0}{100} = \frac{F-32}{180}$$

or, $$1 = \frac{F-32}{180}$$

or, $180 = F - 32$

or, $F = 180 + 32$

or, $F = 212$

$\therefore$ 100°C = 212°F

Activity 3

- Go to the science laboratory with your science teacher. Study the structure and working mechanism of a clinical and laboratory thermometer.
- Measure the temperature of melting ice, hot water and boiling water using a laboratory thermometer.

Activity 4

- Take a clinical thermometer and measure your body temperature.
- Compare your body temperature with your friend's body temperature.

Key Concepts

1. Heat can be defined as the sum of kinetic energy of the molecules present in a body. Its SI unit is joule (J).
2. Temperature can be defined as the average kinetic energy of the molecules present in a body. Its SI unit is kelvin (K).
3. A device which is used to measure the temperature of a body is called thermometer.
4. When a body is heated, it expands and when it is cooled, it contracts. This is the working principle of a thermometer.
5. The thermometer which is used to measure the temperature of a human body is called clinical thermometer.
6. Two liquids, i.e. mercury and alcohol are used in a thermometer. These liquids are called thermometric liquids.

7. Calibration of thermometer is the process of determining the scale in a thermometer.
8. The temperature of pure melting ice at the standard temperature and pressure is called the lower fixed point or ice point.
9. The temperature of pure boiling water at the standard temperature and pressure is called the upper fixed point or steam point.
10. There are three scales for measuring temperature by thermometer. They are (i) Celsius scale (ii) Fahrenheit scale and (iii) Kelvin scale.

Exercise

1. Put a (√) for the correct statement and a cross (×) for the incorrect one.

a. Heat is the sum of kinetic energy present in the molecules of a body. ☐

b. Temperature is measured by using calorimeter. ☐

c. The melting point of ice is taken as the lower fixed point. ☐

d. Alcohol thermometer cannot measure the temperature of boiling water. ☐

e. Mercury and alcohol are thermometric liquids. ☐

2. Fill in the blanks using appropriate words.

a. The SI unit of heat is ....

b. .... is the average kinetic energy of molecules.

c. The boiling point of water is ....

d. .... thermometer is not suitable to measure the temperature in very cold countries.

e. The melting point of pure ice is .... °C.

3. Tick (√) the most appropriate answer from the given alternatives.

a. The SI unit of temperature is ....

☐ K ☐ °C ☐ °F ☐ J

b. The boiling point of mercury is ....

☐ 100°F ☐ 100°C ☐ 212°C ☐ 357°C

c. The average temperature of the human body is ....

☐ 37°F ☐ 37°C ☐ 98.6°C ☐ 32°F

d. In Fahrenheit scale, there are .... equal divisions between lower fixed point and upper fixed point.

☐ 100 ☐ 180 ☐ 212 ☐ 32

4. Answer the following questions.

a. Define heat and write its SI unit.

b. Name the instrument which is used to measure heat.

c. What is temperature? Write its SI unit.

d. What is thermometer? Write down its working principle.

e. What is laboratory thermometer? Draw a neat and labelled figure of a laboratory thermometer.

f. Why is clinical thermometer used?

g. What are thermometric liquids? Give two examples.

h. Write any two advantages and two disadvantages of alcohol as a thermometric liquid.

i. Why is mercury used as a thermometric liquid? Give any two reasons.

j. What is meant by calibration of a thermometer?

k. Define lower fixed point and upper fixed point.

l. What are temperature scales? Write down the relation among Celsius, Fahrenheit and Kelvin scales.

5. Give reason.

a. Clinical thermometer has a constriction near the bulb.

b. Mercury thermometer is not suitable to measure extremely low temperature.

c. Clinical thermometer cannot measure the temperature of boiling water.

6. **Differentiate between:**

   a. Heat and Temperature

   b. Laboratory thermometer and Clinical thermometer

   c. Mercury and Alcohol

   d. Celsius scale and Fahrenheit scale

7. **Describe the structure of a clinical thermometer with a neat figure.**

8. **Describe an activity to determine the:**

   a. lower fixed point b. upper fixed point

8. **At what temperature both Celsius and Fahrenheit scale show the same reading? Show by calculation.**

Numerical Problems

1. Convert 37°C into °F. [Ans: 98.6°F]
2. Convert 212°F into °C. [Ans: 100°C]
3. Convert 0°C in K. [Ans: 273 K]
4. Convert 373 K into °F. [Ans: 212°F]
5. Convert 32°F into °C. [Ans: 0°C]
6. Convert 100 °C into °F. [Ans: 212°F]
7. Convert 98.6°F into °C. [Ans: 37°C]
8. Convert –40°C into °F. [Ans: –40°F]

UNIT 7

Light

Weighting Distribution (Approximate)	Teaching periods : 4	Marks (in %): 1

Before You Begin

In a dark room, we cannot see the things kept there although our eyes are open. We need light to see the things kept there. So, light is a form of energy which makes things visible. It is produced from extremely hot objects. The objects which emit light are called the sources of light. The sun is the main source of light on the earth. Some other sources of light are light bulb, burning candle, kerosene lamp, etc.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce light, ray and beam of light.
ii. introduce mirror and describe its types.
iii. demonstrate reflection of light from spherical mirrors.
iv. introduce real image and virtual image and demonstrate them.
v. draw the images formed by spherical mirrors.
vi. explain the uses of spherical mirrors.
vii. introduce refraction of light and state the laws of refraction.

Syllabus

- Introduction to light
- Ray and beam of light
- Mirror and its types
- Characteristics of the image formed by plane mirror
- Spherical mirrors
- Real and virtual image
- Images formed by convex and concave mirror
- Uses of spherical mirrors
- Refraction of light
- Cause of refraction of light
- Laws of refraction of light

Glossary: A dictionary of scientific/technical terms

light	:	a form of energy which makes things visible
convex	:	curving out
concave	:	curving in
aperture	:	the total reflecting surface of a mirror
inversion	:	the act of changing the position of something
inverted	:	facing upside down
erect	:	upright in position

Light

Light is a form of energy which causes the sensation of sight. Light makes things visible. So we can see things around us. Light does not require a material medium (like solid, liquid or gas) for its propagation.

Objects such as the sun, a lighting bulb and a burning candle emit light and make things visible. We can see objects when light from a luminous body falls on them.

Do You Know

- Light travels at a very high speed. The speed of light in vacuum is 3×10^8m/s. However, the speed of light is different in different media.
- The objects which have their own source of light for shining are called luminous objects, e.g. the sun, lightning bulb, etc.

The objects that emit light are called sources of light, e.g. the sun, lighting bulb, burning candle, etc. All luminous objects are the sources of light.

Fig. 7.1

Sun

Lighting bulb

Burning candle

Ray of Light

A ray of light is the direction of the path followed by light. It is represented by a straight line with an arrowhead. The arrowhead shows the direction in which light is travelling.

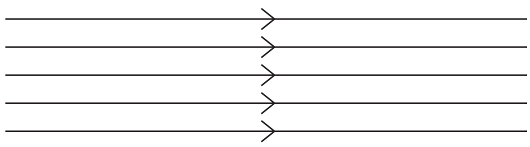
Fig. 7.2

Ray of light

Beam of light

A group of light rays moving in the same direction is called a beam of light. The light rays from far-off objects such as the sun are almost parallel to each other. It is called a parallel beam of light. The sun produces a parallel beam of light.

Fig. 7.3



Parallel beam of light

Mirror and its Types

A mirror is a smooth reflecting surface which forms an image by reflecting light. There are two types of mirror.

They are:

1. Plane mirror
2. Spherical mirror

Fig. 7.4

1. Plane mirror

The mirror having a smooth plane surface for reflection of light is called a plane mirror. A plane mirror is a piece of transparent glass having a reflecting surface and another polished surface.

Fig. 7.5

Plane mirror

Uses of plane mirror

1. A plane mirror is used in our home to see our face and in the bathroom for shaving.
2. It is used in hair-cutting saloons and science laboratory.
3. It is also used for making periscope and kaleidoscope.

Activity 1

- Take a plane mirror and fix it on a wall. Now, go in front of the mirror and observe the image formed by it.
- Move back and forth from the mirror and observe the size of the image formed by the mirror.

Characteristics of the image formed by the plane mirror

1. Plane mirror forms an image equal to the size as of the object.
2. Plane mirror forms an erect image, i.e. upright in position.
3. In a plane mirror, the image distance is always equal to the object distance.
4. The image formed by a plane mirror is laterally inverted.

Real Image

An image which is obtained on the screen is called the real image. It is always inverted. The concave mirror forms a real image. When two rays of light meet each other at a point, real image is formed.

Fig. 7.6

Lateral inversion

Do You Know

- The phenomenon in which the left side of an image is formed on the right side and vice-versa is called lateral inversion.
- Lateral inversion can be seen in a plane mirror.

Virtual Image

An image which cannot be obtained on the screen is called the virtual image. It is always erect. The convex mirror and plane mirror form the virtual image. A virtual image is formed at a point where the rays of light appear to meet when they are produced back.

Differences between Real image and Virtual image

Real image	Virtual image
1. It is formed at the point where the reflected rays meet.	1. It is formed at the point where the reflected rays appear to meet after diverging.
2. It is always inverted.	2. It is always erect.
3. It is always formed in front of the mirror.	3. It is always formed behind the mirror.

Spherical Mirrors

A spherical mirror is a mirror whose polished reflecting surface is a part of the hollow sphere. In short, the mirror having curved reflecting surface is called a spherical mirror.

There are two types of spherical mirrors. They are (i) concave mirror and (ii) convex mirror.

1. Concave mirror

A mirror having an inner reflecting surface is called a concave mirror. A parallel beam of light falling on it converges at a point after reflection. So, a concave mirror is also called a converging mirror. This mirror has a real focus.

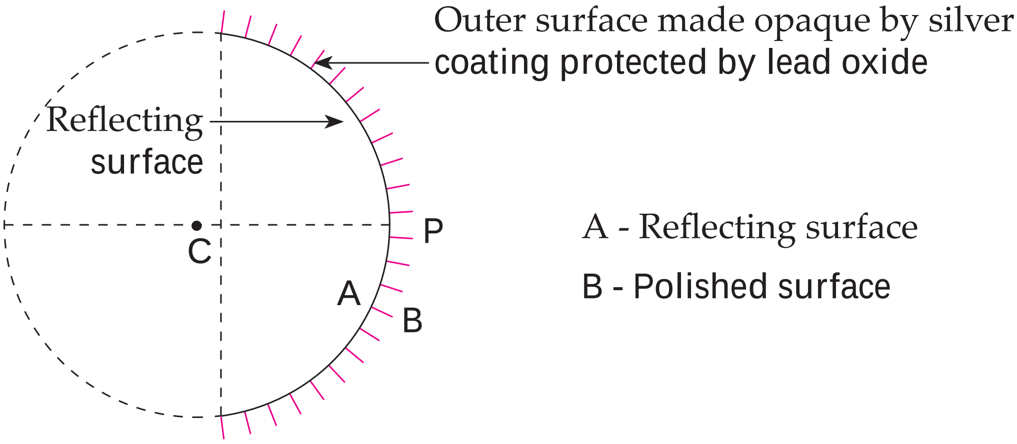


Fig. 7.7

Concave mirror

2. Convex mirror

A mirror having an outer reflecting surface is called a convex mirror. A parallel beam of light falling on this mirror appears to diverge from a point after reflection. So a convex mirror is also called a diverging mirror. This mirror has a virtual focus.

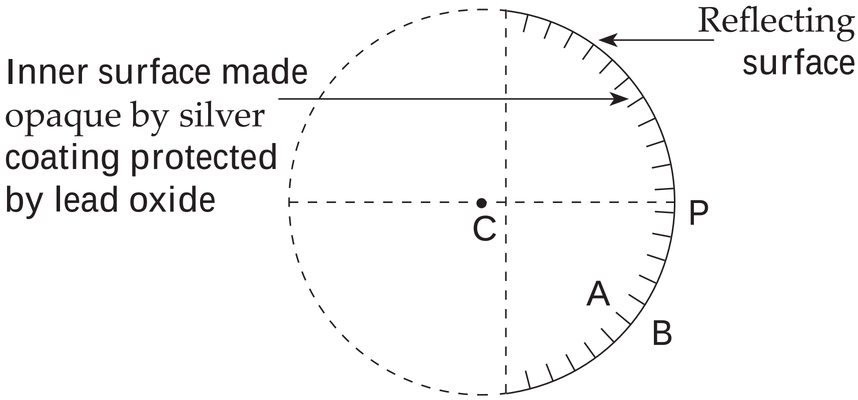


Fig. 7.8

Convex mirror

Terms related to spherical mirrors

1. **Aperture:** The effective width of the spherical mirror from which reflection of light can take place is called an aperture.

2. **Pole:** The centre of a spherical mirror is called its pole. It is denoted by P. All the distances should be measured from the pole.

3. **Centre of curvature:** It is the centre of the sphere of which the mirror is a part. It is denoted by C.

4. **Radius of curvature:** It is the radius of the sphere of which the mirror is a part. It is denoted by R. In other words, distance between the pole of the mirror and the centre of curvature is called the radius of curvature.

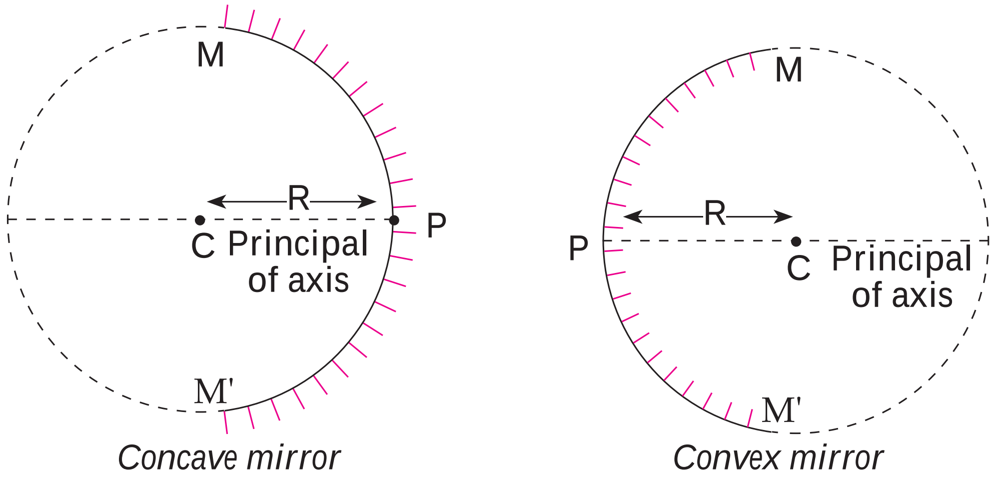


Fig. 7.9

5. **Principal axis:** The straight line passing through the pole and centre of curvature of a spherical mirror is called the principle axis. In the figure, line PC represents the principal axis.

6. **Principal focus:** The point at which all rays parallel to the principal axis strike a mirror and meet or appear to meet after reflection is called the principal focus. In a concave mirror, reflected rays meet at a focus, which is called the real focus. But in case of a convex mirror, the reflected rays appear to meet at the focus. So, it is calledthe virtual focus.

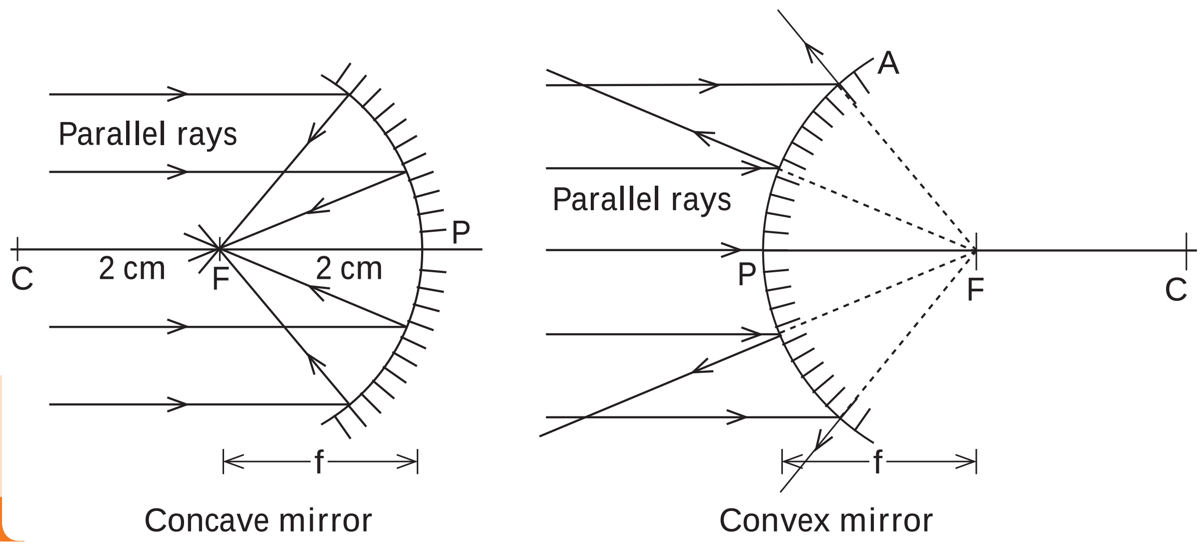


Fig. 7.10

7. **Focal length:** The distance between the focus and pole of the mirror is called the focal length. It is denoted by 'f'. A focal length is equal to half of the radius of curvature, i.e. $f = \frac{R}{2}$

Activity 2

- Produce a clear image of an object present outside the room using a concave mirror.
- Measure the distance between the screen and the mirror.

  The distance between the mirror and screen is called the rough focal length of a mirror.

Do You Know

- A concave mirror is called a converging mirror. The focus of a concave mirror is in front of the mirror.
- A convex mirror is called a diverging mirror. The focus of a convex mirror is situated behind the mirror.

Rules for Drawing Ray Diagrams in a Concave Mirror

1. A ray of light parallel to the principal axis passes through the focus after reflection.

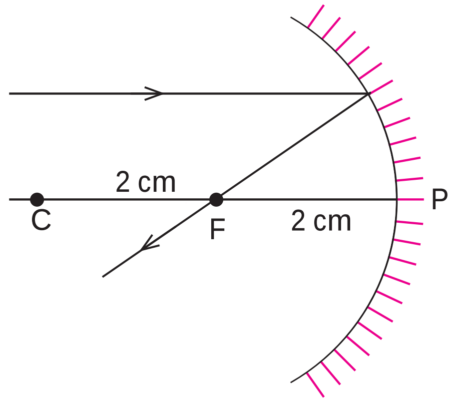


Fig. 7.11

2. A ray of light passing through the centre of curvature reflects along the same path and is perpendicular to the surface of the mirror.

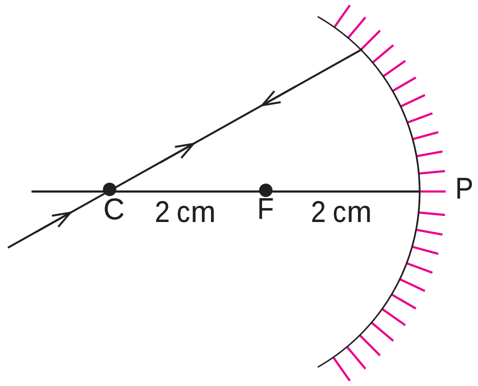


Fig. 7.12

3. A ray of light passing through the principal focus reflects parallel to the principal axis.

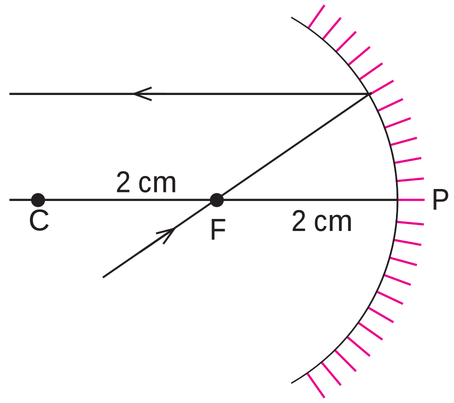


Fig. 7.13

4. A ray of light incident at the pole of a concave mirror gets reflected along a path such that the angle of incidence is equal to the angle of reflection.

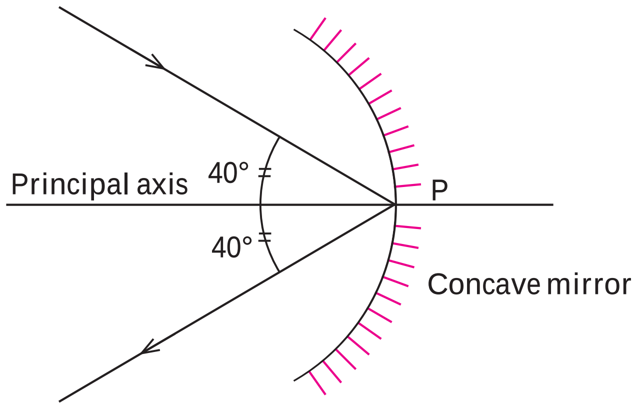


Fig. 7.14

Images formed by a Concave Mirror

The position, size and nature of the image formed by a concave mirror depends on the distance of the object from the pole of the mirror. Different types of images are formed when an object is placed at different positions as follows:

1. At infinity

When an object is placed at infinity, parallel beam of light falls on the mirror and an image is formed at focus after reflection. The image is real, inverted and highly diminished.

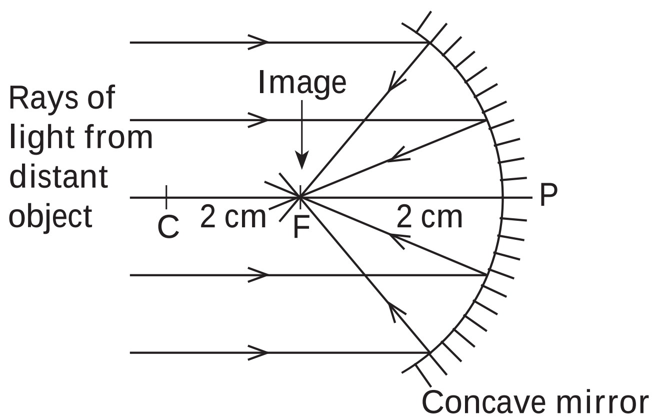


Fig. 7.15

Object at infinity	
Position	: At focus
Nature	: Real and inverted
Size	: Highly diminished

2. Beyond the centre of curvature (C or 2F)

When an object is placed beyond the centre of curvature (C or 2F), the image is formed between centre of curvature (C) and focus (F). The image is real, inverted and diminished.

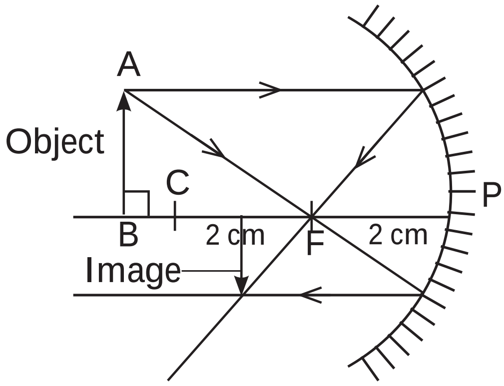


Fig. 7.16

Object beyond C	
Position	: Between F and C
Nature	: Real and inverted
Size	: Diminished

3. At the centre of curvature (C or 2F)

When an object is placed at the centre of curvature (C or 2F), the image is formed at the same point. The image is real, inverted and of the same size as the object.

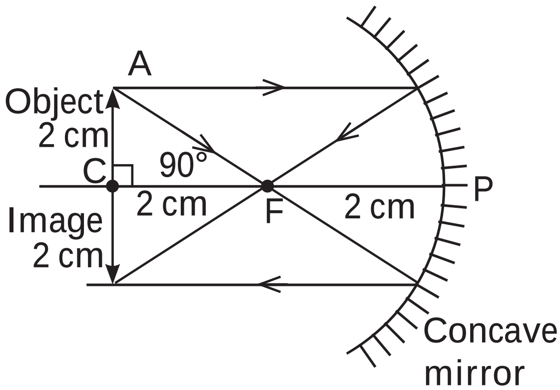


Fig. 7.17

Object C or 2F	
Position	: At C or 2F
Nature	: Real and inverted
Size	: Same size as the object

4. Between C and F

When an object is placed between C and F of the object, the image is formed beyond C or 2F. The image is real, inverted and enlarged.

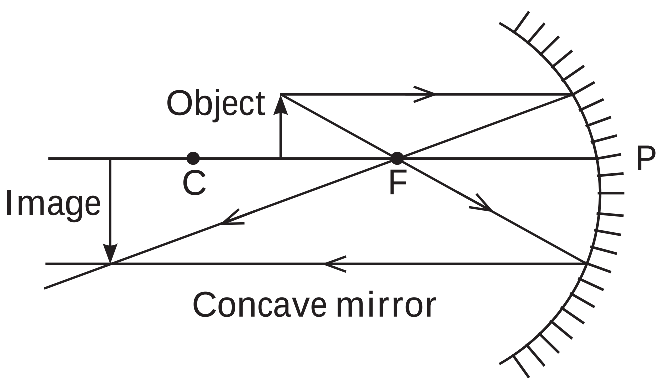


Fig. 7.18

Object between C and F	
Position	: Beyond C
Nature	: Real and inverted
Size	: Enlarged

5. At F

When an object is placed at F, the image is formed at infinity. The image is real, inverted and highly enlarged.

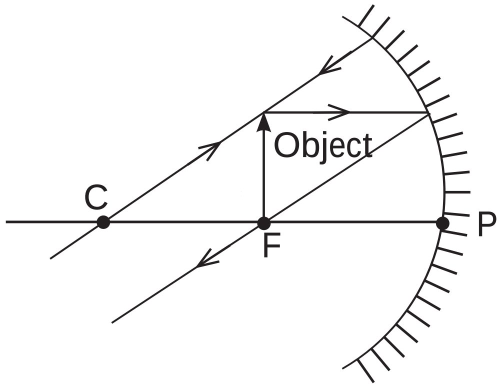


Fig. 7.19

Object at F	
Position	: At infinity
Nature	: Real and inverted
Size	: Highly enlarged

6. Between F and P

When an object is placed between F and P, the image is formed beyond the mirror. The image is virtual, erect and enlarged.

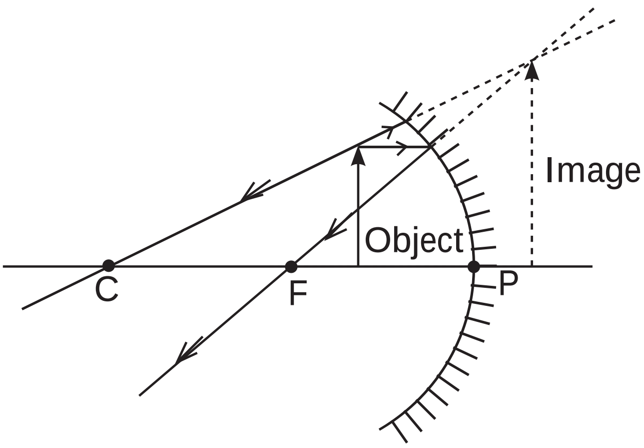


Fig. 7.20

Object Between F and P	
Position	: Beyond the mirror
Nature	: Virtual and erect
Size	: Enlarged

Rules for Drawing Ray Diagrams in a Convex Mirror

1. A ray of light passing parallel to the principal axis appears to diverge from the focus.

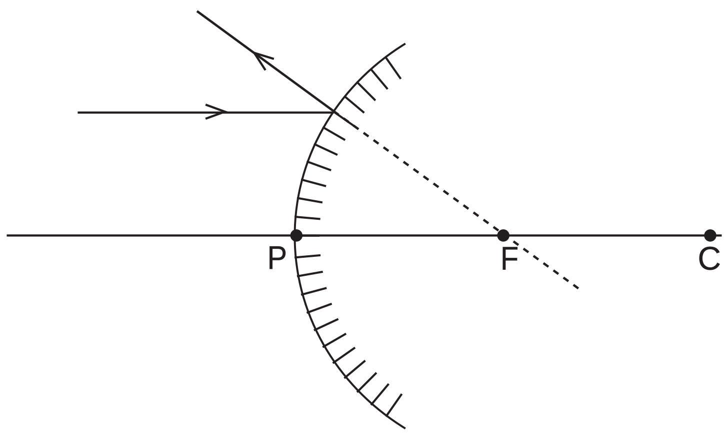


Fig. 7.21

2. A ray of light passing through the centre of curvature is reflected back through the same path.

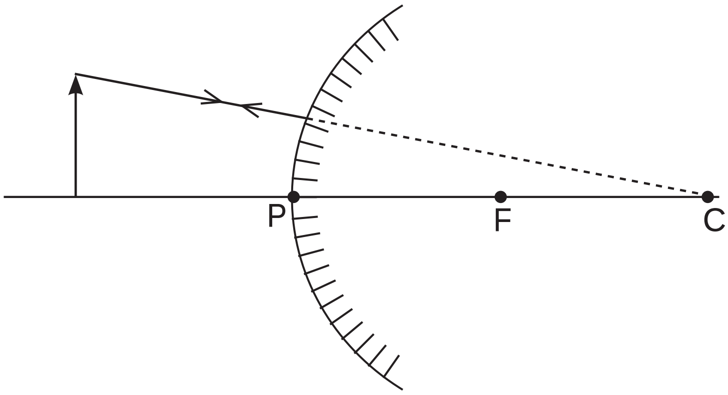


Fig. 7.22

3. A ray of light coming from an object which strikes the pole of mirror at a certain angle reflects at the same angle.

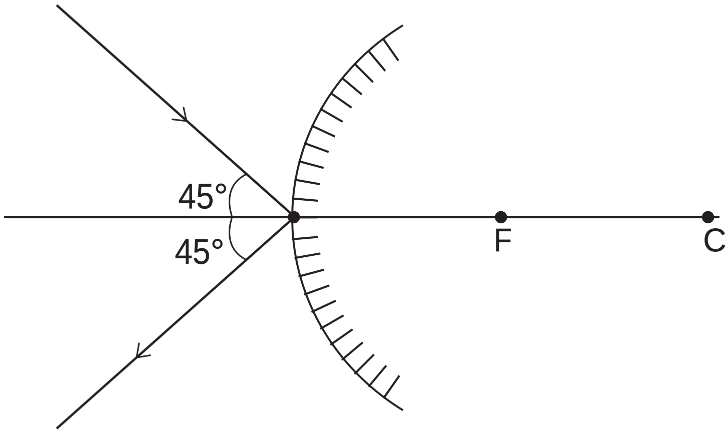


Fig. 7.23

Images Formed by a Convex Mirror

When an object is placed anywhere between infinity and pole of the mirror, an image is formed behind the mirror between the pole and focus of the mirror. The image is virtual, erect and diminished.

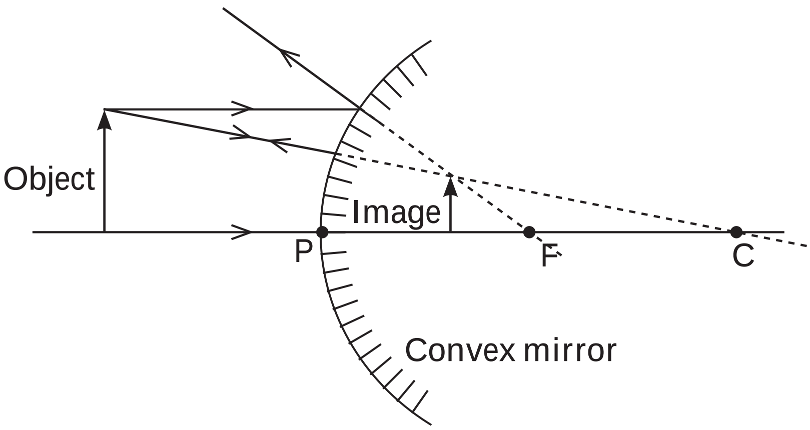


Fig. 7.24

Uses of Spherical Mirrors

Uses of Concave Mirror

1. A concave mirror is used for making solar cooker.
2. It is used by doctors to check the inside of mouth, nose, ear and throat.
3. It is used for making shaving and cosmetic mirrors.
4. It is used in astronomical telescope as a reflector.
5. It is used for making reflectors in torch lights, search lights and headlights of vehicles to spread light.

Do You Know

Concave mirror allows the light rays to be focused as a single beam and gives more power to the light that makes more efficient for seeing and to be seen by others. So, concave mirror is used in headlight of vehicles.

Uses of Convex Mirror

1. A convex mirror is used to make rear view mirrors in automobiles because it has a wide range of view.
2. It is used to make reflector of street lights because convex mirror spreads light in a wide range.

Do You Know

Convex mirror gives a diminished, virtual and an erect image of the side or rear with wider field of view. A convex mirror enables the driver to view much larger area than would be possible with a plane mirror. So, convex mirror is used as side-view mirror of vehicle.

Differences between Concave mirror and Convex mirror

Concave mirror	Convex mirror
1. It has the inner surface reflecting and outer surface polished.	1. It has the outer surface reflecting and inner surface polished.
2. It may form an enlarged, diminished equal-sized image of an object.	2. It always forms diminished image of an object.

Refraction of Light

Light travels in a straight path as long as it travels in a vacuum or in the same medium. But it bends when it passes from one medium to another. This process is called the refraction of light. So, the bending of light when it passes from one medium to another is called the refraction of light.

Fig. 7.25 Refraction of light

Light travels through different media like glass, air, water, plastic, etc. The medium through which light can pass is called an optical medium. Different optical media have different densities. On this basis, there are two types of optical media, viz. rarer medium and denser medium.

Rarer medium

The optical medium having relatively lower density is called the rarer medium. For example, out of glass and air media, air is the rarer medium.

Do You Know

- The speed of light is more in a rarer medium and less in a denser medium.
- The speed of light is the maximum in a vacuum, i.e. 3 × 108 m/s.

Denser medium

The optical medium having relatively higher density is called the denser medium. For example, out of air and glass media, glass is the denser medium.

Differences between Denser medium and Rarer medium

Denser medium	Rarer medium
1. The medium having relatively higher density is called a denser medium.	1. The medium having relatively lower density is called rarer medium.
2. Velocity of light is less in denser medium.	2. Velocity of light is more in rarer medium.

Cause of Refraction of Light

The density of different optical media is different. Due to this, the speed of light differs in different media. The change in the speed of light when it passes from one optical medium to another is the main cause of the refraction of light.

Refraction of Light through a Glass Slab

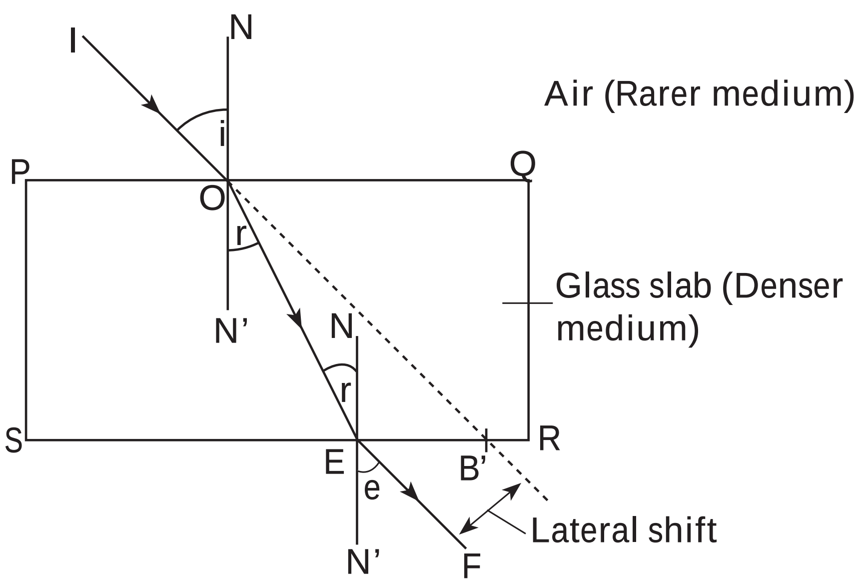


Fig. 7.26

When a ray of light IO strikes a glass slab PQRS, it bends at O and travels along OE. The ray OE again refracts and emerges out.

The terms related to refraction of light are given below.

1. Incident ray

The ray of light which strikes a transparent medium is called incident ray. In this figure, IO is an incident ray.

2. Normal

The perpendicular drawn at the point of incidence is called normal. In the figure, NN' is the normal.

3. Refracted ray

The ray of light that passes in the second medium after refraction is called refracted ray. In the figure, OE is the refracted ray.

4. Emergent ray

The ray of light which emerges out of the second medium is called emergent ray. In the figure, EF is the emergent ray.

5. Angle of incidence

The angle made by incident ray to the normal is called angle of incidence. It is denoted by $\angle i$ or i. In the figure, $\angle$ION is the angle of incidence.

6. Angle of refraction

The angle made by refracted ray to the normal is called angle of refraction. It is denoted by $\angle r$ or r. In the figure, $\angle$N'OE is the angle of refraction.

7. Emergent angle

The angle made by emergent ray to the normal is called emergent angle. It is denoted by $\angle e$ or e. In the figure, $\angle$N'EF is the emergent angle.

8. Lateral displacement or Lateral Shift

The perpendicular distance between the emergent ray and the incident ray is called the lateral displacement or lateral shift.

Laws of Refraction of Light

1. The incident ray, normal and refracted ray are all in the same plane at the point of incidence.

2. When a ray of light travels from a rarer medium to a denser medium, it bends towards the normal and when a ray of light travels from a denser medium to a rarer medium, it bends away from the normal.

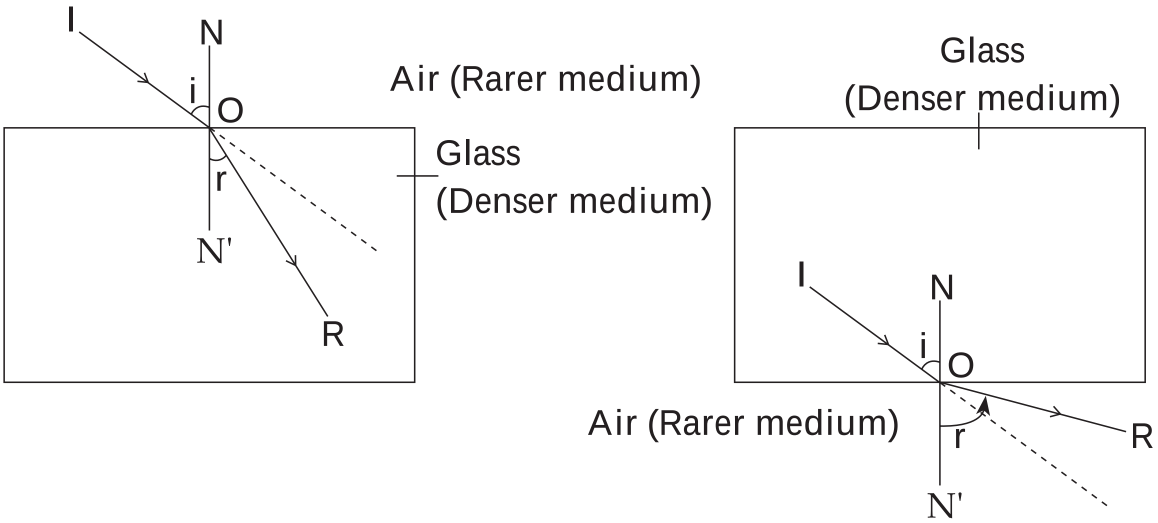


Fig. 7.27

3. The ray of light does not bend when it passes normally from one medium to another.

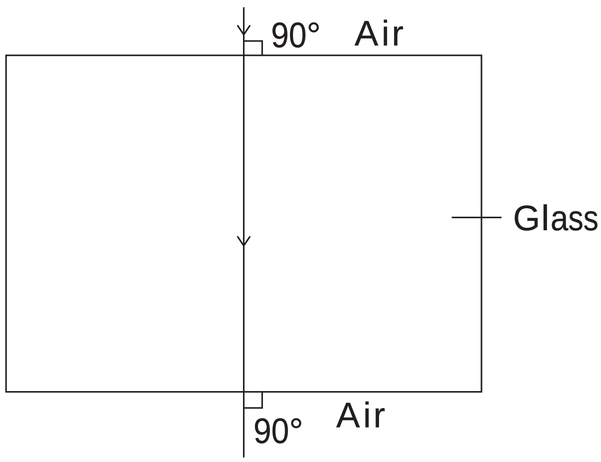


Fig. 7.28

Differences between Reflection of light and Refraction of light

Reflection of light	Refraction of light
1. The process of returning of light to the same medium after striking a surface is called reflection of light.	1. The bending of light in between two media when it travels from one medium to another medium is called refraction of light.
2. It depends on the reflection from either smooth or curved surface.	2. It depends on medium which is either rare or denser.

Activity 3

Demonstration of refraction of light through a glass slab.

- Take an A4 size paper and fix it on a drawing board with push pins.
- Take a glass slab and put it in the middle of the paper and draw an outline PQRS.
- Draw a line A at a certain angle that meets PQ at point B. Draw a normal NM at point B.
- Fix two pins P_1 and P_2 on the line AB as shown in the figure.
- Now, observe the pins P_1 and P_2 in a straight position from another side of the glass slab and fix two pins P_3 and P_4.
- Remove the glass slab and join B and C with the line CD.
- Now, measure the angle of incidence, angle of refraction and angle of emergence.

This activity shows the refraction of light through a glass slab.

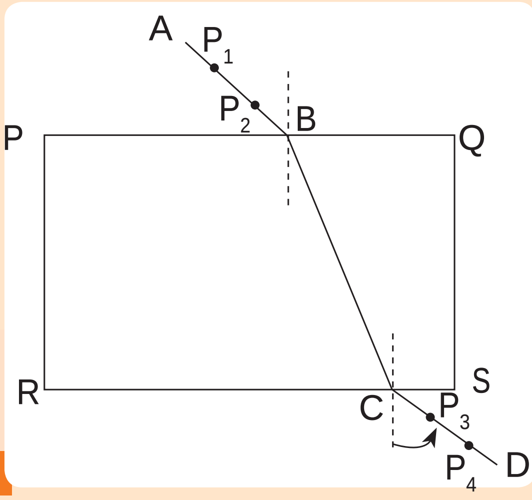


Fig. 7.29

Activity 4

Take a beaker and fill it half with water. Take a glass rod and immerse half portion of the glass rod into water. What do you observe? Does the glass rod appear bent? Why?

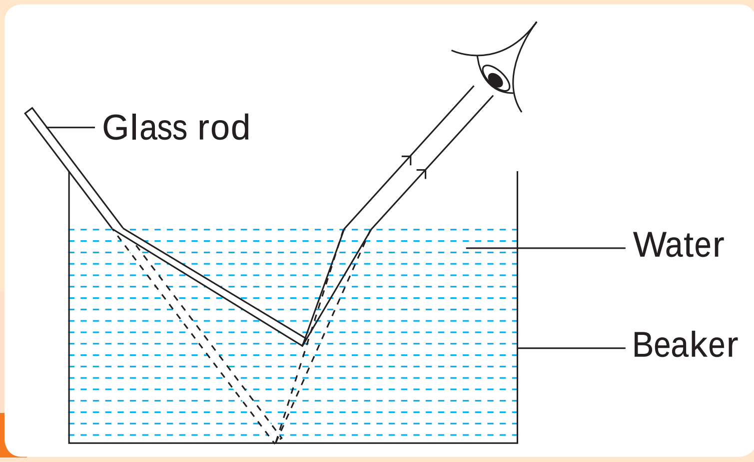


Fig. 7.30

The glass rod immersed in water appears to be bent at the surface water due to the refraction of light. Similarly, a coin placed at the bottom of a beaker full of water appears to be raised due to the refraction of light. We observe a number such phenomena due to refraction of light. Some of them are mentioned below.

1. We cannot kill a fish when we spear a fish where it appears in a pond.
2. A swimming pool or a pond appears less deep than its actual depth.
3. The legs of a person standing in a pond appear shorter.
4. The letter on a paper lying at the bottom of the glass slab appears to be raised when viewed through the glass.

Activity 5

- Take an empty beaker and place a coin into it. Observe the coin in the beaker. Does it appear raised or not?
- Now, fill the beaker with water and observe the position of the coin.

What is the conclusion of this activity?

Key Concepts

1. Light is a form of energy which causes the sensation of sight.
2. An image which is obtained on the screen is called real image.
3. An image which cannot be obtained on the screen is called virtual image.
4. A spherical mirror is the mirror whose polished reflecting surface is a part of the hollow sphere.
5. The point at which all rays parallel to the principal axis strike a mirror and meet or appear to meet after reflection is called the principal focus.
6. The bending of light when it passes from one optical medium to another is called the refraction of light.
7. An optical medium having relatively lower density is called the rarer medium.
8. An optical medium having relatively higher density is called the denser medium.
9. The change in the speed of light when it passes from one medium to another is the main cause of the refraction of light.
10. When a ray of light travels from a rarer medium to a denser medium, it bends towards the normal and when a ray of light travels from a denser medium to a rarer medium, it bends away from the normal.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Light is a form of energy which makes things visible. ☐

b. Virtual image can be obtained on the screen. ☐

c. A convex mirror is called a diverging mirror. ☐

d. A concave mirror always forms a real image. ☐

e. A convex mirror is used for making solar cooker. ☐

2. Fill in the blanks using appropriate words.

a. .... mirror is used for making periscope.

b. When two rays of light meet each other at a point, ... image is formed.

c. The centre of a spherical mirror is called ....

d. When an object is placed at F of a concave mirror, image is formed at ....

e. The bending of light when it passes from one medium to another is called ....

3. Tick (√) the most appropriate answer from the given alternatives.

a. An image which can be obtained on the screen is called .... image.

☐ erect ☐ diminished ☐ real ☐ virtual

b. A straight line passing through the pole and the centre of curvature is called ....

☐ focus ☐ pole ☐ principal axis ☐ aperture

c. A concave mirror forms a virtual image when an object is placed ....

☐ at F ☐ between C and F

☐ between P and F ☐ between F and 2F

d. A .... mirror is used to make reflector of street lights.

☐ plane ☐ concave ☐ convex ☐ spherical

4. Answer the following questions.

a. What is light?

b. What is meant by ray and beam of light?

c. What is a mirror? Name two types of mirror

d. What is a plane mirror? Write its two uses.

e. Write any two characteristics of the image formed by a plane mirror.

f. Define real image and virtual image.

g. What are spherical mirrors? Name their types.

h. What is a concave mirror? Draw a ray diagram showing the image formed by a concave mirror when an object is placed

i. at F   ii. between F and 2F

iii. at P   iv. between F and P

i. What is a convex mirror? Draw a neat figure showing the image formed by a convex mirror when an object is placed between F and 2F.

j. Write any three uses of each concave mirror and convex mirror.

k. What is refraction of light? Write down its cause.

l. Define denser medium and rarer medium with one example of each.

m. State the laws of refraction of light.

5. Define the following terms.

a. Pole of the mirror

b. Centre of curvature

c. Principal focus

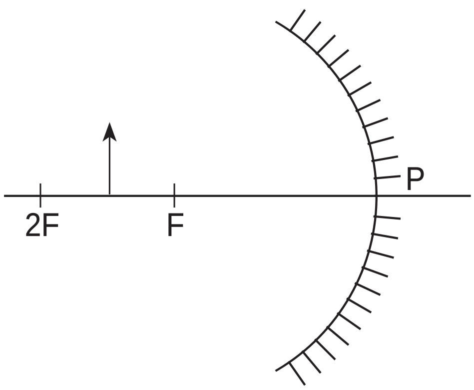
d. Incident ray

e. Refracted angle

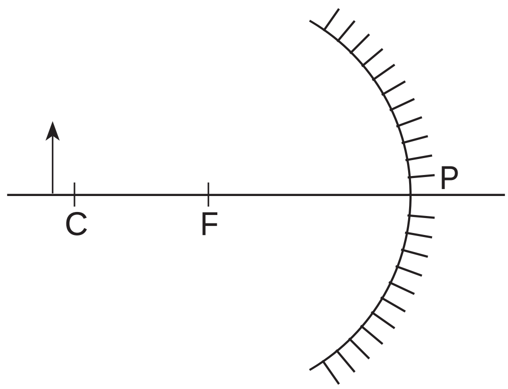
f. Normal

6. Complete the given ray diagrams. Also, write down the nature of the image formed.

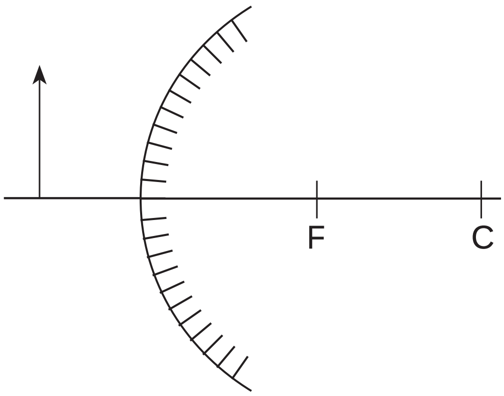
a.



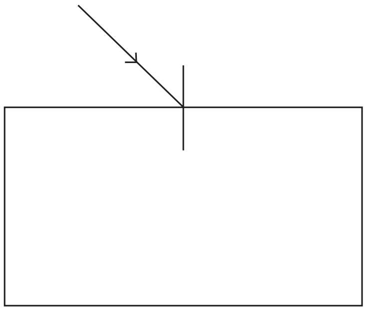
b.



c.



d.



7. Differentiate between:

a. Real image and Virtual image

b. Rarer medium and Denser medium

c. Convex mirror and Concave mirror

8. Give reason.

a. Light bends when its passes from one medium to another.

b. A concave mirror is called a converging mirror.

c. A convex mirror is called a diverging mirror.

d. A concave mirror is used for making solar cooker.

e. A convex mirror is used in street lights.

f. A glass rod immersed in water appears bent.

g. A fisherman targets at the tail of a fish in a pond to kill it.

h. A coin placed at the bottom of a beaker filled with water appears to be raised.

UNIT 8

Sound

Weighting Distribution (Approximate)	Teaching periods : 2	Marks (in %): 1

Before You Begin

In our surroundings, we see different things that produce sound. When materials vibrate, sound is produced. So, sound is a form of energy which is produced due to vibration of a material medium. Sound produces sensation of hearing. The substances that produce sound are called sources of sound. Temple bell, horn of vehicles, loudspeaker, guitar, television, etc. are some sources of sound. Sound waves are produced when a material vibrates. Sound propagates through these waves.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce some terms related to sound, i.e. speed, frequency and wavelength.
ii. introduce echo and reverberation and differentiate between them.
iii. describe the effect of echo and reverberation.

Syllabus

- Introduction to sound and sound wave
- Wave length
- Frequency
- Speed of sound
- Reflection of sound
- Echo
- Reverberation
- Simple Numerical problems related to sound

Glossary: A dictionary of scientific/technical terms

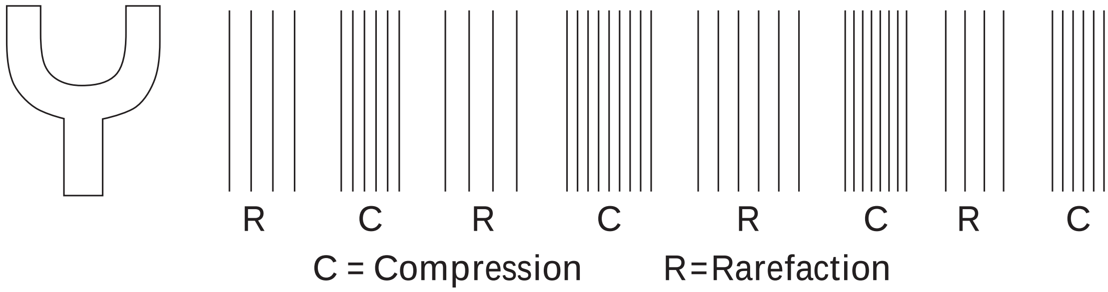
sound	:	a form of energy which is produced due to vibration of a body
longitudinal wave	:	a wave that vibrates in the direction that is moving
frequency	:	the number of complete cycles made in one second
echo	:	the repetition of sound caused by reflection
reverberation	:	the prolongation of the original sound

Sound

Sound Wave

A wave produced due to the vibration of a material medium is called a sound wave. It is produced due to vibration of solid, liquid and gas. A sound wave needs a medium (solid, liquid or gas) for propagation. It cannot propagate through vacuum.

Fig. 8.1



Sound wave

When sound waves coming from a source propagate through air, and reach our ears, we hear the sound. Sound propagates in the form of longitudinal waves. A longitudinal wave consists of alternately arranged compressions and rarefactions. When a sound wave passes through air, the particles of air vibrate back and forth parallel to the direction of propagation forming compressions and rarefactions.

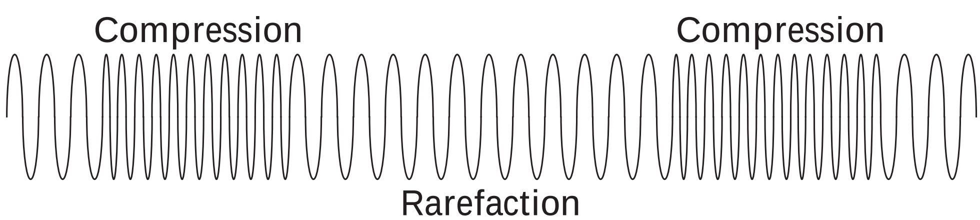
Do You Know

- A compression is that part of a longitudinal wave in which the particles of the medium are closer to one another.
- Rarefaction is the part of a longitudinal wave in which the particles are farther apart.

Longitudinal Wave

A longitudinal wave is a wave in which the medium vibrates to-and-fro in the direction of the propagation of the wave. For example, sound wave, waves formed in a slinky when pulled and released, etc. In other words, a wave having regions of compressions and rarefactions is called a longitudinal wave.

Fig. 8.2



Longitudinal wave formed by pulling and pushing a slinky

Wave Length

A wave length is defined as the distance between any two consecutive compressions or rarefactions. It is denoted by lambda (λ). In the SI system, a wave length is measured in meter.

Frequency of Sound

Frequency of sound is defined as the number of complete cycles produced in one second. It is denoted by 'f'. In the SI system, frequency is measured in hertz(Hz). The larger units of frequency are kilohertz(kHz), megahertz (MHz), etc. The relation between hertz, kilohertz and megahertz is given below:

1000 Hz	= 1 kHz
1000 kHz	= 1 MHz
1 MHz	= 1000000 Hz

Do You Know

The frequency of a sound wave is 40 Hz which means that the sound wave produces 40 complete cycles or vibrations in one second.

Differences between Wavelength and Frequency

Wavelength	Frequency
1. The distance between any two consecutive compressions or rarefactions is called wavelength.	1. The number of complete cycles made in one second is called frequency.
2. Its SI unit is meter (m).	2. Its SI unit is hertz (Hz).

Speed of Sound Wave

A sound wave can propagate through solids, liquids and gases. A sound travels with different speed in different media. The speed of sound is maximum in solids and minimum in gases. The molecules in solids are closely packed together and hence carry more vibrations. As a result, the speed of sound is maximum in solids.

The speed of sound in some common media is given below:

S.N.	Medium	Speed of sound
1.	Iron (20 °C)	5130 m/s
2.	Glass (25 °C)	5500 m/s
3.	Aluminium	5100 m/s
4.	Water (20 °C)	1498 m/s
5.	Alcohol (25 °C)	1210 m/s
6.	Air (0 °C)	332 m/s
7.	Hydrogen (0 °C)	1284 m/s

Formula to calculate the speed of sound

Speed of sound (v) = Frequency (f) × Wave length (λ)

∴ $\boxed{v = f \times \lambda}$

Worked out Numerical: 1

The frequency of a sound wave is 60 Hz and its wave length is 85 m. Calculate the speed of sound in the medium.

Given,

Frequency (f) = 60 Hz

Wave length (λ) = 85 m

Speed of sound (v) = ?

We know,

$$V = f \times \lambda$$
$$= 60 \times 85$$
$$= 5100 \text{ m/s}$$

∴ The speed of sound (v) = 5100 m/s

Worked out Numerical: 2

The speed of sound in water is 1500 m/s. If the wave length is 12.5 m, calculate the frequency of the sound.

Given,

Speed of sound (v) = 1500 m/s

Wave length (λ) = 12.5 m

Frequency (f) = ?

We know,

$$v = f \times \lambda$$

or, $1500 = f \times 12.5$

or, $f = \dfrac{1500}{12.5}$

$= 120$ Hz

∴ The frequency of sound is 120 Hz.

Reflection of Sound

When a sound wave travelling in a medium strikes a surface, it returns to the same medium. This process is called the reflection of sound. So, the reflection of sound is defined as returning of sound in the same medium when it strikes a hard surface. When we shout in front of a cliff or wall or a hill, we can hear a reflected sound. This reflected sound is called echo. Reflection of sound obeys the laws of reflection of light. We utilize the reflection of sound in the working of megaphone, sound boards, etc.

Fig. 8.3 *Reflection of sound in a megaphone*

Echo

When a sound wave strikes any hard surface, it gets reflected, which is called echo. So, echo can be defined as the repetition of sound caused by the reflection of sound.

The conditions required for formation of echo are as follows:

1. The minimum distance between the source of sound and the reflecting surface should be more than 17 metres.
2. The size of the reflector should be large.
3. The loudness of the sound should be sufficient.

Reverberation

If we speak in a large unoccupied hall, we can hear a number of echoes of original sound. This phenomenon is called reverberation. So, reverberation can be defined as the prolongation of original sound due to reflection. A reverberation is a process of intermixing of original sound with a reflected sound. A number of echoes are heard during reverberation.

A reverberation occurs when the distance between the source of sound and the reflecting surface is less than 17 m. We hear reverberation in an unfurnished empty room and a newly built room. It does not occur in an occupied room or furnished room due to the presence of sound absorbing materials.

Do You Know

- Sound absorbing materials are kept in the walls of cinema hall to minimize the reverberation. These materials reflect sound less and absorb more. As a result, the quality of sound heard by the people becomes clear.
- Reverberation makes music melodious providing continuity. So, recording studios are designed to produce reverberation.

Activity 1

- Go in an empty room or an unfurnished room and produce a sound "Hello". Can you hear the reverberation?
- Now, go in an occupied or furnished room of the same size and repeat the above activity. Can you hear the reverberation ? What are the reasons behind this fact?

Differences between Echo and Reverberation

Echo	Reverberation
1. The repetition of sound caused by the reflection of sound wave is called echo.	1. The prolongation of the original sound is called reverberation.
2. The distance between the reflecting surface and the source of sound to hear an echo should be more than 17m.	2. The distance between the reflecting surface and the source of sound to experience reverberation should be less than 17m.

Echolocation

A process of locating an object with respect to surroundings is called echolocation. This process is based on reflection of sound. Bats, dolphins, whales, and some birds use echo to locate their body, to find their prey and to navigate without the use of eyes. We can calculate the depth of a pond, river or ocean with this method. A fathometer is used to calculate the depth. The method of finding position or depth with respect to surrounding object is called SONAR. The full form of SONAR is Sound Navigation and Ranging. We use the following formula to calculate the depth of a pond, river or ocean.

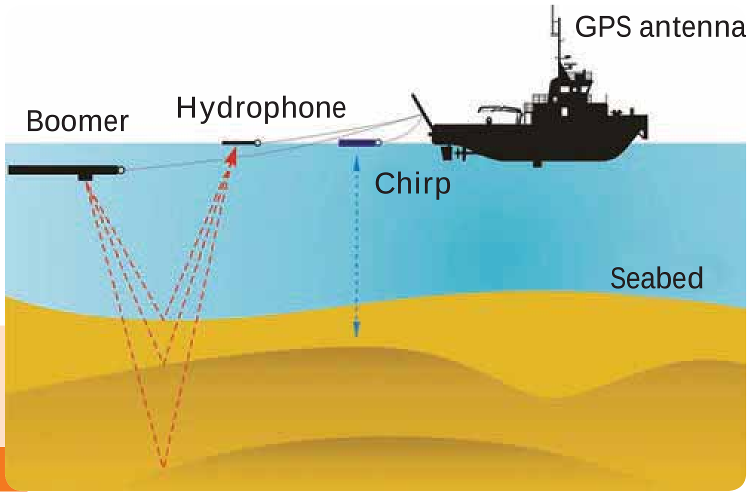


Fig. 8.4 *SONAR*

$\therefore \quad s = \frac{v \times t}{2}$

Where, s = Depth

v = Speed of sound in the given medium

t = time taken to hear echo

Worked out Numerical: 3

A man shouts in front of a cliff and hears the echo after 0.4 seconds. If the speed of sound in air is 330 m/s, calculate the distance between the man and the cliff.

Given,

Time (t) = 0.4 s

Speed of sound (v) = 330 m/s

Distance (s) = ?

We know that,

$$s = \frac{v \times t}{2}$$

or, $$s = \frac{330 \times 0.4}{2} \text{ m}$$

$$= 66 \text{ m}$$

∴ The distance between the man and the cliff (s) = 66 m.

Worked out Numerical: 4

The depth of a sea is 6200m and the speed of sound in water is 1500 m/s. Calculate the time at which the echo is heard after sending the sound wave.

Given,

Depth of sea (d) = 6200 m

Speed of sound in water (v) = 1500 m/s

Time to hear echo (t) = ?

According to the formula,

$$v = \frac{2d}{t}$$

or, $$v \times t = 2d$$

or, $$t = \frac{2d}{t} = \frac{2 \times 6200}{1500} = 8.26 \text{ s}$$

∴ Time to hear echo is 8.26 s.

Activity 2

- Take a sensitive stop watch and go to a nearby cliff or in front of a tall building along with your science teacher.
- Shout in front of the cliff or wall and record the time taken to hear the echo.
- Now, calculate the distance between you and the cliff or wall using the formula.

Key Concepts

1. A wave produced due to vibration of a material medium is called a sound wave.
2. A longitudinal wave is a wave in which the medium vibrates to-and-fro in the direction of the propagation of the wave.
3. A wave length is defined as the distance between any two consecutive compressions or rarefactions.
4. A frequency of sound is defined as the number of complete cycles produced in one second.
5. The speed of sound is maximum in solids and minimum in gases.
6. An echo can be defined as the repetition of sound caused by the reflection of sound.
7. A reverberation is the process of intermixing of original sound with a reflected sound.
8. A process of locating an object with respect to surroundings is called echolocation.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. A sound is produced due to vibration of a material medium. ☐

b. A sound can propagate through a vacuum. ☐

c. The number of complete cycles produced in one second is called frequency. ☐

d. A reverberation generally occurs in a well furnished room. ☐

e. An echolocation is based on reflection of sound. ☐

2. Fill in the blanks using appropriate words.

a. A sound wave is a .... wave.

b. A longitudinal wave consists of .... and ....

c. The speed of sound is maximum in ....

d. The full form of SONAR is ....

e. .... is used to calculate the depth.

3. Tick (√) the most appropriate answer from the given alternatives.

a. The form of energy which is produced due to vibration of a material medium is called ....

☐ sound ☐ light ☐ heat ☐ echo

b. The SI unit of frequency is ....

☐ Hz ☐ kHz ☐ m ☐ MHz

c. The speed of sound in air is ....

☐ 1500 m/s ☐ 332 m/s ☐ 5100 m/s ☐ 5500 m/s

d. The formula to calculate the depth of a sea is ....

☐ $s = \frac{vt}{2}$ ☐ $s = \frac{2v}{t}$ ☐ $s = \frac{v}{2t}$ ☐ $s = \frac{2t}{v}$

4. Answer the following questions.

a. What is sound?

b. How is sound produced?

c. What is a longitudinal wave?

d. What is meant by the frequency of sound?

e. What is a wave length? Write its SI unit.

f. What is reflection of sound?

g. Define echo and reverberation.

h. Write down the condition required to hear an echo and reverberation.

i. What is echolocation? What is fathometer?

j. Write down the full form of SONAR.

k. Write down applications of echo.

5. Differentiate between:

a. Echo and Reverberation

b. Compression and Rarefaction

6. Give reason:

a. A sound wave is called a longitudinal wave.

b. A sound absorbing materials are kept in walls of cinema hall.

c. An echo is not heard in a small room.

d. A reverberation does not occur in furnished rooms.

Numerical Problems

a. The sound of wave length 0.022 m has a frequency of 15 kilohertz. Calculate the speed of the wave. [Ans: 330 m/s]

b. If the speed of a sound wave in a medium is 5100 m/s and the frequency is 200 Hz, calculate the wave length. [Ans: 25.5 m]

c. The speed of sound in a medium is 1200 m/s and the wave length is 15.5 m. Calculate the frequency of the sound wave. [Ans: 77.41 Hz]

d. A sound wave is sent to the bottom of a sea. If the echo is heard after 2 seconds, calculate the depth of the sea. The speed of sound in water is 1500 m/s. [Ans: 2250 m]

e. If the sound of thunderstorm in the sky is heard after 20 seconds, calculate the height where thunder storm occurred. The speed of sound in air is 332 m/s. [Ans: 3320 m]

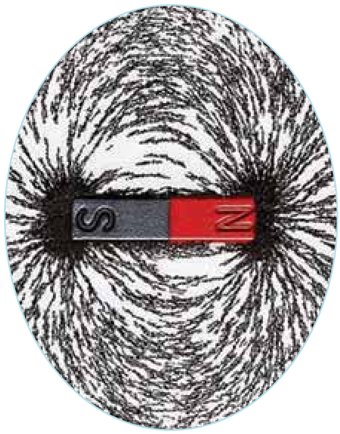
UNIT 9

Magnetism

Weighting Distribution (Approximate) | Teaching periods : 4 | Marks (in %): 1

Before You Begin

The substance which attracts iron, nickel and cobalt is called magnet. A freely suspended magnet always points to the north-south direction. The substances that are attracted towards magnet are called magnetic substances. Iron, nickel and cobalt are some examples of magnetic substances. The special property of a magnet due to which it attracts iron, cobalt and nickel, etc. and points to north-south direction when suspended freely is called magnetism.



Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce magnet and magnetism.
ii. state molecular theory of magnetism.
iii. introduce magnetic induction and demonstrate with explanation.
iv. state causes of demagnetization.
v. state the methods of conserving magnetism.

Syllabus

- Introduction to magnet and magnetism
- Molecular theory of magnetism
- Magnetic induction
- Demagnetization
- Methods of conserving magnetism

Glossary: A dictionary of scientific/technical terms

magnetism	:	the properties of a magnet to attract iron, cobalt, etc. and to point to north-south direction when suspended freely
navigator	:	a person who navigates, for example, on a ship or an aircraft
magnetic	:	connected with or produced by magnetism
monopole	:	having a single pole
induction	:	the process by which magnetism or electricity passes from one object to another without touching them
demagnetization	:	the process by which a magnet loses its properties

Magnetism

A substance which has the property of attracting iron, nickel, etc. and rests in the north-south direction when suspended freely is called a magnet. The property of a magnet by virtue of which it attracts iron is called magnetism. Similarly, the force that a magnet exerts on iron, cobalt, nickel, etc. is called magnetic force.

Do You Know

- Substances which are attracted by a magnet are called magnetic substances, e.g. iron, steel, cobalt, etc.
- Substances which are not attracted by a magnet are called non-magnetic substances, e.g. plastic, glass, paper, etc.

Fig. 9.1

Bar magnet | *U-shaped magnet* | *Horse-shoe shaped magnet* | *Magnetic compass*

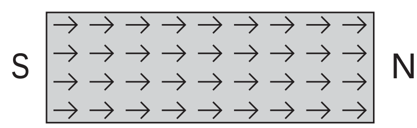
Differences between Natural magnet and Artificial magnet

Natural Magnet	Artificial Magnet
1. The magnet which is found in nature is called natural magnet.	1. The magnet made by artificial method is called artificial magnet.
2. It is less powerful than artificial magnet.	2. It is more powerful than natural magnet.

Molecular theory of Magnetism

1. Each molecule of a magnetic substance (whether magnetized or unmagnetized) is an independent magnet.
2. In a magnet or a magnetized substance, the molecular magnets are arranged such that the south pole of each molecular magnet points in one direction and the north pole in the opposite direction. At one end of a bar magnet, there is a south pole in each molecular magnet. Therefore, this end of the bar acts like a strong south pole. Similarly, the other end acts like a strong north pole.

Fig. 9.2



Arrangements of molecular magnets in a magnet or magnetized substance

In the middle of the bar, the north polarity of molecular magnet cancels the effect of south polarity. Therefore, the bar has no magnetic property at its centre.

3. In an unmagnetized substance or a magnetic substance, the molecular magnets are randomly oriented. They form a closed chain so that they neutralize the effect of each other resulting in zero net magnetism.

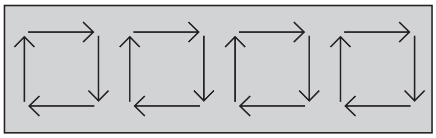


Fig. 9.3 *Arrangement of molecular magnets in a magnetic or unmagnetized substance*

4. When a piece of iron is magnetized, the molecular magnets start setting themselves along straight chains. As a result, the magnetism of the piece of iron increases.

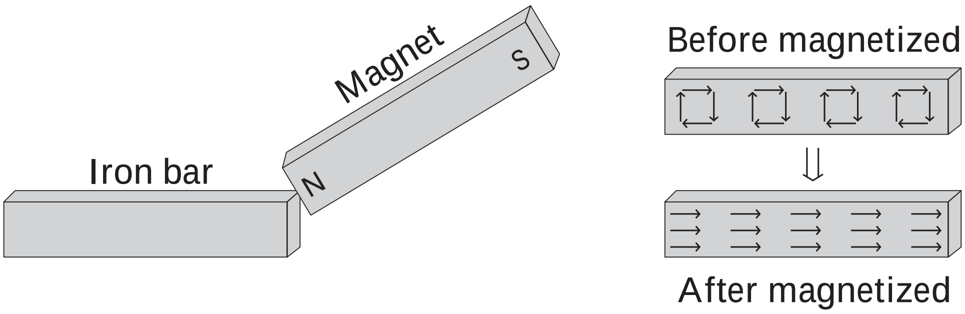


Fig. 9.4

5. Every magnet has two poles - north and south. If a bar magnet is broken into two or more smaller pieces, then, even the smallest piece is a complete magnet, having both north and south poles. Thus, it is impossible to obtain a magnet having only one pole. Therefore, we can say that magnetic poles always occur in pairs.

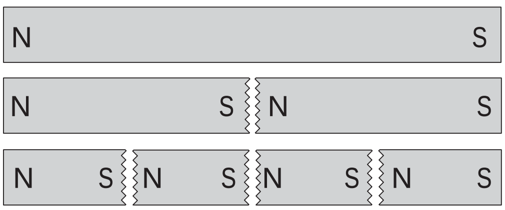


Fig. 9.5 *Magnetic poles always occur in pairs*

Do You Know

If a magnet is cut into two equal parts, the magnetic strength of each part is half the magnetic strength of the original magnet.

6. When a magnet is strongly heated or hammered, the straight chains of molecular magnets get disrupted. As a result, the molecules go back to closed chain arrangement. Thus, the magnet gets demagnetized.

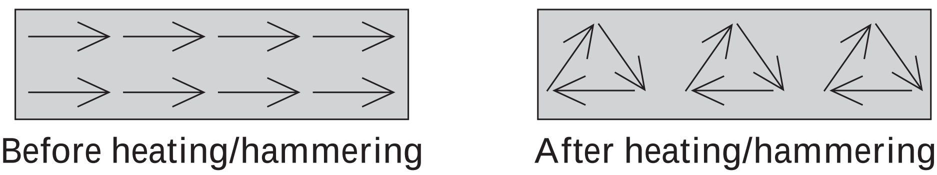


Fig. 9.6

Differences between Magnet and Magnetic substances

Magnet	Magnetic substances
1. A magnet is a substance which has the property of attracting iron, cobalt, etc.	1. The substances which are attracted by a magnet are called magnetic substances.
2. In a magnet, molecular magnets are arranged in a parallel way of alignment in the same direction.	2. In a magnetic substance, the north pole of one molecular magnet is attached to the south pole of another molecular magnet in the form of a closed chain.

Activity 1

To demonstrate that magnetic poles occur in pairs

- Take an old blade and break it into two pieces carefully.
- Now, magnetize one piece of the blade with the help of a bar magnet.
- Now, break the magnetized piece of the blade and check the magnetism of these pieces.
- Break each piece of the magnetized blade and check their magnetism. What do you observe?

When we break the piece of magnetized blade, each piece behaves as a complete magnet. This activity proves that magnetic poles occur in pairs.

Magnetic Induction

When a magnet is brought close to an unmagnetized piece of iron or any other magnetic substance, the piece of iron/magnetic substance becomes a magnet. This process is called the magnetic induction. So, the phenomenon by which a piece of magnetic substance acquires magnetic properties when it is placed near a magnet is called the magnetic induction.

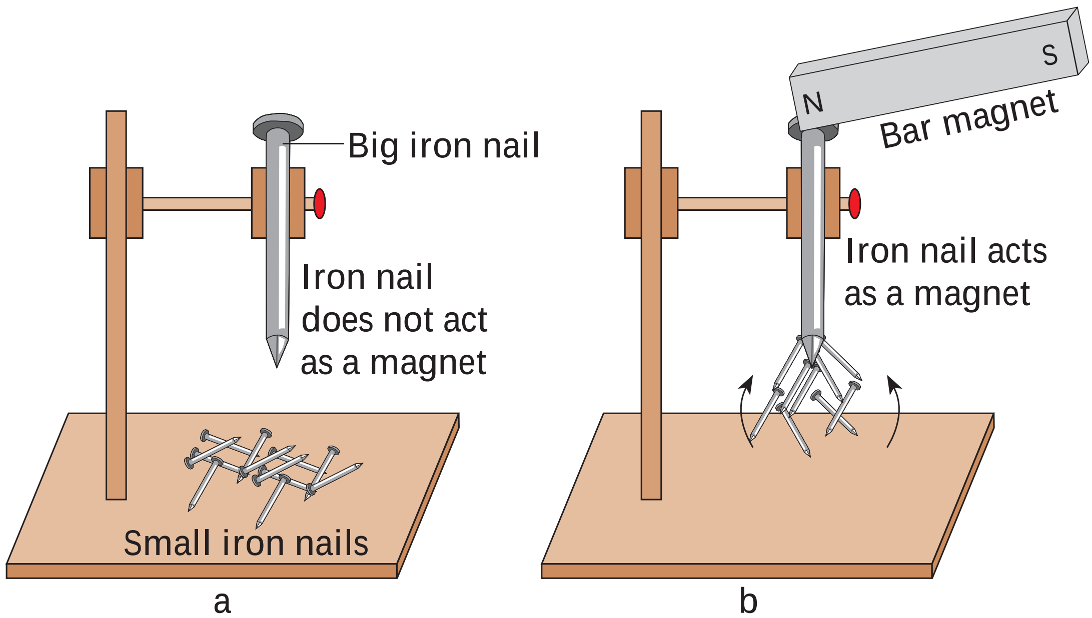


Fig. 9.7 *Magnetic induction*

On removing the magnet, the nail loses its magnetism and the small iron nails fall down. It shows that the magnetism acquired by induction is temporary in nature.

Activity 2

- Take an iron nail/iron bar and some pins. Then bring the pins near the nail. You will see that the nail does not attract the pins. The nail does not behave as a magnet.
- Now, hold a bar magnet above the nail and bring the magnet close to it. You will see that the nail attracts the pins. This is because the iron nail behaves as a magnet when a bar magnet is kept close to it.
- Now, move the magnet away. You will see that the pins fall off.

This process is called the magnetic induction.

Demagnetization

Demagnetization is the process by which a magnet loses its properties. A magnet gets demagnetized due to disturbance in the arrangement of molecular magnets.

A magnet gets demagnetized when

i. it is heated strongly.
ii. it is hammered.
iii. it is dropped from a height.
iv. like poles of magnets are rubbed.
v. magnets are stored haphazardly without using keepers.
vi. magnets are kept in a moist place for a long time.

Do You Know

- In a magnet, molecular magnets are arranged in parallel in a certain direction. All the north poles are arranged in one side and all the south poles are arranged in another side which form north pole and south pole respectively. So, north and south poles of the magnet has more energy.
- When a magnet is heated, the array of order of molecular magnets will be disordered. So, magnetic properties are lost when a magnet is heated.
- When a magnet is hammered, the array of order of molecular magnets will be disordered. So, magnetic properties are lost when a magnet is hammered.

Methods of Conserving Magnetism

i. We should not heat the magnet.
ii. We should not hammer the magnet.
iii. We should not drop the magnet.
iv. We should not rub similar poles of magnets.
v. We should store magnets in a dry place by using keepers.

Key Concepts

1. A substance which has the property of attracting iron, nickel, etc. and rests in the north-south direction when suspended freely is called a magnet.
2. Substances which are attracted by a magnet are called magnetic substances, e.g. iron, steel, cobalt, etc.
3. Each molecule of a magnetic substance (whether magnetized or unmagnetized) is an independent magnet.
4. Every magnet has two poles - north and south.
5. Magnetic poles always occur in pairs.
6. The phenomenon by which a piece of magnetic substance acquires magnetic properties when it is placed near a magnet is called the magnetic induction.
7. Demagnetization is the process by which a magnet loses its properties.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. A freely suspended magnet points to the north-south direction. ☐

b. Plastic and glass are magnetic substances. ☐

c. In a magnet, molecular magnets are arranged in rings. ☐

d. A magnet gets demagnetized when it is hammered. ☐

e. We should store magnets using keepers. ☐

2. Fill in the blanks using appropriate words.

a. Substances which are not attracted by magnet are called ....

b. Molecular magnets are randomly oriented in .... substances.

c. Magnetic poles occur in ....

d. When a magnet is strongly heated it gets ....

e. We should store magnets joining their ....

3. Answer the following questions.

a. What is a magnet?

b. Define magnetic substance with any two examples.

c. Define non-magnetic substances. Give any two examples.

d. Name the two poles of a magnet.

e. What is meant by magnetism?

f. What is magnetic force?

g. Write any three points of molecular theory of magnetism.

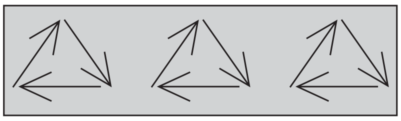
h. What is a magnetic induction?

i. What is demagnetization?

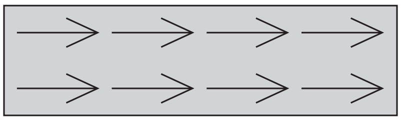
j. Write any four methods for conserving magnetism.

4. Study the given figures and write which one is a magnetic substance, a or b? Why?

a.



b.



5. Draw a neat figure showing the arrangement of molecular magnets in a magnetic substance.

6. Describe an activity to demonstrate magnetic induction.

7. Write any four conditions when a magnet gets demagnetized.

UNIT 10

Electricity

Weighting Distribution (Approximate)	Teaching periods : 2	Marks (in %): 1

Before You Begin

The form of energy which is produced due to the continuous flow of electrons or flow of charges is called electricity. It is of two types, viz. static electricity and current electricity. The electricity which is produced due to the continuous flow of electrons through a conductor is called current electricity. Cell and battery are the sources of electricity. We can convert electrical energy into heat energy, light energy, mechanical energy, sound energy, etc. Therefore, electricity is the most important form of energy.

Learning Objectives

After completing the study of this unit, students will be able to:

i. explain the structure and utilities of simple cell and dry cell.

ii. ii. introduce household wiring system and domestic electric appliances.

iii. iii. introduce fuse and MCB and to state their uses.

iv. iv. introduce some domestic electrical devices.

Syllabus

- Simple cell
- Dry cell
- House hold wiring system
- Some domestic electrical devices
  - Electric lamp
  - Heater
  - Electric bell
  - Radio/Television
  - Telephone/Mobile
  - Computer
- Fuse and MCB

Glossary: A dictionary of scientific/technical terms

electricity	:	a form of energy which is produced due to flow of electrons/charges
cell	:	a device which converts chemical energy into electrical energy
earthing	:	a process of connecting main switch box to the earth through a conductor
fuse	:	a thin wire made of tin and lead which melts itself when current exceeds the safe value
MCB	:	miniature circuit breaker, advanced form of fuse
hazard	:	a thing that can be dangerous or cause damage

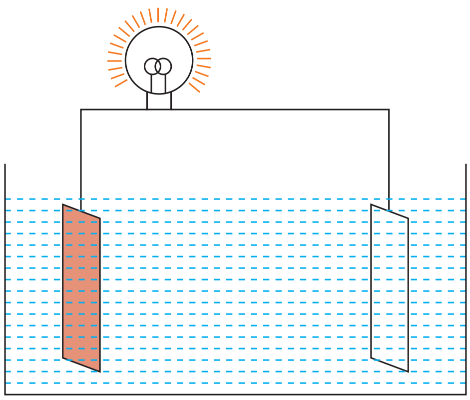
Cell

The device which converts chemical energy into electrical energy is called a cell. It is used in various equipment like watch, torch, radio, toys, etc. There are two types of cell, viz. primary cell and secondary cell.

Primary cell

The cell which cannot be recharged after use is called a primary cell. This cell stops working when chemicals in it get exhausted. For example, simple cell and dry cell.

Fig. 10.1



Simple cell

Dry cell

Secondary cell

The cell which can be recharged again and again is called secondary cell. Lead-acid cell, nickel-cadmium cell, etc. are examples of secondary cell. This type of cell stores electrical energy in the form of chemical energy which can be changed into electrical energy when required.

Fig. 10.2

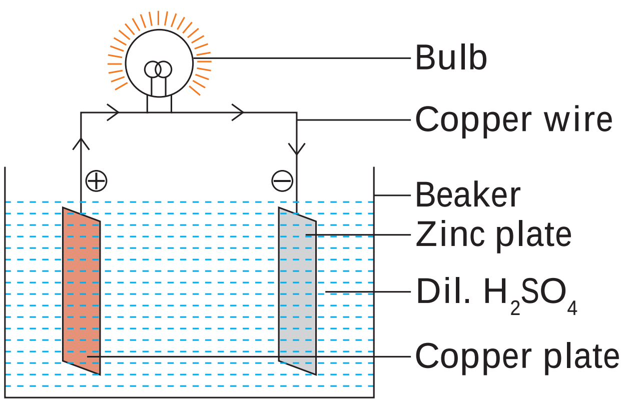
Lead-acid cell

Simple cell

The cell made by immersing two metal plates (copper and zinc) into acid solution (sulphuric acid) is called simple cell.

A simple cell has a container of dilute sulphuric acid (dil. H_2SO_4) in which two metal plates (one copper plate and another zinc plate) are dipped/immersed.

Fig. 10.3



Simple cell

In a simple cell, the copper plate acts as an anode and works as a positive terminal. Similarly, the zinc plate acts as a cathode and works as a negative terminal. Simple cell produces maximum potential difference of 1 volt.

In a simple cell, zinc reacts with dilute sulphuric acid and gets dissolved into acid. Zinc plate acts as a negative terminal. The hydrogen gas produced during chemical reaction gets deposited on copper plate. The copper plate loses electrons and acts as a positive terminal. When copper plate and zinc plate are connected to a bulb through copper wire, the bulb glows.

A simple cell cannot work for a long time because of two defects, viz. local action and polarization.

1. Local action

It is the defect of a simple cell which resists the flow of current in the external circuit due to flow of local currents. The zinc plate kept in a simple cell contains impurities like iron, copper, carbon, etc. These impurities act on iron plate, copper plate, carbon plate, etc. and local current flows. The local currents resist the flow of current in the external circuit. This type of defect is called local action. It reduces the life of a simple cell.

Local action can be reduced by using pure zinc plate or by using mercury coated zinc plate.

2. Polarization

The defect of a simple cell is that the cell stops working due to deposition of hydrogen gas on the copper plate. In this defect, the hydrogen gas produced during chemical reaction forms a layer on the copper plate. This layer stops the reaction between acid and copper plate. As a result, the cell stops working.

Polarization can be minimized by using depolarizers like potassium dichromate ($K_2 Cr_2 O_7$), copper sulphate ($CuSO_4$) or manganese dioxide (MnO_2) in the acid.

Activity 1

- Take a beaker and keep 100 ml of dilute sulphuric acid.
- Take a zinc plate and connect a piece of copper wire with the zinc plate.
- Take a copper plate and connect a piece of copper wire with the copper plate.
- Now, immerse copper plate and zinc plate into the acid.
- Connect a bulb with the wires. What do you observe? Does the bulb glow?

This type of cell is called simple cell.

A simple cell contains chemicals in liquid state. It is difficult to transport and produces less current. There is a risk of spilling acid from simple cell. Therefore, this type of cell is rarely used.

Differences between Polarization and Local action

Polarization	Local action
1. It is the defect of a simple cell in which hydrogen gas formed during the chemical reaction gets deposited on the surface of copper plate and stops the flow of electric current.	1. It is the defect in which impurities present in the zinc like carbon, iron, copper, etc. cause to flow local current. It resists the flow of current in the external circuit and reduces the life span of the cell.
2. Polarization can be minimized by cleaning the copper plate regularly with a brush of adding potassium dichromate ($K_2Cr_2O_7$) or manganese dioxide (MnO_2) in the solution.	2. Local action can be minimized by using pure zinc or mercury coated zinc plate.

Dry cell

The cell which does not contain acid is called dry cell. This cell can be carried easily from one place to another and produces more current. Therefore, dry cell is widely used in torchlight, camera, radio, tape-recorder, etc.

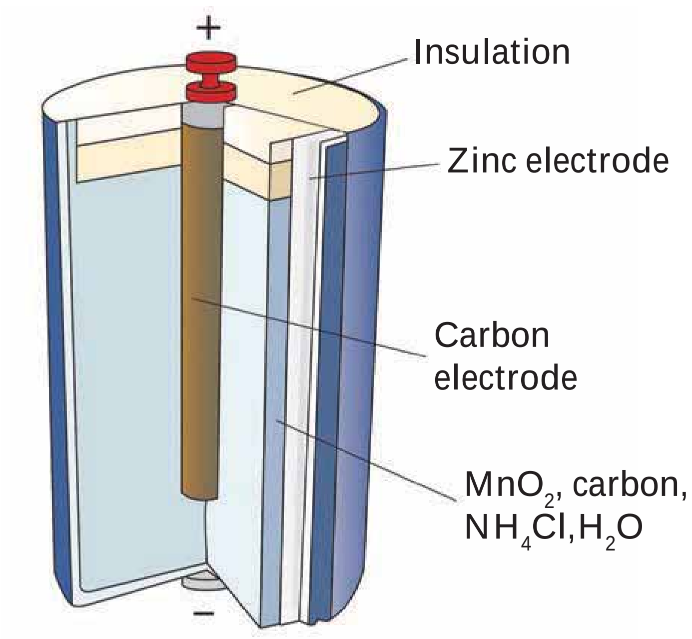


Fig. 10.4 *Internal structure of a dry cell*

A dry cell is made in a zinc container. A carbon rod with a brass cap is kept at the middle of the zinc container without touching it. Then the zinc container is filled with a moist paste of ammonium chloride. The carbon rod is surrounded by a closely packed mixture of carbon powder and manganese dioxide in a muslin bag. The upper part of the cell is sealed with wax. But a small hole is left for the gas to escape formed in it. Then the cell is wrapped with paper, over which it is wrapped with metal or polythene.

In a dry cell, carbon rod acts as the positive terminal and zinc container acts as the negative terminal. Chemical reaction takes place inside the dry cell. When two terminals of a dry cell are connected by a conduction wire, current flows.

In a dry cell, manganese dioxide acts as a depolarizer. So, polarization does not occur in a dry cell. The potential difference or voltage of a dry cell is 1.5 V. When reaction in dry cell is complete, the cell no longer supplies electricity and the cell stops working. If the dry cell is not used for a long time, it stops working due to local action.

Do You Know

Dry cell has no solution and can be formed in any shape according to the requirement. It can be stored and transported easily. So, dry cell is widely used in comparison of simple cell.

Differences between Simple cell and Dry cell

Simple cell	Dry cell
1. In a simple cell, the acid solution, i.e. dilute sulphuric acid (H_2SO_4) is used.	1. In a dry cell, the acid solution, i.e. dilute sulphuric acid (H_2SO_4) is not used.
2. It is difficult to carry a simple cell from one place to another.	2. It is easy to carry a dry cell from one place to another.

Household Wiring System

Electricity is generated from hydropower stations. Generally, hydropower stations are located far away from human settlements. The electricity generated by turbines is transmitted by cables through high transmission lines at very high voltage. The high voltage is decreased to 220 volt by using transformers before being distributed to houses.

The household electric system consists of three wires, viz. live wire or phase wire (L), neutral wire (N) and earthing wire (E).

From the electrical pole, electricity is distributed to the houses through wires. A fuse is connected before the kilo-watt-hour metre box. This fuse is called corporation fuse. A switch is connected to the wire taken out from the metre box. This switch is called the main switch. This switch supplies or cuts the electricity of entire house. The main switch box is made of iron and a wire is connected from the iron box to the earth. This process is called earthing. Earthing saves us from electric shock and prevents the flow of excessive

Fig. 10.5 *kWh meter box*

current during overloading. The fuses which are connected after the metre box are called consumers' fuses. The wires which are emerging out of the main switch box are connected to the distribution board as shown in the given figure.

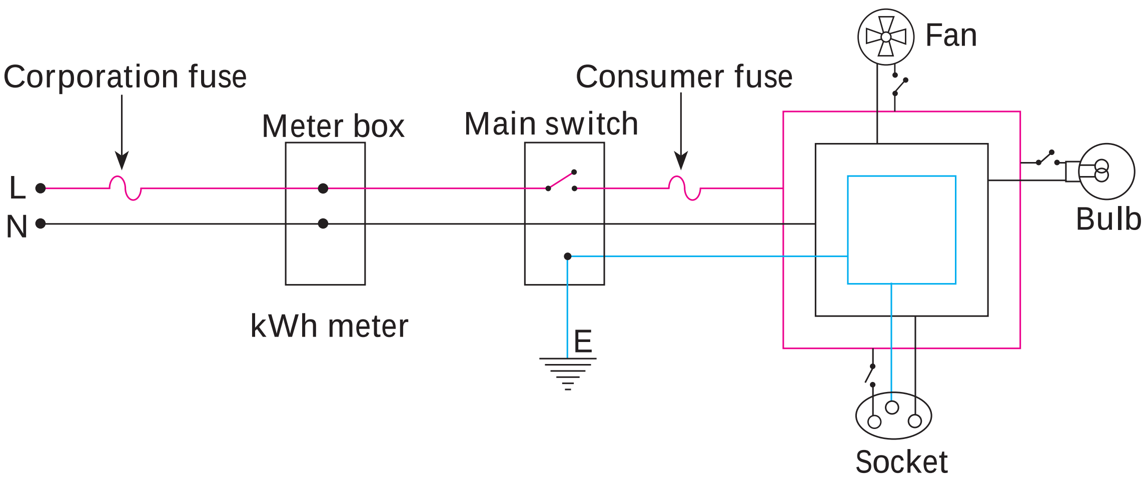


Fig. 10.6

Household wiring system

All electric appliances like bulb, radio, television, computer, etc. are connected with separate circuit in parallel ways. Each circuit is controlled by a separate switch.

Some Domestic Electrical Devices

The devices which are used to convert electrical energy into other forms of energy are called electrical devices. Bulb, CFL, tubelight, radio, heater, television, etc. are examples of electrical devices. These devices can be operated with the help of electricity. Some common electrical devices which are widely used in our homes are as follows:

1. Electric lamp

An electric lamp is a device which converts electrical energy into light energy and heat energy. It is widely used in houses and offices to get light. Now-a-days, three types of electric lamps are commonly used. They are (i) filament lamp, (ii) fluorescent lamp and (iii) LED lamp.

Fig. 10.7

Filament lamp *CFL* *LED lamp*

2. Electric heater

An electric heater is a device which converts electrical energy into heat energy. It is used for making room warm, heating water, cooking food, pressing clothes, etc. Electric kettle, immersion rod, room heater, electric iron, etc. convert electrical energy into heat energy.

Fig. 10.8

Electric kettle *Electric iron* *Immersion rod* *Room heater*

3. Electric bell

An electric bell is a device which converts electrical energy into sound energy. In an electric bell, a temporary magnet is made by using electricity. Then kinetic energy is produced by the magnet to ring the bell. Electric bells are used in houses, schools and offices.

Fig. 10.9

Electric bell

4. Radio and television

Radio and television are very important means of information and communication. Electrical energy is required to operate radio and television. They are one-way means of communication.

Fig. 10.10

Radio *Television*

5. Telephone and mobile

Telephone and mobile are widely used for communication. They are very important devices for two way communications. Telephone and mobile are operated with the help of electricity.

Fig. 10.11

Telephone

Mobile

6. Computer

A computer is the most important electronic equipment operated by electricity. It is used to operate e-mail, internet, etc. in the field of information and communication. It is used to store data, process data, write books, play and store music and videos, etc.

Fig. 10.12

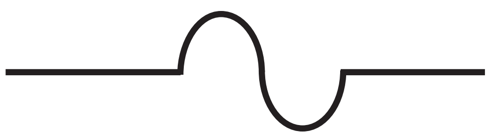
Computer

Fuse

A fuse is a short piece of wire having low melting point. It breaks the electric circuit by melting itself when current exceeds the safe value. A fuse is made of tin and lead. A fuse protects electrical devices from damage due to overloading or short circuiting.

Fig. 10.13

Fuse



Symbol of fuse

When a short-circuit or overloading occurs, the fuse gets heated and melts itself breaking the circuit. When a fuse melts, new fuse should be kept. In household circuit, we should use the fuse of appropriate rating. To select the fuse of appropriate rating, we should know the amount of current that flows through the circuit. The rating of the fuse should be slightly more than the current flowing through the circuit. For example, if a current of 4A flows through a circuit, a fuse of rating 5A should be used.

MCB

MCB stands for miniature circuit breaker. It is an advanced form of a fuse which protects the household devices during overloading or short-circuiting.

MCB switches off the circuit within a fraction of a second during overloading or short-circuiting. It can be reset immediately after correcting the fault in the circuit.

Fig. 10.14

MCB

Do You Know ?

MCB is the advanced form of fuse which protects the household wiring from overloading or short circuit whereas fuse protects the electric appliances in the circuit from getting damaged. Fuse should be replaced in case of its melting but MCB can be reset after correcting the fault. So, MCB is called the developed form of fuse.

Differences between Fuse and M.C.B.

Fuse	M.C.B.
1. A fuse is a thin wire made of lead (37%) and tin (63%) which is used in electric circuit.	1. MCB is advanced form of fuse which switches off the circuit within the fraction of second in case of overloading.
2. It needs wire to be exchanged.	2. It does not need wire to be exchanged.

Key Concepts

1. The device which converts chemical energy into electrical energy is called a cell.
2. The cell which cannot be recharged after use is called a primary cell.
3. The cell which can be recharged again and again is called a secondary cell.
4. The cell made by immersing two metal plates (copper and zinc) into acid solution (sulphuric acid) is called a simple cell.
5. The cell which does not contain acid is called a dry cell.
6. The devices which are used to convert electrical energy into other forms of energy are called electrical devices.
7. A fuse is a short piece of wire having low melting point. It is made of tin and lead.
8. MCB stands for miniature circuit breaker.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Electricity is produced due to continuous flow of electrons. ☐

b. A simple cell is very easy to transport. ☐

c. In a dry cell, zinc acts as a positive terminal. ☐

d. A fuse is made of copper and lead. ☐

e. An electric heater converts electrical energy into heat energy. ☐

2. Fill in the blanks using appropriate words.

a. In a simple cell, ... acts as a negative electrode.

b. Local action can be reduced by using .... in a simple cell.

c. In a dry cell, ... acts as a positive terminal.

d. In household wiring system, there are .... types of wires.

e. An electrical lamp converts .... energy to .... energy.

3. Answer the following questions.

a. What is electricity?

b. What is a simple cell? Draw a neat and labelled figure of a simple cell.

c. What is a local action? How is it reduced?

d. What is polarization in a simple cell? How is it reduced?

e. What is a dry cell? Draw a neat and labelled figure showing the structure of a dry cell.

f. What is a corporation fuse?

g. What are consumers' fuse?

h. What is earthing? Why is earthing done?

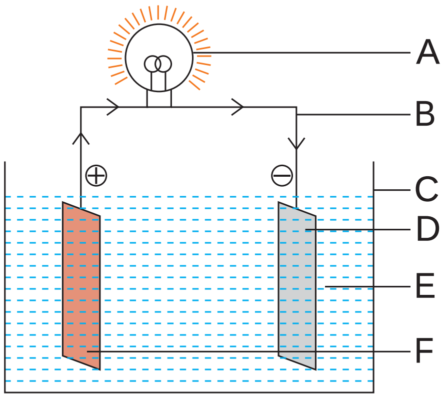
i. What are electrical devices? Name any three electrical devices that are used at your home.

j. What is a fuse? What is it made of?

k. Why is a fuse used in household wiring system.

l. What is MCB? Write down its use.

4. Study the given figure and name the parts A, B, C, D, E and F.



5. Differentiate between:

a. Simple cell and dry cell

b. Local action and polarization

c. Fuse and MCB

6. Draw a neat and labelled figure showing the structure of a dry cell.

7. Identify the given electrical devices and write down the utility of each.

a. 

b. 

c. 

8. Draw a neat figure showing household wiring system.

9. Dry cell is widely used as compared to the simple cell. Give any two reasons to support this statement.

Chemistry

UNIT 11

Matter

Weighting Distribution (Approximate)	Teaching periods : 9	Marks (in %): 4

Before You Begin

Any thing having a mass and volume is called a matter. Different substances around us are matter. Solid, liquid and gas are three states of matter. Some matter can be decomposed into simple substances. These substances are called compounds. A compound is a substance formed by combination of two or more elements in a fixed proportion by weight. The smallest particle of a compound is called molecule. Water (H_2O), Sodium chloride (NaCl), Carbon dioxide (CO_2), etc. are some examples of compounds. Some matters cannot be divided into simple substance by ordinary chemical means. These matters are called elements. The smallest particle of an element is called atom. An element is a pure substance made of atoms. Hydrogen (H), Oxygen (O), Carbon (C), Sodium (Na), etc. are some examples of elements. Scientists have discovered 118 elements so far. Among them 92 elements are found in nature and the remaining 26 elements have been synthesized in laboratory by scientists.

Learning Objectives

After completing the study of this unit, students will be able to:

i. describe the structure of an atom and state the properties of proton, neutron and electron.

ii. define valency and find out the valency of the first 20 elements on the basis of electronic configuration.

iii. define atomic number and atomic weight and find out the number of proton, neutron and electron on the basis of atomic number.

iv. define molecular weight and calculate the molecular weight of some common compounds.

v. define chemical reaction and express some simple chemical changes into word equation and formula equation.

Syllabus

- Introduction of matter
- Atom and molecule
- Structure of an atom
- Proton, neutron and electron
- Atomic mass unit
- Electric charge
- Atomic number
- Atomic mass or Atomic weight
- Electronic configuration
- Valency
- Molecular formula
- Molecular weight
- Periodic table
- Chemical reaction
- Word equation
- Formula equation
- Things to remember while writing chemical reaction

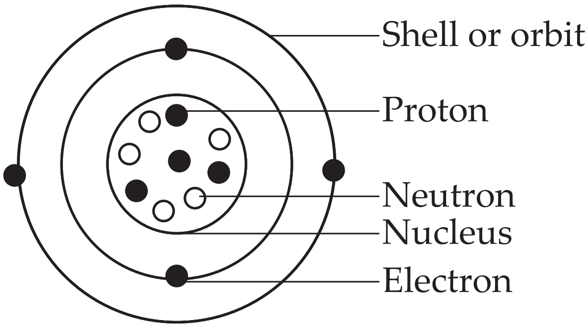
Glossary: A dictionary of scientific/technical terms

matter	:	anything having mass and volume
atom	:	the smallest particles of an element
molecule	:	the smallest particle of a compound
valency	:	the combining capacity of an atom with another atom to form a molecule
symbol	:	an abbreviation of the full name of an element
abbreviation	:	a short form of a word

Atom

An atom is the smallest particle of an element which can take part in a chemical reaction. All atoms of an element are similar but atoms of different elements are different. For example, all atoms of gold are identical but the atom of gold differs from that of copper or silver. Scientists have discovered 118 types of atoms so far. Among them, most atoms cannot exist freely in nature but atoms of helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn) exist freely in nature. Carbon (C), hydrogen (H), oxygen (O), sodium (Na),calcium (Ca), etc. are the examples of atom.

Fig. 11.1



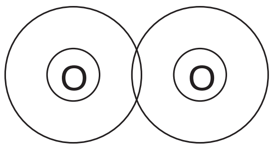
An atom

Molecule

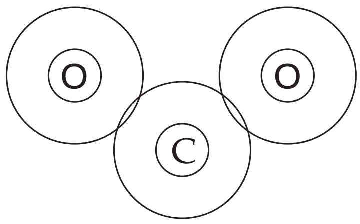
The smallest particle of an element or a compound which can exist freely in nature is called a molecule. There are a thousand types of molecules. The molecule of an element consists of two or more atoms of the same kind where as the molecules of a compound consists of two or more atoms of different elements. Hydrogen (H_2), oxygen (O_2), ozone (O_3), water (H_2O), calcium carbonate ($CaCO_3$), etc. are some examples of molecules.

A molecule of oxygen consists of two atoms of oxygen. Similarly, a molecule of carbon dioxide consists of one atom of carbon and two atoms of oxygen.

Fig. 11.2



Oxygen molecule



Carbon dioxide molecule

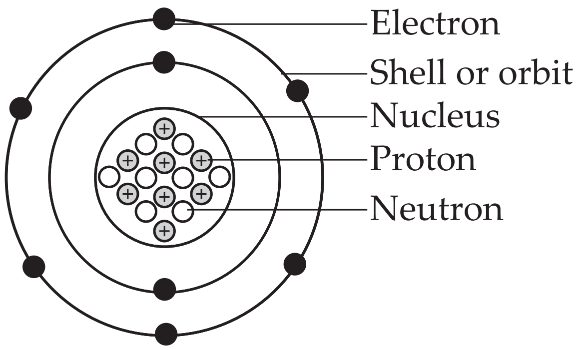
Differences between Atom and Molecule

Atom	Molecule
1. An atom of an element is the smallest particle of that element.	1. A molecule is the smallest particle of an element or compound which can exist freely.
2. It can take part in chemical reaction.	2. It is the result of chemical reaction.

Structure of an atom

An atom is made of three fundamental particles or sub-atomic particles. They are proton, neutron and electron. Among them, proton and neutron are located in the nucleus whereas electrons revolve around the nucleus in elliptical orbits or shell.

Fig. 11.3



Oxygen atom

Protons are positively charged sub-atomic particles located in the nucleus of an atom. The mass of one proton is equal to that of one hydrogen atom. The mass of one hydrogen atom is considered as one amu (atomic mass unit). The mass of one proton is 1837 times more than that of one electron. A proton is denoted by p^+.

Neutrons are chargeless sub-atomic particles located in the nucleus of an atom. The mass of a neutron is equal to that of a proton. A neutron is denoted by n°.

Electrons are negatively-charged sub-atomic particles that revolve around the nucleus in elliptical orbits or shells. The mass of one electron is 1837 times smaller than that of one proton. An electron is denoted by e^-.

Atomic mass unit (amu)

The mass of an atom is very very small. It cannot be expressed into milligram, gram and kilogram. So the mass of proton, neutron and electron is expressed in atomic mass unit (amu). The mass of a hydrogen atom is 1 amu. 1 gram is equal to 6×10^{23} amu. The mass of a proton is 1 amu. So the mass of 6×10^{23} protons is equal to 1 gram. The mass of one proton is equal to that of one neutron. Similarly, the mass of one neutron is 1837 times more than that of one electron.

In short,

$$1p^+ = 1n^\circ = 1837e^- = 1 \text{ amu}$$

Electric charge

Protons and electrons are electrically charged. Protons have positive charge and electrons have negative charge but neutrons do not have any charge. The unit of electronic charge is coulomb (coul). In a neutral atom, the number of protons is equal to that of electrons.

Do You Know

An atom is electrically neutral due to the presence of equal number of protons and electrons having opposite charges.

One coulomb charge contains 6.25×10^{18} electrons. The given table shows the comparative study of proton, neutron and electron.

	Sub-atomic particles	Symbol	Charge	Mass	Location
1.	Proton	p+	+ve	1amu	Neucleus
2.	Neutron	n°	nil	1 amu	Nucleus
3.	Electron	e–	–ve	$\frac{1}{1837}$ amu	Orbit or shell

Atomic number

An atomic number of an atom is the total number of protons present in the nucleus of that atom. It is also defined as the total number of electrons present in a neutral atom. An atomic number is denoted by z.

In short,

Atomic number (z) = No. of p^+ = No. of e^- in a neutral atom

Atomic mass or Atomic weight

The sum of number of protons and neutrons present in the nucleus of an atom is called atomic mass or atomic weight. It is denoted by A.

Atomic mass (A) = No. of p+ + No. of n°

No. of p+ = Atomic mass (A) – No. of n°

No. of n° = Atomic mass (A) – No. of p+

No. of n° = Atomic mass (A) – Atomic number (z) [∵ Atomic number = No. of p^+]

Worked out Numerical: 1

An atomic number of calcium atom is 20 and its atomic mass is 40. Calculate the number of protons, neutrons and electrons.

Given,

Atomic no. (z) = 20

Atomic weight (A) = 40

We know,

Atomic no. (z) = No. of p^+ = No. of e^-

= 20 = 20

$\therefore$ No. of $p^+ = 20$

No. of $e- = 20$

Now,

Atomic mass = No. of p^+ + No. of n°

or, $40 = 20 +$ No. of n°

or, No. of $n^\circ = 40 - 20 = 20$

Electronic Configuration

Electronic configuration is the systematic distribution of electrons in various orbits or energy levels around the nucleus of an atom. The distribution of electrons around the nucleus was proposed by Bohr and Bury in 1921 AD.

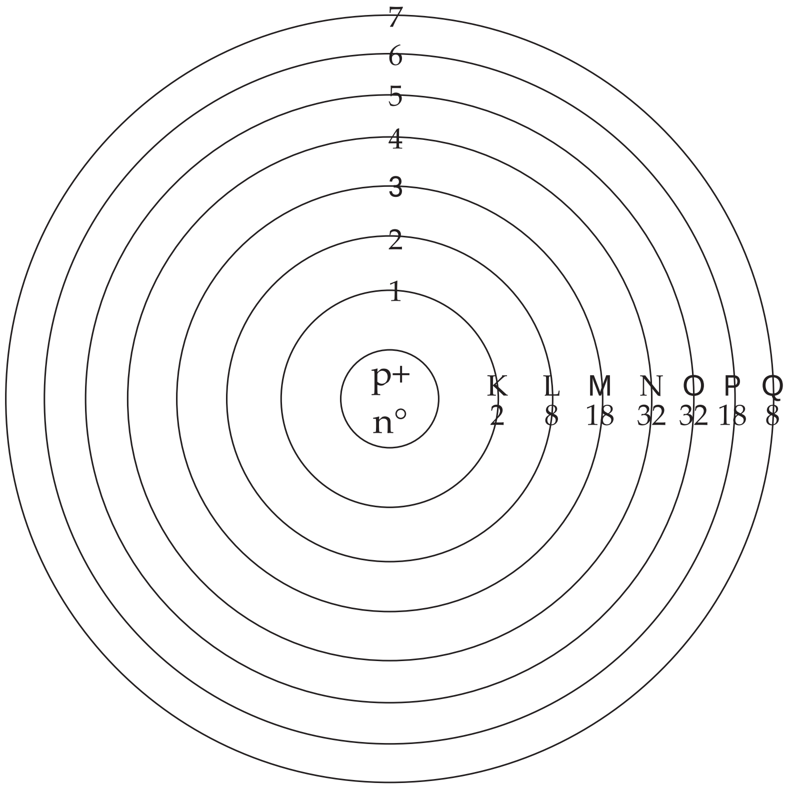


Fig. 11.4 *Electronic configuration in various orbits*

In an atom, the shells or orbits are named as K, L, M, N, O, P and Q according to the increasing distance from the nucleus. $2n^2$ rule determines the maximum number of electrons that are accommodated in different shells of an atom. In this rule, 'n' represents the number of shells or orbits.

Orbit/shell	No. of shell	Maximum number of electrons
K	$n = 1$	$2n^2 = 2 \times 1^2 = 2$
L	$n = 2$	$2n^2 \times 2 \times 2^2 = 8$
M	$n = 3$	$2n^2 = 2 \times 3^2 = 18$
N	$n = 4$	$2n^2 = 2 \times 4^2 = 32$

The outermost shell of an atom cannot accommodate more than 8 electrons. So $2n^2$ rule is applicable for a few elements and shells K, L, M and N. The maximum number of electrons that can be accommodated by shells O, P and Q is 32, 18 and 8 respectively.

Atomic number	Name of elements	Symbol	Number of			Atomic mass ($p^+ + n^\circ$)	Electronic configuration				Valency
			p^+	n°	e^-		K	L	M	N	
1.	Hydrogen	H	1	0	1	1 + 0 = 1	1				1
2.	Helium	He	2	2	2	2 + 2 = 4	2				0
3.	Lithium	Li	3	4	3	3 + 4 = 7	2	1			1
4.	Beryllium	Be	4	5	4	4 + 5 = 9	2	2			2
5.	Boron	B	5	6	5	5 + 6 = 11	2	3			3
6.	Carbon	C	6	6	6	6 + 6 = 12	2	4			4
7.	Nitrogen	N	7	7	7	7 + 7 = 14	2	5			3
8.	Oxygen	O	8	8	8	8 + 8 = 16	2	6			2
9.	Fluorine	F	9	10	9	9 + 10 = 19	2	7			1
10.	Neon	Ne	10	10	10	10 + 10 = 20	2	8			0
11.	Sodium	Na	11	12	11	11 + 12 = 23	2	8	1		1
12.	Magnesium	Mg	12	12	12	12 + 12 = 24	2	8	2		2
13	Aluminium	Al	13	14	13	13 + 14 = 27	2	8	3		3
14.	Silicon	Si	14	14	14	14 + 14 = 28	2	8	4		4
15.	Phosphorus	P	15	16	15	15 + 16 = 31	2	8	5		3
16.	Sulphur	S	16	16	16	16 + 16 = 32	2	8	6		2
17.	Chlorine	Cl	17	18	17	17 + 18 = 35	2	8	7		1
18.	Argon	Ar	18	22	18	18 + 22 = 40	2	8	8		0
19.	Potassium	K	19	20	19	19 + 20 = 39	2	8	8	1	1
20.	Calcium	Ca	20	20	20	20 + 20 = 40	2	8	8	2	2

The atomic structure and electronic configuration of the first 20 elements is given below:

1. Hydrogen (H)
   Atomic number = 1
   Atomic mass = 1

Shells	K	L	M	N
No. of e^-	1	×	×	×

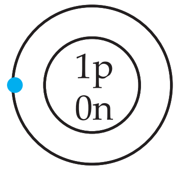


Fig. 11.5

Hydrogen

2. Helium (He)
   Atomic number = 2
   Atomic mass = 4

Shells	K	L	M	N
No. of e^-	2	×	×	×

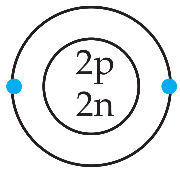


Fig. 11.6

Helium

3. Lithium (Li)
   Atomic number = 3
   Atomic mass = 7

Shells	K	L	M	N
No. of e^-	2	1	×	×

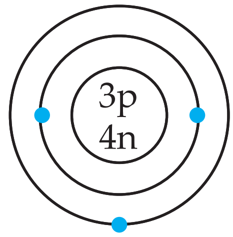


Fig. 11.7

Lithium

4. Beryllium (Be)
   Atomic number = 4
   Atomic mass = 9

Shells	K	L	M	N
No. of e^-	2	2	×	×

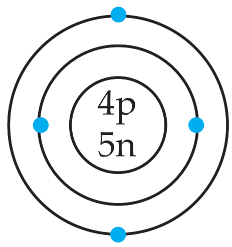


Fig. 11.8

Beryllium

5. Boron (B)
   Atomic number = 5
   Atomic mass = 11

Shells	K	L	M	N
No. of e^-	2	3	×	×

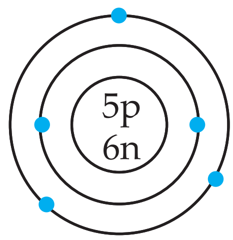


Fig. 11.9

Boron

6. Carbon (C)
   Atomic number = 6
   Atomic mass = 12

Shells	K	L	M	N
No. of e^-	2	4	×	×

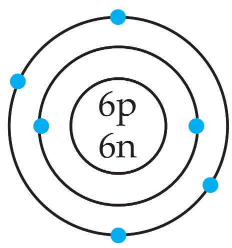


Fig. 11.10

Carbon

7. Nitrogen (N)
Atomic number = 7
Atomic mass = 14

Shells	K	L	M	N
No. of e^-	2	5	×	×

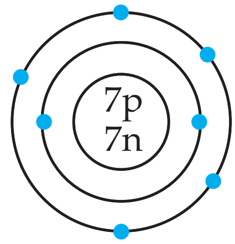


Fig. 11.11

8. Oxygen (O)
Atomic number = 8
Atomic mass = 16

Shells	K	L	M	N
No. of e^-	2	6	×	×

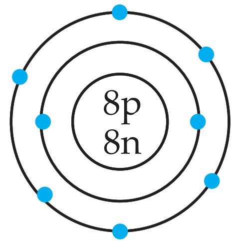


Fig. 11.12
Oxygen

9. Fluorine (F)
Atomic number = 9
Atomic mass = 19

Shells	K	L	M	N
No. of e^-	2	7	×	×

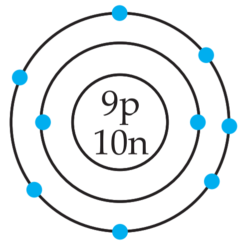


Fig. 11.13
Fluorine

10. Neon (Ne)
Atomic number = 10
Atomic mass = 20

Shells	K	L	M	N
No. of e^-	2	8	×	×

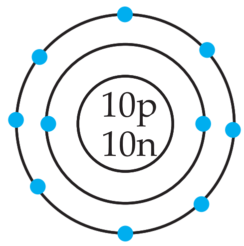


Fig. 11.14
Neon

11. Sodium (Na)
Atomic number = 11
Atomic mass = 23

Shells	K	L	M	N
No. of e^-	2	8	1	×

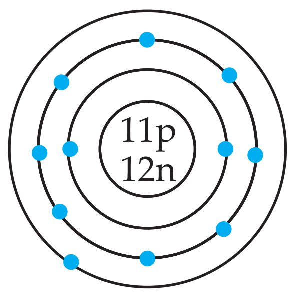
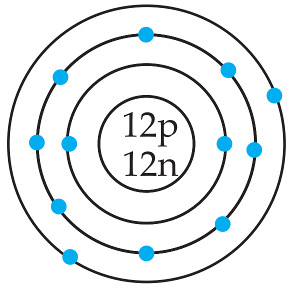


Fig. 11.15
Sodium

12. Magnesium (Mg)
Atomic number = 12
Atomic mass = 24

Shells	K	L	M	N
No. of e⁻	2	8	2	×

Fig. 11.16

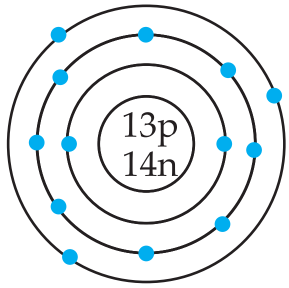


Magnesium

13. Aluminium (Al)
Atomic number = 13
Atomic mass = 27

Shells	K	L	M	N
No. of e⁻	2	8	3	×

Fig. 11.17

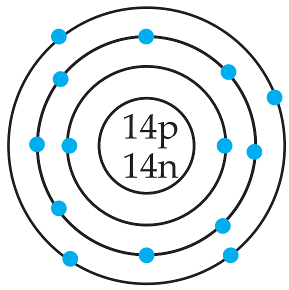


Aluminium

14. Silicon (Si)
Atomic number = 14
Atomic mass = 28

Shells	K	L	M	N
No. of e⁻	2	8	4	×

Fig. 11.18

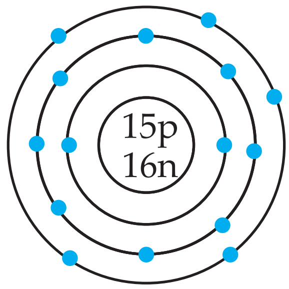


Silicon

15. Phosphorus (P)
Atomic number = 15
Atomic mass = 31

Shells	K	L	M	N
No. of e⁻	2	8	5	×

Fig. 11.19

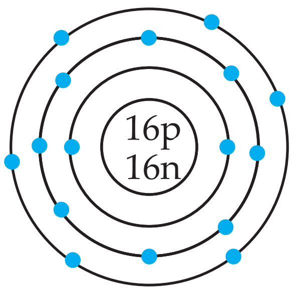


Phosphorus

16. Sulphur (S)
Atomic number = 16
Atomic mass = 32

Shells	K	L	M	N
No. of e⁻	2	8	6	×

Fig. 11.20

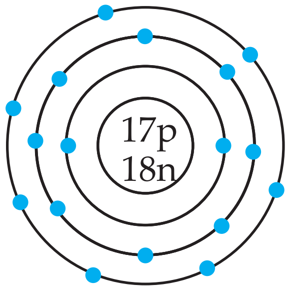


Sulphur

17. Chlorine (Cl)
Atomic number = 17
Atomic mass = 35

Shells	K	L	M	N
No. of e^-	2	8	7	×

Fig. 11.21

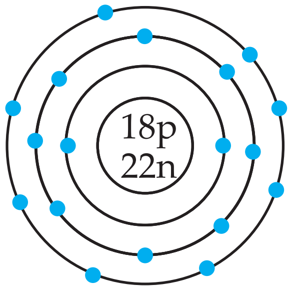


Chlorine

18. Argon (Ar)
Atomic number = 18
Atomic mass = 40

Shells	K	L	M	N
No. of e^-	2	8	8	×

Fig. 11.22

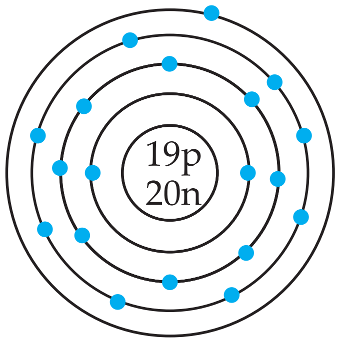


Argon

19. Potassium (K)
Atomic number = 19
Atomic mass = 39

Shells	K	L	M	N
No. of e^-	2	8	8	1

Fig. 11.23

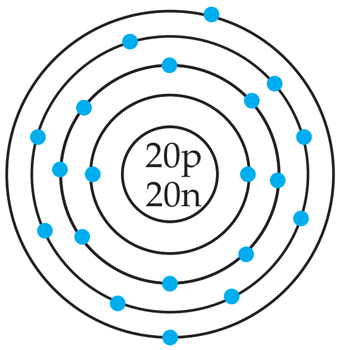


Potassium

20. Calcium (Ca)
Atomic number = 20
Atomic mass = 40

Shells	K	L	M	N
No. of e^-	2	8	8	2

Fig. 11.24



Calcium

Symbol

The abbreviation of the full name of an element is called symbol. It is represented by one or more English letters. If the symbol of an element has only one letter, it is written in the capital letter. If the symbol has two letters, the first letter is written in the capital and the second in small letter.

Some elements which are symbolized by only one letter are as follows:

Atomic number	Name of element	Symbol	Atomic number	Name of element	Symbol
1	Hydrogen	H	15	Phosphorus	P
5	Boron	B	16	Sulphur	S
7	Nitrogen	N	23	Vanadium	V
8	Oxygen	O	53	Iodine	I
9	Fluorine	F	92	Uranium	U

Some elements which are symbolized by two letters are as follows:

Atomic number	Name of element	Symbol	Atomic number	Name of element	Symbol
2	Helium	He	17	Chlorine	Cl
3.	Lithium	Li	20	Calcium	Ca
4	Beryllium	Be	24	Chromium	Cr
10	Neon	Ne	25	Manganese	Mn
12	Magnesium	Mg	27	Cobalt	Co
13	Aluminium	Al	30	Zinc	Zn
14	Silicon	Si			

Some elements whose names are written in English but symbolized from Latin or German names are as follows:

English name	Latin/German name	Symbol
1. Sodium	Natrium (Latin)	Na
2. Potassium	Kalium (Latin)	K
3. Iron	Ferrum (Latin)	Fe
4. Copper	Cuprum (Latin)	Cu
5. Silver	Argentum (Latin)	Ag
6. Gold	Aurum (Latin)	Au
7. Tungsten	Wolfram (German)	W

Valency

Valency is the combining capacity of an atom or a radical with another atom or radical to form a molecule. Valency of an atom is determined by the number of electrons present in the valence shell.

Valency is the number of electrons lost, gained or shared. For example, the valency of sodium (Na) is 1 because it loses one electron from its outermost shell. The valency of magnesium (Mg) is 2 because it loses 2 electrons from its outermost shell during chemical reaction. Similarly, the valency of chlorine is 1 as it gains 1 electron from other atoms and the valency of oxygen (O) is 2 as it gains 2 electrons from other atoms during chemical reaction.

If an atom has only a shell K having two electrons, the atom does not take part in chemical reaction. For example, the outermost shell of Helium (He) contains 2 electrons. So the valency of Helium (He) atom is zero. The state of an atom having two electrons in the shell K is called a duplet state.

The elements like Ne, Ar, Kr, Xn and Rn have eight electrons in their valence shell. This state is called an octet state. The state of an atom having eight electrons in the valence shell is called the octet state. The outermost shell of these elements is already fulfilled. So, these elements do not take part in chemical reaction. Hence, their valency is zero. The elements having a valency of zero are called inert gases.

If elements have 1, 2 or 3 electrons in their outermost shell except shell K, their valency is 1, 2 or 3 respectively. If elements have 4 electrons in their valence shell, their valency is also 4. If elements have 5, 6 or 7 electrons in their valence shell, their valency is 3, 2 and 1 respectively. If an atom has only one shell K and the shell K has two electrons, the valency of the atom is zero. If an atom has eight electrons in the outermost shell, its valency is also zero.

Radicals

Radicals are charged atoms or group of atoms having a common charge which acts as a single unit during a chemical reaction. Radicals have either a positive charge or a negative charge. So, they are chemically reactive and do not occur in free state. On the basis of electric charge, there are two types of radicals, viz. electro-positive radicals or basic radicals and electro-negative radicals or acidic radicals.

1. Electro-positive radicals or Basic radicals

The atoms or groups of atoms having a positive charge are called electro-positive radicals. They are also called basic radicals.

Some common electro-positive radicals with their valencies are given below:

a. Electro-positive radicals having valency 1 (Monovalent radicals)

i. Hydrogen (H^+)
ii. Lithium (Li^+)
iii. Sodium (Na^+)
iv. Potassium (K^+)
v. Cuprous (Cu^+)
vi. Mercurous (Hg^+)
vii. Aurous (Au^+)
viii. Ammonium (NH_4^+)

b. Electro-positive radicals having valency 2 (Bivalent radicals)

i.	Beryllium (Be^{++})	ii.	Magnesium (Mg^{++})
iii.	Calcium (Ca^{++})	iv.	Cupric (Cu^{++})
v.	Ferrous (Fe^{++})	vi.	Zinc (Zn^{++})
vii.	Nickel (Ni^{++})	viii.	Manganous (Mn^{++})

c. Electro-positive radicals having valency 3 (Trivalent radicals)

i.	Boron (B^{+++})	ii.	Aluminium (Al^{+++})
iii.	Ferric (Fe^{+++})	iv.	Auric (Au^{+++})

d. Electro-positive radicals having valency 4 (Tetravalent radicals)

i.	Silicon (Si^{++++})	ii.	Plumbic (Pb^{++++})
iii.	Stannic (Sn^{++++})		

2. Electro-negative radicals or Acidic radicals

The atoms or group of atoms having negative charge/s are called electro-negative radicals. They are also called acidic radicals.

Some common electro-negative radicals with their valency are given below:

a. Electro-negative radicals having valency 1

i.	Fluoride (F^-)	ii.	Chloride (Cl^-)
iii.	Bromide (Br^-)	iv.	Iodide (I^-)
v.	Nitrate (NO_3^-)	vi.	Nitrite (NO_2^-)
vii.	Hydroxide (OH^-)	viii.	Bisulphate (HSO_4^-)
ix.	Bicarbonate (HCO_3^-)	x.	Chlorate (ClO_3^-)

b. Electro-negative radicals having valency 2

i.	Oxide (O^{--})	ii.	Sulphate (SO_4^{--})
iii.	Carbonate (CO_3^{--})	iv.	Sulphide (S^{--})
v.	Sulphite (SO_3^{--})	vi.	Silicate (SiO_3^{--})

c. Electro-negative radicals having valency 3

i.	Nitride (N^{---})	ii.	Phosphate (PO_4^{---})
iii.	Phosphide (P^{---})	iv.	Phosphite (PO_3^{---})

Molecular Formula

A molecular formula is defined as the symbolic representation of the molecule of an element or a compound in a molecular form. It represents the number and type of atoms present in a molecule. For example, the molecular formula of Sodium Chloride (Common salt) is NaCl. It means that one molecule of Sodium Chloride is formed by combination of one atom of sodium and one atom of chlorine. Similarly, the molecular formula of calcium carbonate is $CaCO_3$. It means that one molecule of Calcium Carbonate is formed by one atom of calcium, one atom of carbon and three atoms of oxygen. We follow criss-cross method while writing molecular formulae.

Steps for writing molecular formulae

1. First of all, the symbols of electro-positive and electro-negative radicals are written side by side.
2. The valency of each radicals is written just below the symbol.
3. The valency of these radicals is exchanged. HCF is taken when required.
4. Radicals should be combined with exchanged valency to get the correct molecular formula.

Examples:

1. Hydrochloric acid

H Cl
1 1

H_1 Cl_1

= HCl

2. Sodium chloride

Na Cl
1 1

Na_1 Cl_1

= NaCl

3. Magnesium oxide

Mg O
2 2

$Mg_{\cancel{2}1}$ $O_{\cancel{2}1}$

= MgO

4. Carbon dioxide

C O
4 2

$C_{\cancel{2}1}$ $O_{\cancel{4}2}$

= CO_2

5. Ammonia

N H
3 1

N_1 H_3

= NH_3

6. Magnesium chloride

Mg Cl
2 1

Mg_1 Cl_2

= $MgCl_2$

Molecular Weight

The molecular weight of a molecule is defined as sum of atomic weights of the atoms present in the molecule. It is the total weight of the molecule of a substance.

The molecular weights of some common molecules are given below:

1. Hydrogen (H_2)

H_2 = 2H
= 2 × 1
= 2 amu

2. Water (H_2O)

H_2O = 2H + O
= 2 × 1 + 16
= 18 amu

3. Sodium chloride (NaCl)

NaCl = Na + Cl
= 23 + 35
= 58 amu

4. Carbon dioxide (CO_2)

CO_2 = C + 2[O]
= 12 + 2 × 16
= 44 amu

5. Calcium carbonate ($CaCO_3$)

$CaCO_3$ = Ca + C + 3[O]
= 40 + 12 + 3 × 16
= 100 amu

6. Aluminium sulphate [$Al_2(SO_4)_3$]

$Al_2(SO_4)_3$ = 2Al + 3S + 12 [O]
= 2 × 27 + 3 × 32 + 12 × 16
= 342 amu

Periodic Table

Till date, scientists have discovered 118 elements. Out of which, 92 elements are found in nature and 26 elements have been synthesized in the laboratory. It is very difficult to study all known elements one by one. So these elements are arranged in the form of a table to make the study of elements easy and systematic. The table in which these elements are arranged into periods and groups on the basis of their properties is called a periodic table.

Mendeleev's Periodic Table

Dmitri Mendeleev studied the properties of 63 known elements and their compounds. He arranged elements into horizontal rows (periods) and vertical columns (groups) on the basis of increasing atomic weights.

Mendeleev's periodic law states that, "The physical and chemical properties of elements are a periodic function of their atomic weights." He felt the existence of some undiscovered elements and he left gaps for them in the periodic table. There were many demerits in his periodic table. He could not arrange hydrogen properly. He kept highly reactive metals and less reactive metals in the same group.

There is no place for inert gases, lanthanides and actinides. However, Mendeleev's periodic table was the first scientific and systematic study of elements.

	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
Period 1	H							
Period 2	Li	Be	B	C	N	O	F	
Period 3	Na	Mg	Al	Si	P	S	Cl	
Period 4	K	Ca	1*	Ti	V	Cr	Mn	Fe Co
	Cu	Zn	2*	3*	As	Se	Br	Ni
Period 5	Rb	Sr	Y	Zr	Nb	Mo	4*	Ru Rh
	Ag	Cd	In	Sn	Sb	Te	I	Pd
Period 6	Cs	Ba	La	Hf	Ta	W	Re	Os Ir
	Au	Hg	Th	Pb	Bi	Po	At	Pt

Mendeleev's Periodic Table : 1: Eka-boron, 2*: Eka-aluminium, 3*: Eka-Silicon, 4*: Eka-Manganese*

Fig. 11.25 *Mendeleev's Periodic Table*

Modern Periodic Table

Henery Moseley led a group of chemists and studied the physical and chemical properties of the elements in the Mendeleev's periodic table. They found that properties of elements depend more accurately on atomic numbers rather than atomic weights. They concluded that atomic number is the fundamental property of an atom and they proposed a law called the Modern Periodic law.

The Modern Periodic law states that, "The physical and chemical properties of elements are a periodic function of their atomic numbers." In the Modern Periodic Table, elements have been arranged on the basis of increasing atomic numbers. In this table, elements having similar chemical properties lie in the same group and elements having gradual change in properties lie in the same period. There are seven horizontal rows (periods) and 18 vertical columns (groups) in the Modern Periodic Table. There is a separate place for inert gases, highly reactive metals, less reactive metals, lanthanides and actinides in the modern periodic table.

Fig. 11.26

Modern Periodic Table

- Alkali metals
- Alkaline earth metals
- Halogens
- Inert gases

	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9 VIII	10 VIII	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 0
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

Lanthanides	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinides	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Fig. Modern periodic table

Differences between the Mendeleev's Periodic Table and the Modern Periodic Table

Mendeleev's Periodic Table	Modern Periodic Table
1. Elements are arranged on the basis of increasing atomic weights.	1. Elements are arranged on the basis of increasing atomic numbers.
2. There are eight vertical columns.	2. There are eighteen vertical columns.
3. There is no place for inert gases, lanthanides and actinides.	3. There is a separate place for inert gases, lanthanides and actinides.

Chemical Reaction

The combination, decomposition or displacement that occurs in molecules of matter during a chemical change is called a chemical reaction.

$$\text{Carbon} + \text{Oxygen} \xrightarrow{\text{burn}} \text{Carbon dioxide}$$

$$C + O_2 \longrightarrow CO_2 \text{ [Combination]}$$

When calcium carbonate is heated, it decomposes into calcium oxide and carbon dioxide.

$$\text{Calcium carbonate} \xrightarrow{\text{heat}} \text{Calcium oxide} + \text{Carbon dioxide}$$

$$CaCO_3 \xrightarrow{\triangle} CaO + CO_2 \text{ [Decomposition]}$$

When magnesium reacts with suphuric acid, it forms magnesium sulphate and hydrogen gas.

$$\text{Magnesium} + \text{Sulphuric acid} \longrightarrow \text{Magnesium Sulphate} + \text{Hydrogen}$$

$$Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2 \text{ [Displacement]}$$

The above examples show that a chemical change is expressed in both word equation and formula/chemical equation.

Word Equation

A word equation is the chemical reaction expressed by writing the full names of reactants and products.

Examples

$$\text{Sodium} + \text{Chlorine} \longrightarrow \text{Sodium chloride}$$

$$\text{Hydrogen} + \text{Oxygen} \longrightarrow \text{Water}$$

$$\text{Magnesium} + \text{Chloride} \longrightarrow \text{Magnesium chloride}$$

Calcium carbonate $\longrightarrow$ Calcium oxide + Carbon dioxide

Zinc + Sulphuric acid $\longrightarrow$ Zinc sulphate + Hydrogen

Potassium Chlorate $\longrightarrow$ Potassium chloride + Oxygen

Formula Equation

A formula equation or chemical equation is the chemical reaction expressed by writing symbols and molecular formulae of reactants and products.

Examples:

$2Na + Cl_2 \longrightarrow 2NaCl$

$2H_2 + O_2 \longrightarrow 2H_2O$

$Mg + Cl_2 \longrightarrow MgCl_2$

$CaCO_3 \longrightarrow CaO + CO_2$

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

$2KClO_3 \longrightarrow 2KCl + 3O_2$

Do You Know

Formula equation gives more information than a word equation.

Reactants and Products

Reactants are chemical substances which take part in a chemical reaction. They are written on the left hand side of the arrow.

Products are the chemical substances which are produced after a chemical reaction. They are written on the right hand side of the arrow.

For example

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

(Reactants) (Products)

Do You Know

Reactants are written on the left hand side and products are written on the right hand side of the arrow?

Differences between Reactants and Products

Reactants	Products
1. The chemical substances which take part in a chemical reaction are called reactants.	1. The chemical substances which are produced after chemical reaction are called products.
2. Reactants are written on the left side of the arrow while writing a chemical equation.	2. Products are written on the right side of the arrow while writing a chemical equation.

Unbalanced Chemical Equation

The chemical equation in which the total number of atoms of each element in reactants and products are not equal is called an unbalanced chemical equation.

Examples:

$H_2 + O_2 \longrightarrow H_2O$

$Zn + HCl \longrightarrow ZnCl_2 + H_2$

$NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$

Balanced Chemical Equation

The chemical equation written by balancing the total number of atoms of each element in reactants and products is called a balanced chemical equation.

Examples

$2H_2 + O_2 \longrightarrow 2H_2O$

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$

Methods of Writing Balanced Chemical Equation

1. First of all, a chemical change is written correctly in the form of word equation.

   For example: Sodium + Chlorine $\longrightarrow$ Sodium Chloride

2. A word equation is written correctly in the form of formula equation.

   For example: $Na + Cl_2 \longrightarrow NaCl$

3. The number of atoms of each element are balanced by using suitable coefficient without changing the molecular formulae of reactants and products.

   For example: $2Na + Cl_2 \longrightarrow 2\,NaCl$

Information obtained from a Balanced Chemical Equation

We can get the following information from a balanced chemical equation.

1. The names of reactants and products.
2. Symbols and molecular formulae of reactants and products.
3. Total number of atoms or molecules of reactants and products.
4. Type of chemical reaction.

Project Work

- Prepare a model of atom of Carbon, Magnesium and Argon.
- Prepare a chart showing atomic structure and electronic configuration of first twenty elements.

Key Concepts

1. An atom is the smallest particle of an element which can take part in a chemical reaction.
2. An atom is made of three fundamental particles or sub-atomic particles. They are proton, neutron and electron.
3. An atomic number of an atom is the total number of protons present in the nucleus of that atom.
4. The sum of the number of protons and neutrons present in the nucleus of an atom is called atomic mass or atomic weight.
5. An electronic configuration is the systematic distribution of electrons in various orbits or energy levels around the nucleus of an atom.
6. The abbreviation of the full name of an element is called a symbol. It is represented by one or more English letters.
7. Valency is the combining capacity of an atom or a radical with another atom or radical to form a molecule.
8. Radicals are charged atoms or group of atoms having a common charge which acts as a single unit during a chemical reaction.
9. A molecular formula is defined as the symbolic representation of the molecule of an element or a compound in a molecular form.
10. A molecular weight of a molecule is defined as the sum of atomic weights of the atoms present in the molecule.
11. A table in which elements are arranged into periods and groups on the basis of their properties is called a periodic table.
12. Mendeleev's periodic law states that, "The physical and chemical properties of elements are a periodic function of their atomic weights."
13. The combination, decomposition or displacement that occurs in molecules of matter during a chemical change is called a chemical reaction.
14. A word equation is the chemical reaction expressed by writing the full names of reactants and products.

15. The chemical equation in which the total number of atoms of each element in reactants and products are not equal is called an unbalanced chemical equation.
16. The chemical equation written by balancing the total number of atoms of each element in reactants and products is called a balanced chemical equation.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. The smallest particle of an element is called an atom. ☐

b. Neutrons have negative charge. ☐

c. The symbol of sodium is S. ☐

d. The valency of ammonium radical is 1. ☐

e. In the modern periodic table, elements are arranged on the basis of increasing atomic weights. ☐

2. Fill in the blanks using appropriate words.

a. The smallest particle of a compound is called ....

b. Atomic mass is the sum of .... and ....

c. .... is the combining capacity of an atom or a radical.

d. .... is the chemical reaction expressed by writing the full names of reactants and products.

e. The chemical substances that take part in a chemical reaction are called ....

3. Tick (√) the most appropriate answer from the given alternatives.

a. The positively charged sub-atomic particles are called ....

☐ protons ☐ neutrons ☐ electrons ☐ shells

b. The atomic weight of chlorine atom is ....

☐ 17 ☐ 18 ☐ 35 ☐ 34

c. The symbol of potassium atom is ....

☐ P ☐ Po ☐ K ☐ Ka

d. The valency of sulphate radical is ....

☐ 2 ☐ 1 ☐ 3 ☐ 4

e. The molecular weight of water (H_2O) is ....

☐ 10 ☐ 18 ☐ 17 ☐ 8

4. Answer the following questions.

a. Define matter with any three examples.

b. What is an atom? Write any two examples of molecules.

c. Describe the structure of an atom with a neat figure.

d. What is an atomic mass unit? Write down the electric charge of protons, neutrons and electrons.

e. Define atomic number and atomic mass.

f. What is meant by an electronic configuration? State $2n^2$ rule.

g. Define symbol. Write down the symbol of carbon, sodium, chlorine, calcium, copper and gold.

h. What is valency? Write down the valency of O, Ne, Al, S and K.

i. What are radicals? Write their types.

j. Define electro-positive and electro-negative radicals with any three examples of each.

k. What is molecular formula? Write down the molecular formula of the given compounds.

i. Calcium Sulphate ii. Sodium Carbonate iii. Water

iv. Carbon dioxide v. Potassium Nitrate

vi. Ammonium Chloride

l What is a molecular weight? Find out the molecular weight of (i) NaCl (ii) K_2SO_4 (iii) $CaCO_3$ (iv) $MgCl_2$ (v) $CaSO_4$ (vi) $Mg(NO_3)_2$ (vii) $MgSO_4$

m. State Mendeleev's and Modern Periodic law.

n. Define chemical reaction with any two examples.

o. Define word equation and formula equation.

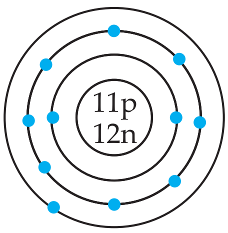
p. Define reactants and products.

q. What is meant by a balanced chemical equation? Give any two examples.

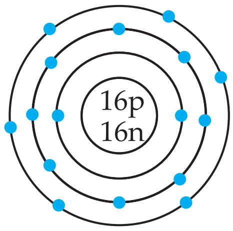
r. Write any three pieces of information that can be obtained from a balanced chemical equation.

5. Identity the atoms from the given figures.

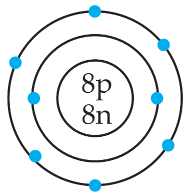
a.



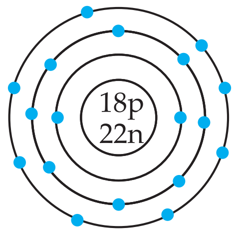
b.



c.



d.



6. The atomic number of Sodium is 11 and its atomic weight is 23. Calculate the number of p^+, n° and e^-.

7. The atomic number of Chlorine is 17 and its atomic mass is 35. Calculate the number of p^+, n° and e^-.

8. Differentiate between:

a. Atom and Molecule

b. Proton and Electron

c. Acidic radical and Basic radical

d. Word equation and Formula equation

9. Complete the given word equations and write them in the form of balanced formula equations.

a. Sodium + Chlorine $\longrightarrow$ ....

b. Calcium carbonate $\xrightarrow{\text{heat}}$ .... + ...

c. Hydrogen + Oxygen $\longrightarrow$ ....

d. Potassium chlorate $\xrightarrow{\text{heat}}$ .... + Oxygen

e. Water $\longrightarrow$ .... + Oxygen

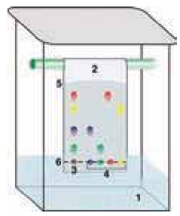
UNIT 12

Mixture

Weighting Distribution (Approximate)	Teaching periods : 3	Marks (in %): 2

Before You Begin

We use a variety of substances in our daily life. Among them, most are found in the form of a mixture and a few are found in pure state. A mixture contains two or more than two substances in any proportion by weight. The components of a mixture do not undergo chemical change. When two or more substances are brought together in any proportion, the resulting mass is called mixture. Tea, coffee, turbid water, air, etc. are examples of mixture. The state of a mixture may be solid, liquid or gas. Similarly, a mixture may be homogeneous or heterogeneous. In this unit, we will study distillation and chromatography in brief.



Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce mixture with examples.

ii. introduce distillation and demonstrate distillation and fractional distillation.

iii. explain and demonstrate chromatography.

Syllabus

- Introduction to mixture
- Distillation and its types
- Simple distillation and fractional distillation
- Chromatography and its principle
- Application of chromatography

Glossary: A dictionary of scientific/technical terms

mixture	:	the resulting mass formed when two or more substances are brought together in any proportion by weight
homogeneous	:	having things of the same type
heterogeneous	:	having things of different types
distillation	:	a method which is used to separate liquids from solids or other liquids through evaporation and condensation
chromatography	:	method of separating different colour from their mixture
condenser	:	a device that cools gas in order to change it into a liquid

Mixture

Methods of separation of a Mixture

The substances that are mixed together to form a mixture are called components of the mixture. The different components of a mixture have different physical state, shape, size, colour, solubility, density, etc. So, different methods are used to separate the components of a mixture on the basis of their properties. In this unit, we will study two methods for separating the components of a mixture. They are distillation and chromatography.

Distillation

The method which is used to separate liquids from solids or from other liquids through evaporation and condensation is called distillation. This method is used to separate volatile liquids from a non-volatile solid or the mixture of two or more liquids having different boiling points. In distillation, a liquid is heated to convert it into vapour and then the vapour is cooled to convert into liquid again. Distillation can be used to separate the components from the mixture of salt and water, alcohol and water, etc. Different liquids can also be purified by distillation.

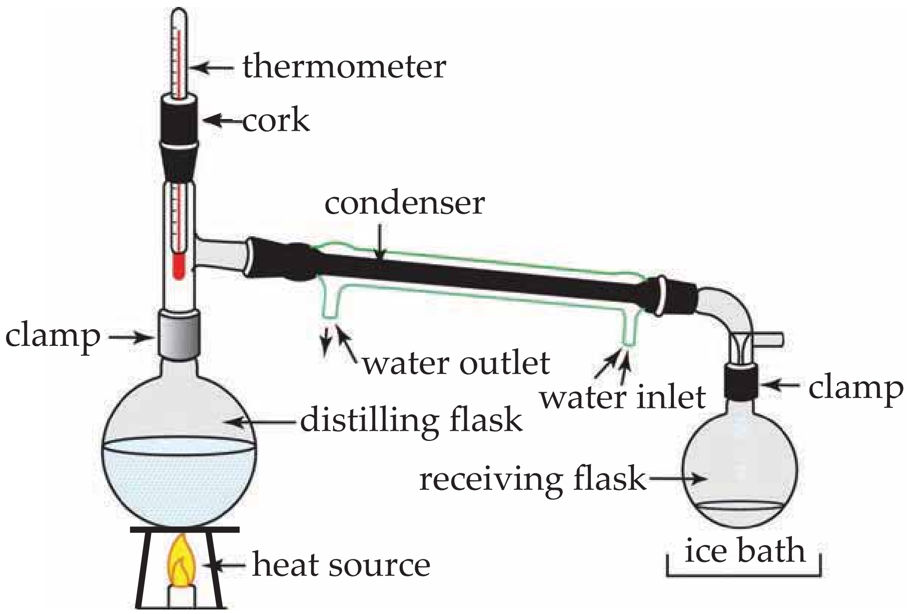


Fig. 12.1

Simple Distillation

Distillation involves two processes viz. evaporation and condensation. When a liquid is boiled, it changes into vapour. The vapour is passed through a condenser to form a pure liquid. The liquid is collected into a container called receiver. The apparatus which is used in distillation is called still. The still consists of a boiler, a condenser and a receiver. A boiler is used to boil the liquid, a condenser is used to convert vapour into liquid and a receiver is used to collect pure liquid.

Types of Distillation

There are two types of distillation. They are:

a. Simple distillation   b. Fractional distillation

a. Simple distillation

A simple distillation is a method which is used to separate the components of the mixture of solid and liquid or the mixture of two liquids having different boiling points of a wide range. A simple distillation is method used to obtain a pure liquid from the impurities dissolved in it. Generally, a simple distillation is used to purify sea water and to separate the mixture of salt and water.

Two liquids of different boiling points of a wide range are also separated by simple distillation. When the boiling point of the liquid having the low boiling point is reached, the liquid changes into vapour. The vapour is passed through Liebig's condenser to convert the vapour into liquid again.

Substances	Boiling points
Alcohol	78 °C
Water	100 °C
Mercury	357 °C
Sea water	103 °C

The liquid formed after condensation is collected in a receiver. The temperature of the mixture does not increase till all liquid changes into vapour. When the boiling point of second liquid is reached, it gets evaporated. The vapour passes through condenser and changes into liquid which is collected into second receiver. The liquids having different boiling points are thus separated by simple distillation. The mixture of alcohol and water can be separated by this method. Similarly, distilled water can be obtained by simple distillation.

Activity 1

To separate the mixture of salt and water.

- Take a round bottom flask and keep the solution of salt and water.
- Set the apparatus as shown in the figure.
- Arrange the flow of cold water in the condenser.
- Now, heat the solution using bunsen burner till all water gets evaporated.

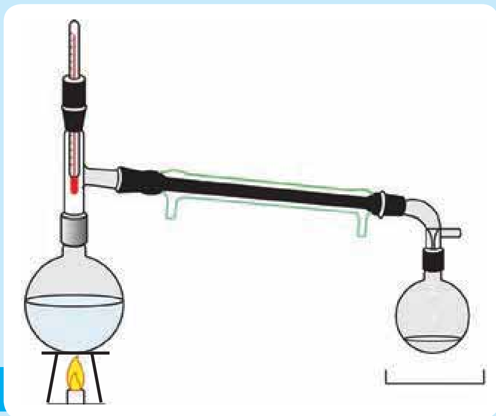


Fig. 12.2

Observe what happens after sometime.

When water boils, it gets evaporated. When the vapour passes through the condenser, it gets condensed into liquid and falls down in the receiver.

In this way, the mixture of salt and water is separated by simple distillation.

2. Fractional distillation

A method which is used to separate the mixture of two or more liquids of close boiling range is called the fractional distillation. The mixture of different liquids is heated till one of the liquids boils. Then the vapour produced is cooled until it condenses to give pure liquid. This process is repeated until all liquids get separated.

In fractional distillation, a fractionating column is used in addition to the still for simple distillation. For fractional distillation, the apparatus is set as shown in the figure.

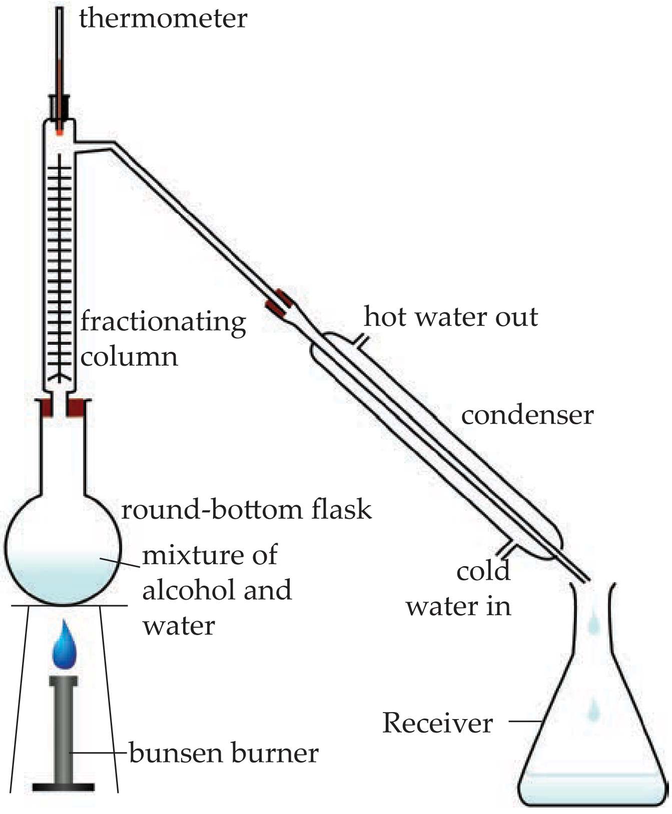


Fig. 12.3 *Fractional distillation*

Fractional distillation is used to separate the mixture of alcohol and water. Liquid air is distilled to separate oxygen and nitrogen gas. An oil refinery distills crude oil separating it into petrol, paraffin, lubricating oil, etc. A spirit distillery distills alcoholic liquors.

Differences between Simple distillation and Fractional distillation

Simple distillation	Fraction distillation
1. It is used to separate a mixture of two miscible liquids having different boiling points.	1. It is used to separate the mixture of two or more liquids of close boiling range.
2. In simple distillation, there is no fractional column.	2. In fractional distillation, a fractional column is used.

Chromatography

A Chromatography is a method of separating different colours from their mixture. The principle of chromatography is that different colours move with different speed when they pass through the same medium. The fixed medium may be a filter paper, alumina, silica gel, cellulose powder, chalk powder, etc.

Chromatography was invented by a Russian scientist Tswett in 1906 AD. The word chromatography has been derived from two Greek words *kroma* and *graphy*. Here,"*Kroma*" means colour and *graphy* means to "write". Chromatography is widely used to separate different mixtures of solids, liquids and gases. Generally, pigments of different colours are separated from their mixture by chromatography. However, colourless pigments can also be separated by this method.

Types of chromatography

On the basis of nature of moving and fixed phases, chromatography is of three types, viz. (i) paper chromatography, (ii) column chromatography and (iii) gas chromatography. In class 8, we will study paper chromatography and column chromatography.

1. Paper chromatography

Paper chromatography is a method of separating various colours from the mixture by using filter paper. It is based on the principle that porous paper adsorbs different substances at different extremes.

For paper chromatography, the mixture of various colours is dissolved in a liquid. A filter paper is taken and a drop of the solution is kept about 1 cm away from the edge of the filter paper. When the solution dries, the strip of filter paper is hung vertically in a beaker. The lower edge of the paper touches the solvent in the beaker. The solvent rises in the paper and carries various components of the mixture to different distances from their original position. In this way, the mixture of different colours can be separated by paper chromatography.

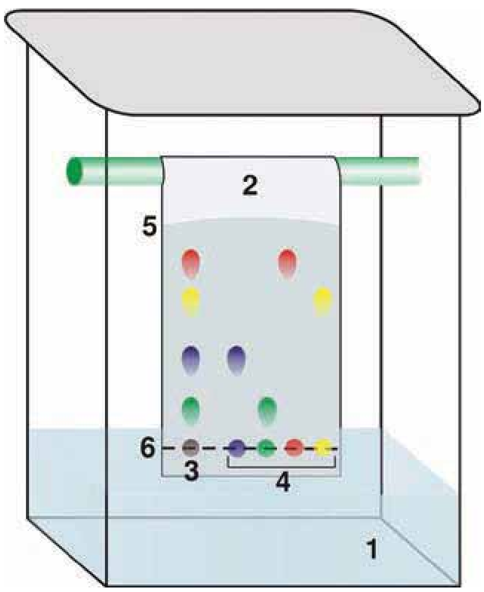


Fig. 12.4 *paper chromatography*

Activity 2

- Take a petri dish and prepare a mixture of red and green ink.
- Take a beaker and pour some water into it.
- Take a filter paper and make a small hole at the centre and insert a roll of a filter paper through its hole.
- Put a drop of mixture of ink about 1 cm away from the centre of the filter paper and wait till the drop dries.

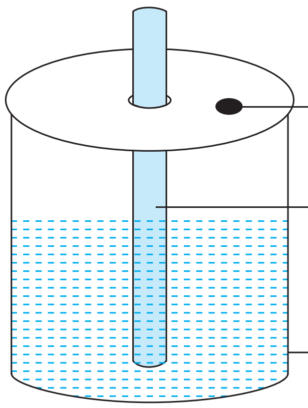


Fig. 12.5

- Now, keep the roll of the filter paper on the beaker in such a way that the lower end of the roll of the filter paper touches the water in the beaker.
- Observe the filter paper after 2-3 hours.

After 2-3 hours, a pattern of different colours can be seen on the filter paper. In this way, different colours can be separated by paper chromatography.

2. Column chromatography

Column chromatography is the method of separating different colours from their mixture by passing the mixture through an adsorbent like silica gel, cellulose powder, chalk powder, alumina, etc. It is based on the principle that an absorbent can adsorb different substances to different extents.

Do You Know

Column chromatography is also called absorption chromatography because an adsorbent is used in this method.

To separate the components of mixture by column chromatography, the mixture of two or more dissolved substances to be separated is passed through the vertical glass tube filled with an adsorbent like silica gel, alumina, chalk powder, etc. When the mixture passes down through the adsorbent, different colours get separated in the form of a band. In this way, different colours can be separated by column chromatography.

Applications of Chromatography

The main applications of chromatography are as follows:

1. It is used to separate different colours from their mixtures.
2. In pathological labs, chromatography is used to separate and identify the medicines mixed in urine and blood.
3. It is used to separate natural colours and artificial colours from their mixture.

Differences between Distillation and Chromatography

Distillation	Chromatography
1. Distillation is the method that is used to separate liquids from solids or from other liquids through vaporization and condensation.	1. Chromatography is the method used to separate various colours from their mixture.
2. This method is used to separate a volatile liquid from a non-volatile one or the mixture of two or more liquids having different boiling points.	2. This method is used to separate the chemicals present in colour, urine, blood, etc.

Activity 3

- Take a 20 cm long glass tube and heat its one end to make it narrow.
- Fill two-thirds of the glass tube with chalk powder.
- Take a stand and a beaker. Arrange the apparatus as shown in the figure.
- Take a beaker and mix different colours in water and stir with a glass rod.
- Now, pass the mixture of colours through chalk powder.
- Collect the various colours one by one into separate containers.

In this way, various colours can be separated by column chromatography.

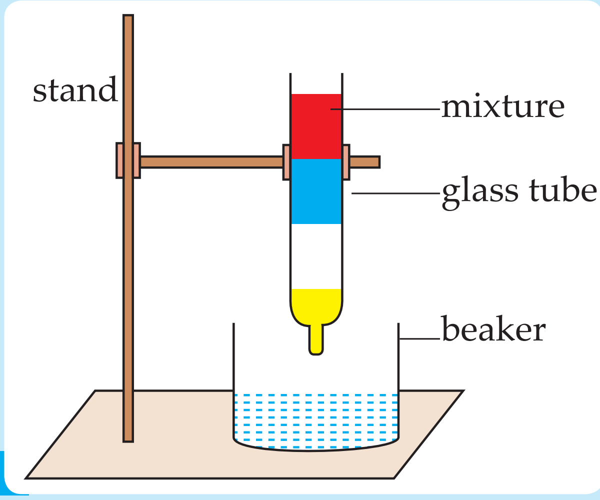


Fig. 12.6

Do You Know

Chromatography is not suitable when two substances move with the same speed in a medium. This is because chromatography is used for separating different substances that travel at different speeds into its individual components. Similarly, if two substances which have the same speed, they travel together. As a result, the components of the mixture cannot be separated.

Key Concepts

1. When two or more substances are brought together in any proportion, the resulting mass is called a mixture.
2. The substances that are mixed together to form a mixture are called components of the mixture.
3. The method which is used to separate liquids from solids or from other liquids through evaporation and condensation is called distillation.
4. Simple distillation is a method which is used to separate the components of the mixture of solid and liquid or the mixture of two liquids having different boiling points of a wide range.
5. Chromatography is a method of separating different colours from their mixture. The principle of chromatography is that different colours move with different speed when they pass through the same medium.
6. Column chromatography is the method of separating different colours from their mixture by passing the mixture through an adsorbent like silica gel, cellulose powder, chalk powder, alumina, etc.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. The component of a mixture do not undergo chemical change. ☐

b. The mixture of solid and gas is not found in nature. ☐

c. The mixture of alcohol and water can be separated by distillation. ☐

d. Chalk powder is used in paper chromatography. ☐

2. Fill in the blanks using appropriate words.

a. The mixture of salt and water can be separated by ....

b. The mixture of red ink and green ink can be separated by ....

c. Distillation involves two processes, viz. .... and ....

d. ....is used to separate different colours from their mixture.

3. **Answer the following questions.**
   a. Define mixture with any two examples.
   b. What is distillation? Name any two mixtures that can be separated by this method.
   c. Name two types of distillation.
   d. What is simple distillation? What types of mixtures can be separated by this method?
   e. What is fractional distillation? What type of mixtures can be separated by this method?
   f. Give any two examples of mixtures that can be separated by fractional distillation.
   g. What is chromatography? What types of mixtures can be separated by this method?
   h. Write down the principle of chromatography.
   i. Name the chemist who introduced chromatography.

4. **Differentiate between:**
   a. Distillation and Chromatography
   b. Simple distillation and Fractional distillation

5. **Name the method for separating each of the given mixtures.**
   a. Alcohol and water
   b. Salt and water
   c. Red ink and blue ink

6. **Describe the method of separating the mixture of salt and water with a neat and labelled figure.**

7. **Describe the method of separating the mixture of alcohol and water with a neat and labelled figure.**

8. **Distillation cannot be done to separate the mixture of two liquids having the same boiling point, why?**

UNIT 13

Metal and Non-metal

Weighting Distribution (Approximate)	Teaching periods : 7	Marks (in %): 1

Before You Begin

We use a number of metals, non-metals and metalloids in our daily life. Scientists have discovered 118 elements so far. These elements have been classified into metal, non-metals and metalloids on the basis of their physical and chemical properties. Among the 118 elements, most elements are metals and only a few are metalloids.

Metals are hard, malleable and ductile elements which are good conductor of heat and electricity, e.g. iron, copper, aluminiun, gold, silver, zinc, etc. Non-metals are soft, non-malleable and non-ductile elements which are bad conductor of heat and electricity, e.g. nitrogen, oxygen, chlorine, sulphur, carbon, iodine, etc. Similarly, metalloids are those elements that show properties of both metals and non-metals e.g. silicon, arsenic, germanium, etc.

Learning Objectives

After completing the study of this unit, students will be able to:

i. define metals, non-metals and metalloids with examples.

ii. tell the position of metals, non-metals and metalloids in modern periodic table.

iii. introduce and explain the physical properties of some useful metals, non-metals and metalloids (aluminium, iron, copper, silver, gold, sulphur and silicon) with their uses.

Syllabus

- Metals, non-metals and metalloids: Introduction with examples.
- Position of metals, non-metals and metalloids in modern periodic table
- Some useful metals, non-metals and metalloids (aluminium, iron, copper, silver, gold, sulphur and silicon)
- Physical properties and uses of above mentioned metals, non-metals and metalloids.

Glossary: A dictionary of scientific/technical terms

metal	:	solid substances which are malleable, ductile and good conductor of heat and electricity
non-metal	:	soft, non-malleable and non-ductile substances
metalloids	:	the substance which shows properties of both metals and non-metals
malleable	:	that can be beaten into different shapes easily without breaking or cracking
ductile	:	that can be made into a thin wire
crystalline	:	having a fixed geometrical shape, smooth surface and sharp edges

Metals and Non-metals

Metals

Metals are those solid substances which are hard, malleable, ductile and good conductors of heat and electricity. For example, iron, copper, aluminium, gold, silver, etc. They are shiny (lustrous) and produce tinkling sound when heated. All solids exist in solid state except mercury. We use metals like iron aluminium, copper, silver, gold, etc. in our daily life. Metals are used for making cooking utensils, construction materials, vehicles, ornaments, furniture, electric wires, weapons, etc.

> **Do You Know**
> Mercury is a metal which exists in liquid state at room temperature.

Fig. 13.1

Iron Aluminium Silver Gold

Non-metals

Non-metals are those substances which are generally soft, non-malleable, non-ductile and bad conductors of heat and electricity. They exist in all three states, viz. solid, liquid and gas. Carbon, iodine, sulphur, phosphorus, chlorine, etc. are examples of non-metals.

> **Do You Know**
> Graphite is a non-metal that conducts heat and electricity.

We use many non-metals in our daily life. Non-metals are used in construction works, to make containers, utensils, medicines, etc.

Fig. 13.2

Sulphur Iodine Carbon

Differences between Metals and Non-metals

Metals	Non-metals
1. Metals are good conductors of heat and electricity.	1. Non-metals are bad conductors of heat and electricity.
2. Metals have more density.	2. Non-metals have less density.

Metalloids

Metalloids are those solid substances which show the properties of both metals and non-metals, e.g. silicon (Si), germanium (Ge), arsenic (As), etc.

Fig. 13.3

Silicon *Germanium* *Arsenic*

Differences between Metals and Metalloids

Metals	Metalloids
1. Metals are good conductors of heat and electricity.	1. Metalloids are poor conductors of heat and electricity.
2. Metals are malleable and ductile.	2. Metalloids are neither malleable nor ductile.

Position of Metals, Non-metals and Metalloids in Modern Periodic Table

In the modern periodic table, metals are placed on the left side. However, hydrogen is a non-metal which is placed at the top of metals. In the modern periodic table, metals are placed in groups IA, IIA, IIIA, IB, IIB, IIIB, IVB, VB, VIB, VIIB and VIII. Among them, metals of group IA are the most reactive.

Non-metals are placed on the right side of the modern periodic table. They are placed in group VA, VIA, VIIA and zero (0). Among them, non-metals of group VIIA are the most reactive.

Metalloids are placed in between metals and non-metals in the modern periodic table because they show properties of both metals and non-metals.

Some Useful Metals, Non-metals and Metalloids

1. Aluminium

It is a bluish-white metal which is extracted from bauxite ore. It is a reactive metal. So, it is not found in free state in nature.

Fig. 13.4

Properties of aluminium

a. It is a light metal having bluish-white colour.

b. It is malleable and ductile.

c. It is a good conductor of heat and electricity.

d. It is not affected by air and water.

e. It does not rust.

f. It has low melting point.

Uses of aliminium

a. Aluminium is used for making cooking utensils, foils and food wrappers.

b. It is used for making bodies and parts of aeroplene, car, motor cycles, ship, etc. as it is a light and rust-free metal.

c. It is used for making over head electric cables, coins and alloys.

d. It is used for making silver paint.

Do You Know

Aluminium is a light, malleable and rusting free metal as well as it is not affected by air and water. So, aluminium is used for making body and parts of aeroplane.

2. Iron

It is a greyish-white metal which is mainly extracted from haematite and magnetite ores. It is not found in free-state in nature. Iron is widely used in our daily life for various purposes.

Fig. 13.5

Haematite ore *Magnetite ore*

Properties of iron

a. It is a greyish-white metal.

b. It is malleable and ductile.

c. It is a good conductor of heat and electricity.

d. It reacts with moist air and get rusted.

e. It reacts with acids.

f. It can be magnetized.

Fig. 13.6

Iron rods

Uses of iron

a. Iron is used for making cooking utensils.

b. It is used for making vehicles like bus, truck, car, motorcycle, bicycle, etc.

c. It is used for making weapons, tools, furniture, etc.

d. It is used for making rods, pipes, nuts and bolts.

e. It is used for making steel.

3. Copper

Copper is a reddish-brown metal which is extracted from chalcopyrite ore. It is found in pure as well as combined state in nature.

Properties of copper

a. It is a reddish-brown metal.

b. It is malleable and ductile.

c. It is a good conductor of heat and electricity.

d. It reacts with acids.

e. It does not undergo rusting.

f. It becomes black when kept in moist and cold places for a long time.

Fig. 13.7

Chalcopyrite ore

Copper utensils

Uses of copper

a. It is used for making electric wires and electronic equipment.

b. It is used for making cooking utensils, coins, medals and statues.

c. It is used for making medicines and fungicides.

d. It is used for making brass, bronze, bell metal, etc.

4. Silver

Silver is a shiny-white metal which is extracted from argentite ore. It is found in pure as well as combined state in nature.

Properties of silver

a. It is a shiny-white metal.

b. It is malleable and ductile.

c. It is a good conductor of heat and electricity.

d. It does not react with dilute acids.

e. It does not undergo rusting.

Fig. 13.8

Uses of silver

a. It is used for making ornaments.

b. It is used for making medicines.

c. It is used for filling cavities in teeth.

d. It is used for making coins, idols and statues.

5. Gold

Gold is a yellow, shiny and expensive metal. It is extracted from sandy alluvial soil and quartz veins. It occurs in free state in nature.

Fig. 13.9

Properties of gold

a. It is a yellow shiny metal.

b. It is malleable and ductile.

c. It is a good conductor of heat and electricity.

d. It does not react with air, water and acids.

Uses of gold

a. It is used for making ornaments and jewelery.

b. It is used for making medals, coins, statues and idols.

c. It is used for making medicines.

d. It is used for filling cavities in teeth.

Do You Know

Gold is a noble metal. It does not react with air, water, acids and other chemicals in normal condition of temperature and pressure. So, gold is found in pure state. But iron combines with air, acids and other chemicals in ordinary condition to form various types of compounds. So, iron is not found in pure state in nature.

6. Sulphur

Sulphur is a crystalline solid without taste and odour. It is yellow coloured solid which is found in free as well as combined state in nature. It is extracted from underground deposits.

Properties of sulphur

a. It is a yellow crystalline solid.

b. It is odourless and tasteless.

c. It is insoluble in water.

d. It burns in air.

e. Its vapour is poisonous for bacteria and fungi.

f. It does not react with acids.

Fig. 13.10

Uses of sulphur

a. It is used for making sulphuric acid, fire crackers, gun powder, matches and dyes.

b. It is used for making skin ointment for curing skin diseases.

c. It is used in beauty parlours for hair-setting.

d. It is used for making germicides, fungicides and insecticides.

e. It is used for hardening rubber.

7. Silicon

It is a grey metalloid which does not occur in free state in nature. It is found in sand in the form of compounds.

Properties of Silicon

a. It is a grey solid.

b. It shows the properties of both metals and non-metals.

c. It is found in crystalline as well as amorphous form in nature.

d. It is a poor conductor of heat and electricity.

e. It does not react with air, water and acids.

Fig. 13.11

Uses of Silicon

a. It is used for making glass and ceramic utensils.

b. It is used as a semi-conductor in electric equipment.

c. It is used for making polish and colours.

Activity 1

- Prepare a list of metals, non-metals and metalloids that are used at your home.
- Write down their uses.

Key Concepts

1. Metals are hard and solid substances which are malleable, ductile and good conductor of heat and electricity.
2. Non-metals are soft substances which are non-malleable, non-ductile and bad conductors of heat and electricity.
3. We use different types of metals, non-metals and metalloids in our daily life.
4. In the modern periodic table, metals are placed on the left side, non-metals are placed in right side and metalloids are placed in between metals and non-metals.
5. Iron is a greyish-white metal which is used for making cooking utensils, weapons, vehicles, rods, pipes, etc.
6. Gold is a yellow shiny metal which is used for making coins,idols, medals, jewellery, medicines, etc.

Exercise

1. **Put a tick (√) for the correct statement and a cross (×) for the incorrect one.**
   a. Metals are malleable and ductile. ☐
   b. Non-metals are kept on the left side of the modern periodic table. ☐
   c. Metalloids show the properties of both metals and non-metals. ☐
   d. Iron is extracted from the argentite ore. ☐
   e. Gold is found in a pure state in nature. ☐

2. **Fill in the blanks using appropriate words.**
   a. .... are good conductors of heat and electricity.
   b. .... are found in solid, liquid and gaseous states.
   c. .... is a metalloid.
   d. Iron is extracted from .... and ....
   e. .... is a yellow shiny metal.

3. **Tick (√) the most appropriate answer from the given alternatives.**
   a. Which of the given elements is a non-metal?
   ☐ silver ☐ iron ☐ copper ☐ sulphur
   b. Which of the given metals is used for making silver paint?
   ☐ aluminium ☐ silver ☐ copper ☐ iron
   c. Which of the given elements is a bad conductor of heat and electricity.
   ☐ gold ☐ sulphur ☐ iron ☐ silver
   d. Which of the given element is used for making skin ointment?
   ☐ gold ☐ aluminium ☐ sulphur ☐ silver

4. Answer the following questions.

a. What are metals? Give any four examples.

b. What are non-metals? Give any four examples.

c. What are metalloids? Give any two examples.

d. Write down the position of metals, non-metals and metalloids in the modern periodic table.

e. Name the ore from which aluminium is extracted.

f. Write any three properties and three uses of aluminium.

g. Write down the ores of copper, iron and silver.

h. Write any three properties each of copper, gold, sulphur and silicon.

i. Write any three uses each of iron, copper, silver, gold and sulphur.

j. What is meant by malleability and ductility?

k. Where is gold found in nature?

5. Differentiate between:

a. Metals and Non-metals

b. Silicon and Sulphur

c. Gold and Sulphur

6. Give reason

a. Iron and copper are used for making cooking utensils.

b. Copper is used for making electric wires.

c. Silicon is called a metalloid.

d. Aluminium is used for making bodies and parts of aeroplane.

UNIT 14

Acid, Base and Salt

Weighting Distribution (Approximate)	Teaching periods : 4	Marks (in %): 2

Before You Begin

We use a variety of acids, bases and salts in our day to day life. Sour fruits like lemon, orange, citrus, amla, apple, etc. contain acids. Edible soda, lime, bitter gourd, etc. are bases. Similarly, edible salt (sodium chloride), Copper sulphate, etc. are salts.

Acids are substances that produce hydrogen (H^+) ions when dissolved in water. Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3), carbonic acid (H_2CO_3), etc. are examples of acids. Bases are substances that produce hydroxyl (OH^-) ions when dissolved in water. Calcium hydroxide [$Ca(OH)_2$], Sodium hydroxide (NaOH), Ammonium hydroxide (NH_4OH), etc. are examples of bases. Salts are the substances formed by partial or complete replacement of hydrogen atoms by a metal or electro-positive radical, e.g. Sodium Chloride (NaCl), Calcium sulphate ($CaSO_4$), Ammonium chloride (NH_4Cl), etc. Acids are sour, bases are bitter and salts are salty in taste.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce acid, base and salt and explain their properties and uses.

ii. define indicators and identify acid, base and salt using litmus paper.

iii. Prepare litmus paper by using petals of flowers.

iv. introduce pH and pH scale.

Syllabus

- Acid-Introduction and types
- Physical and chemical properties of acids
- Uses of acids
- Base and alkali-Introduction
- Physical and chemical properties of bases/alkalis
- Uses of bases
- Salt: Introduction
- Properties and uses of salts
- Indicators, pH and pH scale

Glossary: A dictionary of scientific/technical terms

acid	:	a substance that gives hydrogen (H+) ions when dissolved in water
corrosive	:	tending to destroy something slowly
base	:	a substance that gives hydroxyl (OH–) ions when dissolved in water
alkali	:	a base that dissolves in water
salt	:	a substance formed by complete or partial replacement of hydrogen ions by a metal or ammonium radical
indicators	:	chemical substances which are used to indicate whether a substance is acid, base or salt

Acid, Base and Salt

Acids

The word 'acid' refers to a sour substance. However, it does not mean that all acids are sour. Most acids are sour. The word 'acid' has been derived from the Latin word 'acidus' which means sour in taste. Citric acid, lactic acid, carbonic acid, hydrochloric acid, sulphuric acid and nitric acid are examples of acids.

> **Do You Know**
>
> Most acids are sour in taste. But it is dangerous to touch and taste acids in laboratory as acids burn our skin and tongue.

The chemical substances which give hydrogen (H^+) ions when dissolved in water are called acids. For example: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3), carbonic acid (H_2CO_3), etc.

Fig. 14.1

Hydrochloric acid (HCl) *Sulphuric acid (H_2SO_4)* *Nitric acid (HNO_3)*

There are two types of acids on the basis of source or chemical nature. They are (i) Inorganic acids and (ii) Organic acids.

i. Inorganic acids

The acids which are obtained from minerals are called inorganic acids. Acids like Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3), Carbonic acid (H_2CO_3), etc are inorganic acids. These acids are commonly used in laboratory. Inorganic acids are also called mineral acids.

ii. Organic acids

The acids which are obtained from living organisms are called organic acids. Citric acid, Acetic acid, Tartaric acid, Formic acid, Lactic acid, etc. are examples of organic acids.

Differences between Organic acids and Inorganic acids

Organic acids	Inorganic acids
1. Acids which are obtained from living organisms and have hydrocarbon are called organic acids.	1. Acids which are obtained from minerals and do not have hydrocarbon are called inorganic acids.
2. These are weak acids.	2. These acids may be strong or weak.

There are two types of acids on the basis of strength. They are (i) Strong acids and (ii) Weak acids.

Strong acids

The acids which produce a high concentration of hydrogen (H^+) ions when dissolved in water are called strong acids. They are more corrosive in nature. Examples: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), nitric acid (HNO_3), etc.

Weak acids

The acids which produce a low concentration of hydrogen (H^+) ions when dissolved in water are called weak acids. They are less corrosive in nature. Examples: Carbonic acid (H_2CO_3), Acetic acid (CH_3COOH), Formic acid (HCOOH), etc.

Differences between Strong acids and Weak acids

Strong acids	Weak acids
1. Acids which undergo almost complete dissociation in aqueous solution and produce high concentration of hydrogen ions are called strong acids.	1. Acids which undergo partial dissociation in aqueous solution and produce low concentration of hydrogen ions are called weak acids.
2. They are good conductor of heat and electricity.	2. They are poor conductor of heat and electricity.
3. They have low pH value.	3. They have high pH value.

Physical properties of acids

1. Most acids are sour in taste.
2. They change blue litmus paper into red and methyl orange into red.
3. They are corrosive in nature.
4. They do not change the colour of phenolphthalein.

Do You Know

Most acids are sour in taste but acids like Boric acid, Stearic acid and Salicylic acid are not sour.

Chemical properties of Acids

1. Acids reacts with active metals like Zn, Mg, etc. and form hydrogen gas.

Dilute acid + Metal $\longrightarrow$ Salt + Hydrogen gas

$2HCl + Zn \longrightarrow ZnCl_2 + H_2$

$H_2SO_4 + Zn \longrightarrow ZnSO_4 + H_2$

$2HCl + Mg \longrightarrow MgCl_2 + H_2$

$H_2SO_4 + Mg \longrightarrow MgSO_4 + H_2$

2. Acids react with bases and form salt and water.

Acid + Base $\longrightarrow$ Salt + Water

$HCl + NaOH \longrightarrow NaCl + H_2O$

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

$HNO_3 + KOH \longrightarrow KNO_3 + H_2O$

$2HNO_3 + Ca(OH)_2 \longrightarrow Ca(NO_3)_2 + 2H_2O$

3. Acids dissolve in water and produce hydrogen ions.

$HCl \xrightarrow{+H_2O} H^+ + Cl^-$

$H_2SO_4 \xrightarrow{+H_2O} 2H^+ + SO_4^{--}$

$HNO_3 \xrightarrow{+H_2O} H^+ + NO_3^-$

Uses of Acids

1. Hydrochloric acid, sulphuric acid and nitric acid are used in science laboratories and industries to do various experiments.
2. Sulphuric acid is used for making chemical fertilizers, drugs and detergents.
3. Hydrochloric acid is used in tanning and printing industries.
4. Nitric acid is used for making plastics, dyes and explosives.
5. Carbonic acid is used in soft drinks like coca-cola, soda water, beer, etc.
6. Acetic acid (vinegar) is used in pickles.
7. Carbolic acid (phenol) is used to kill germs.
8. Citric acid is used as a source of vitamin C.

Some acids of daily use and their sources are given below.

S.N.	Acids	Source
1.	Citric acid	Lemon, tomato
2.	Tartaric acid	Grape fruit
3.	Formic acid	Red ant
4.	Lactic acid	Milk, curd
5.	Ascorbic acid	Sour fruits
6.	Oxalic acid	Chari amilo

Bases

Bases are metallic oxides and metallic hydroxides. For example, Sodium oxide (Na_2O), Calcium oxide (CaO), Magnesium oxide (MgO), Sodium hydroxide ($NaOH$), Calcium hydroxide [$Ca(OH)_2$], etc. The bases that dissolve in water and produce hydroxyl (OH^-) ions are called alkalis.

Do You Know

The bases that dissolve in water are called alkalis. But bases like CuO, HgO, BaO, PbO, etc. do not dissolve in water. So, all alkalis are bases but all bases are not alkalis.

Sodium hydroxide ($NaOH$), Potassium hydroxide (KOH), Calcium hydroxide [$Ca(OH)_2$], etc. are examples of alkalis. Bases are bitter in taste.

Differences between Acids and Bases

Acids		Bases	
1.	Acids produce hydrogen (H^+) ions when dissolved in water.	1.	Bases produce hydroxyl (OH^-) ions when dissolved in water.
2.	They turn blue litmus paper into red.	2.	They turn red litmus paper into blue.

Types of bases

On the basis of strength, there are two two types of bases, viz. (i) Strong bases and (ii) Weak bases.

a. Strong bases

The bases that produce a high concentration of hydroxyl (OH^-) ions in water are called strong bases. Examples: Sodium hydroxide ($NaOH$), Potassium hydroxide (KOH), Magnesium hydroxide [$Mg(OH)_2$], Calcium hydroxide [$Ca(OH)_2$], etc.

b. Weak bases

The bases that produce a low concentration of hydroxyl (OH^-) ions in water are called weak bases. Examples: Copper hydroxide ([Cu)OH)$_2$], Ferric hydroxide [$Fe(OH)_3$], etc.

Physical Properties of Bases/Alkalis

1. Bases are bitter in taste.
2. They have a soapy touch.
3. They turn red litmus into blue, methyl orange into yellow and phenolphthalein into pink.
4. Strong alkalis dissolve oil and grease.
5. Strong alkalis burn our skin.

Do You Know

Strong bases/alkalis burn our skin, So, we should not touch bases/alkalis in a laboratory.

Chemical Properties of Bases/Alkalis

1. Bases react with acids and form salt and water.

Base/Alkali	+ Acid		Salt	+ Water
$NaOH$	$+ HCl$	$\longrightarrow$	$NaCl$	$+ H_2O$
KOH	$+ HCl$	$\longrightarrow$	KCl	$+ H_2O$
$2NaOH$	$+ H_2SO_4$	$\longrightarrow$	Na_2SO_4	$+ H_2O$
$Ca(OH)_2$	$+ 2HNO_3$	$\longrightarrow$	$Ca(NO_3)_2$	$+ 2H_2O$

2. Bases/Alkalis react with carbon dioxide and form carbonate and water.

Base/Alkali	+ Carbon dioxide		Carbonate	+ Water
$2NaOH$	$+ CO_2$	$\longrightarrow$	Na_2CO_3	$+ H_2O$
$Mg(OH)_2$	$+ CO_2$	$\longrightarrow$	$MgCO_3$	$+ H_2O$
$2KOH$	$+ CO_2$	$\longrightarrow$	K_2CO_3	$+ H_2O$
$Ca(OH)_2$	$+ CO_2$	$\longrightarrow$	$CaCO_3$	$+ H_2O$

3. Alkalis dissolve in water and produce hydroxyl (OH^-) ions.

$$NaOH \xrightarrow{+H_2O} Na^+ + OH^-$$

$$KOH \xrightarrow{+H_2O} K^+ + OH^-$$

$$Ca(OH)_2 \xrightarrow{+H_2O} Ca^{++} + 2OH^-$$

$$NH_4OH \xrightarrow{+H_2O} NH_4^+ + OH^-$$

Uses of Bases/Alkalis

1. Sodium hydroxide (NaOH) is used for making soap, paper, etc.
2. Potassium hydroxide (KOH) is used for making soft soap, chemical fertilizers, etc.
3. Aluminium hydroxide [$Al(OH)_3$] and Magnesium hydroxide [$Mg(OH)_2$] are used for reducing hyperacidity of stomach.
4. Calcium hydroxide [$Ca(OH)_2$] or lime water is used to reduce hardness of water.
5. Ammonium hydroxide (NH_4OH) is used for making chemical fertilizers and plastics.
6. Calcium oxide (CaO) is used for softening hard water, for making cement and in purification of sugar.

Differences between Strong bases and Weak bases

Strong bases	Weak bases
1. Bases which give more amount of hydroxyl ions in aqueous solution are called strong bases.	1. Bases which give very less amount of hydroxyl ions in aqueous solution are called weak bases.
2. They have high degree of ionization.	2. They have low degree of ionization.
3. They have high pH value.	3. They have low pH value.

Salt

A salt is a neutral substance formed by the chemical reaction between an acid and a base. Salt can also be defined as a substance formed by partial or complete replacement of hydrogen atom by a metal or ammonium radical. Most salts are neutral but some are acidic and some are basic in nature. The process in which an acid reacts with a base and forms two neutral substances, i.e. salt and water is called neutralization reaction. The salt formed by complete replacement of hydrogen atom of an acid by a metal or ammonium radical is called neutral salt. For example:

HCl (Acid) + $NaOH$ (Base) $\longrightarrow$ $NaCl$ (Neutral salt) + H_2O (Water)

H_2SO_4 (Acid) + $2KOH$ (Base) $\longrightarrow$ K_2SO_4 (Neutral salt) + $2H_2O$ (Water)

Properties of salts

1. Most salts are bitter in taste. Some are salty.
2. Most salts are neutral but some may be acidic or basic.
3. Most salts dissolve in water.

4. They may be white, colourless or colourful.
5. They conduct electricity in solution or molten state.

Uses of salts

1. Common salt ($NaCl$) is used in our foods.
2. Copper sulphate ($CuSO_4$) is used to make fungicides.
3. Calcium sulphate ($CaSO_4$) is used for making cement and plastering of fractured bones.
4. Ammonium sulphate [$(NH_4)_2SO_4$] is used for making chemical fertilizers.
5. Sodium bicarbonate ($NaHCO_3$) is used for making baking powder.
6. Magnesium sulphate ($MgSO_4$) is used for treating constipation.
7. Sodium carbonate (Na_2CO_3) is used for making glass, soap and detergent.

Do You Know

- Salts of metals like Na, K, Mg, Ca, Al and Ba are white or colourless.
- Salts of metals like Cu, Co, Mn, Fe, Ni and Cr are colourful.

Indicators

We cannot identify whether a given chemical substance is an acid, base or salt just by observing it. We use some chemicals to identify them. These chemicals are called indicators. These chemical substances are used to indicate whether a substance is acidic, basic or neutral in nature. For example, litmus paper (red and blue), methyl orange, phenolphthalein, etc. These indicators are called ordinary indicators.

Indicators are obtained from different parts of plants like roots, flowers, leaves, etc. These parts are collected, crushed and mixed with organic solvents to get indicators.

Following table shows the various indicators and their effects in acid, base and salt.

S.No.	Indicators	Colour in acid solution	Colour in basic solution	Colour in neutral salt solution
1.	Litmus paper (red)	No change in colour	Changes into blue	No change in colour
2.	Litmus paper (blue)	Changes into red	No change in colour	No change in colour
3.	Methyl orange	Changes into red	Changes into yellow	No change in colour
4.	Phenolphthalein	No change in colour	Changes into pink	No change in colour

Universal Indicator

Ordinary indicators can indicate whether a substance is acidic, basic or neutral in nature but cannot measure the strength. Therefore, a special kind of indicator is used to measure the strength of the given substance which is called the universal indicator. So, a universal indicator is a special kind of indicator which is used to measure the strength of acidity or alkalinity of a solution. It changes colour when kept in an acidic, basic or neutral solution which is strength of the solution. A universal indicator is prepared by mixing several ordinary indicators of different colour.

Differences between Indicator and Universal indicator

Indicator	Universal Indicator
1. Indicators indicate only whether the substance in acidic, basic or neutral in nature.	1. Universal indicator indicates whether the substance in acidic, basic or salty along with their strength.
2. The are obtained from the parts of plant like leaves, flowers, roots, etc.	2. The are obtained by mixing different types of ordinary indicators.

pH and pH Scale

A pH is the measure of hydrogen ion concentration present in a solution. It is measured by using pH paper and pH meter.

A pH scale is the standard scale which is used to measure the strength of acidic or alkaline solution. It consists of numbers 1 to 14 with their corresponding colours in the scale. The pH value 1 to 6 represents acidity, pH value 7 represents neutrality and pH value 8 to 14 represents the basicity or alkalinity. The solution having pH value 1 is the strongest acid and that having 14 is the strongest alkali.

Fig. 14.2

pH meter

← Acidity increases				Neutral	Alkalinity increases →		
pH 1	2	3	4 5 6	7	8 9 10	11 12	13 14
Red	Rose	Yellow	Light green	Green	Greenish blue	Blue	Deep blue

The pH value of some common chemicals

Chemicals		pH value
Acidic	Hydrochloric acid (HCl)	1
	Sulphuric acid (H_2SO_4)	1.2
	Lemon juice (citric acid)	2.5
	Carbonic acid, vinegar	3
Neutral	Common salt solution	7
	Water	
	Sugar solution	
Basic/Alkaline	Human blood	7.3
	Baking soda	8.5
	Washing soda	11.5
	Sodium hydroxide (NaOH)	13

Activity 1

- Take red and blue litmus paper and three test tubes. Mark the test tubes 1, 2 and 3.
- Keep the solution of acid in test tube 1, solution of alkali in test tube 2 and solution of common salt in test tube 3.
- Now, take red litmus papers and immerse one litmus paper separately in each test tube. Observe the change in colour.
- Take blue litmus papers and repeat the above activity.
- Prepare a chart after your observation.

Activity 2

- Take solution of acids, bases and salts in different test tubes.
- Measure the pH value of each by using a pH meter.

Do You Know

Ordinary indicators indicate only whether the substance is acid, base or salt whereas the universal indicator indicates whether the substance is acid, base or salt along with their strength (pH value). So, universal indicator is more meaningful than an ordinary indicator.

Key Concepts

1. The chemical substances which give hydrogen (H^+) ions when dissolved in water are called acids.
2. The acids which are obtained from minerals are called inorganic acids.
3. The acids which are obtained from living organisms are called organic acids.
4. Bases are metallic oxides and metallic hydroxides.
5. The bases that dissolve in water and produce hydroxyl (OH^-) ions are called alkalis.
6. The bases that produce a high concentration of hydroxyl (OH^-) ions in water are called strong bases.
7. The bases that produce a low concentration of hydroxyl (OH^-) ions in water are called weak bases.
8. A salt is a neutral substance formed by the chemical reaction between an acid and a base. Salt can also be defined as a substance formed by partial or complete replacement of hydrogen atom by a metal or ammonium radical.
9. The process in which an acid reacts with a base and forms two neutral substances, i.e. salt and water is called the neutralization reaction.
10. Those chemical substances which are used to indicate whether a substance is acidic, basic or neutral in nature are indicators.
11. Indicators are obtained from different parts of plants like roots, flowers, leaves, etc. These parts are collected, crushed and mixed with organic solvents to get indicators.
12. A universal indicator is a special kind of indicator which is used to measure the strength of acidity or alkalinity of a solution.
13. A pH is the measure of hydrogen ion concentration present in a solution.
14. A pH scale is the standard scale which is used to measure the strength of acidic or alkaline solution.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Acids produce hydrogen ions when dissolved in water. ☐

b. Carbonic acid is a strong acid. ☐

c. All bases are alkalis. ☐

d. Litmus paper is a universal indicator. ☐

e. The pH value of neutral salt is 7. ☐

2. Fill in the blanks using appropriate words.

a. .... are sour in taste.

b. Acids react with .... and form hydrogen gas.

c. .... are metal oxides or metal hydroxides.

d. Base reacts with .... and form salt and ....

e. The pH value of the strongest alkali is ....

3. Tick (√) the most appropriate answer from the given alternatives.

a. Which of the given substance is an acid?

☐ NaOH ☐ H_2SO_4 ☐ NaCl ☐ K_2SO_4

b. .... is used as a source of vitamin C.

☐ Carbonic acid ☐ Citric acid

☐ Sulphuric acid ☐ Acetic acid

c. Bases react with carbon dioxide and form .... and water.

☐ nitrates ☐ carbonates ☐ sulphates ☐ oxides

d. The pH value of neutral salt is ....

☐ 1 ☐ 6 ☐ 7 ☐ 14

4. Answer the following questions.

a. Define acids with any four examples.

b. What are strong acids? Give any two examples of weak acids.

c. Define organic acids and inorganic acids with any two examples of each.

d. Write any three physical properties of acids.

e. Write any two chemical properties of acids.

f. Write down the uses of given acids.

i. Acetic acid
ii. Nitric acid
iii. Carbonic acid
iv. Sulphuric acid
v. Tartaric acid
vi. Formic acid

g. What are bases? Give any three examples.
h. What are alkalis? Give any three examples.
i. Write any three physical properties and two chemical properties of bases.
j. Write any four uses of bases.
k. What is a salt? Give any three examples.
l. Write any three properties and four uses of salt.
m. Define indicator and universal indicator.
n. What is a pH? Write down the pH value of the strongest acid, neutral salt and the strongest alkali.
o. What is a pH-scale?

5. Give reason.

a. We should not touch and taste acids in a science laboratory.
b. Sodium chloride is called a neutral salt.
c. All bases are not alkalis but all alkalis are bases.
d. Methyl orange is called an indicator.
e. Universal indicator is better than an ordinary indicator.
f. We eat aluminium hydroxide to reduce hyperacidity.

6. Differentiate between:

a. Inorganic acids and Organic acids
b. Bases and Alkalis
c. Acids and Alkalis
d. Ordinary indicator and Universal indicator

7. All alkalis are bases but all bases are not alkalis. Justify this statement.

8. Write down the effects of litmus paper, methyl orange and phenolphthalein on acid, base and salt.

UNIT 15

Some Useful Chemicals

Weighting Distribution (Approximate)	Teaching periods : 5	Marks (in %): 1

Before You Begin

Different chemical substances like common salt, washing soda, soap, phenol, insecticides, plastics, sodium carbonate, sodium bicarbonate, glycerol, sugar, etc. are widely used in our day to day life. Water is also a chemical substance found on the earth's surface. Living organisms need water to survive. We use water for drinking, washing, bathing, cooking food, irrigation and so on. Water may be hard or soft. Glycerol is a sweet thick liquid which is used for making medicine, printing ink, ink for stamp pads, etc. Sodium carbonate is used for making soap, paper, glass, etc. Sodium bicarbonate is used for baking powder, cold drinks, fire extinguisher, etc. In this unit, we will study about water and its types, hardness of water, glycerol, sodium carbonate, sodium bicarbonate, etc.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce water and explain its properties.

ii. define hard water and soft water.

iii. explain the types of hardness of water and describe the methods of removing hardness of water.

iv. introduce glycerol, sodium carbonate and sodium bicarbonate and state their uses.

Syllabus

- Introduction to water
- Physical properties of water
- Chemical properties of water
- Hard water and soft water
- Temporary and permanent hardness of water
- Removal of hardness of water
- Glycerol, sodium carbonate and sodium bicarbonate-introduction and uses

Glossary: A dictionary of scientific/technical terms

phenol	:	a chemical which is used for killing germs
insecticide	:	a chemical substance which is used to kill insects
glycerol	:	a thick sweet liquid of alcohol group
lather	:	a white mass of small bubble that is produced by mixing soap with water
baking	:	a process of cooking using dry heat in an oven
lubricant	:	a substance, i.e. oil that you put on surfaces or parts of machine so that they move easily and smoothly

Water

Water (H_2O) is a chemical substance formed by a combination of hydrogen and oxygen. One molecule of water consists of two atoms of hydrogen and one atom of oxygen. Water is the most useful chemical substance found in nature. About 71 percent of the earth is covered with water.

Water exists in three different states. They are solid, liquid and gas. In air, water remains in the form of vapour and cloud. In high mountains, water remains in the form of ice or snow. In ponds, lakes, rivers, oceans, etc., water is found in liquid state.

Underground water is another source of water. It is obtained from well, tube well, etc. Water is used for bathing, washing, drinking, cooking, irrigating , swimming, etc. It is also used in industries.

Physical Properties of Water

1. Water exists in all three states, i.e. solid, liquid and gas.
2. It is transparent.
3. It is a bad conductor of heat and electricity.
4. Pure water is colourless, odourless and tasteless.
5. It is a universal solvent.
6. It freezes at 0 °C and boils at 100 °C.
7. It is a neutral substance. Pure water is neither acidic nor basic in nature.

Chemical Properties of Water

1. Water decomposes into hydrogen and oxygen gas when electrolysed.

   $$2H_2O \xrightarrow{\text{electrolysis}} 2H_2 + O_2$$

2. Water reacts with carbon dioxide and forms carbonic acid.

   $$H_2O + CO_2 \longrightarrow H_2CO_3$$

Types of Water

On the basis of absence or presence of chemicals dissolved in it, water is of two types, viz. (a) soft water and (b) hard water.

a. Soft water

Fig. 15.1

The water which does not contain chloride, sulphate and bicarbonate salts of magnesium and calcium is called soft water. It produces more lather with soap, e.g. distilled water and rain water.

b. Hard water

Fig. 15.2

The water which contains chloride, sulphate and bicarbonate salts of magnesium and calcium is called hard water. It produces less lather with soap. So hard water is not suitable for washing clothes. Spout water and water of wells, rivers, oceans, etc. is hard.

Differences between Soft water and Hard water

Soft water	Hard water
1. Soft water does not contain chloride, sulphate and bicarbonate salts of calcium and magnesium.	1. Hard water contains chloride, sulphate and bicarbonate salts of calcium and magnesium.
2. It produces lather with soap easily.	2. It does not produce lather with soap easily.

Types of hardness of water

On the basis of salts dissolved in it, hardness of water is of two types, viz. (a) temporary hardness and (b) permanent hardness.

a. Temporary Hardness

The hardness of water due to dissolved bicarbonate salts of magnesium and calcium is called temporary hardness of water. Temporary hard water is tasty and makes bones healthy.

Do You Know

When temporary hard water is boiled, the soluble bicarbonate salts of calcium and magnesium get converted into insoluble carbonate salts and settle down at the bottom of the container. So, the hardness of water is removed when temporary hard water is boiled.

Temporary hardness can be removed by boiling hard water or treating it with lime-water.

i. By boiling water

When temporary hard water is boiled, the soluble bicarbonate salts of magnesium and calcium decompose into water insoluble carbonate salts, and settle down at the bottom of the container. These salts can be separated by filtration.

$$\text{Magnesium bicarbonate} \xrightarrow{\text{heat}} \text{Magnesium carbonate} + \text{Water} + \text{Carbon dioxide}$$

$$Mg(HCO_3)_2 \xrightarrow{\triangle} MgCO_3 + H_2O + CO_2$$

$$\text{Calcium bicarbonate} \xrightarrow{\text{heat}} \text{Calcium carbonate} + \text{Water} + \text{Carbon dioxide}$$

$$Ca(HCO_3)_2 \xrightarrow{\triangle} CaCO_{3+} H_2O + CO_2$$

i. By treating with lime-water

When temporary hard water is treated with lime-water or calcium hydroxide [$Ca(OH)_2$], a chemical reaction takes place. As a result, insoluble calcium carbonate is formed which makes water soft.

$$\text{Magnesium bicarbonate} + \text{Calcium hydroxide} \longrightarrow \text{Calcium carbonate} + \text{Water} + \text{Magnesium hydroxide}$$

$$Mg(HCO_3)_2 + 2Ca(OH)_2 \longrightarrow 2CaCO_3 + 2H_2O + Mg(OH)_2$$

$$\text{Calcium bicarbonate} + \text{Calcium hydroxide} \longrightarrow \text{Calcium carbonate} + \text{Water}$$

$$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 + H_2O$$

b. Permanent hardness

The hardness of water due to presence of chloride and sulphate salts of magnesium and calcium is called permanent hardness of water.

The permanent hardness of water can be removed by treating hard water with washing soda and permutit process.

Do You Know

When sodium carbonate is added into the hard water, the salts present in it change into carbonates and water becomes soft. So, the permanent hardness of water gets removed when sodium carbonate is added into hard water.

i. By treating permanent hard water with washing soda

When permanent hard water is treated with washing soda or sodium carbonate, the salts present in it change into carbonates and water becomes soft.

$$\text{Magnesium chloride} + \text{Sodium carbonate} \longrightarrow \text{Magnesium carbonate} + \text{Sodium chloride}$$

$$MgCl_2 + Na_2CO_3 \longrightarrow MgCO_3 + NaCl$$

$$\text{Magnesium sulphate} + \text{Sodium carbonate} \longrightarrow \text{Magnesium carbonate} + \text{Sodium sulphate}$$

$$MgSO_4 + Na_2CO_3 \longrightarrow MgCO_3 + Na_2SO_4$$

Calcium chloride	+	Sodium carbonate	$\longrightarrow$	Calcium carbonate	+	Sodium chloride
$CaCl_2$	+	Na_2CO_3	$\longrightarrow$	$CaCO_3$	+	$2NaCl$
Calcium sulphate	+	Sodium carbonate	$\longrightarrow$	Calcium carbonate	+	Sodium sulphate
$CaSO_4$	+	Na_2CO_3	$\longrightarrow$	$CaCO_3$	+	Na_2SO_4

ii. By permutit process

In this process, the permanent hard water is passed through sodium zeolite (Na_2–Z) or Sodium aluminosilicate ($Na_2Al_2SiO_8$).

As a result, the calcium and magnesium ions of hard water are replaced by sodium ions of permutit and water becomes soft.

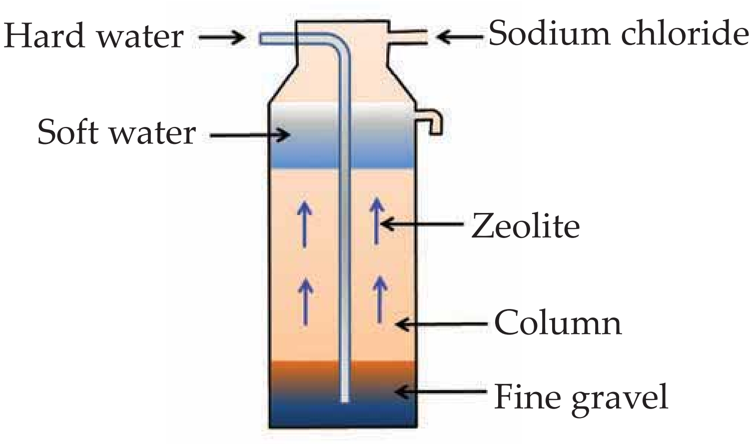


Fig. 15.3 *Permutit process*

Differences between Temporary hardness of water and Permanent hardness of water

Temporary hardness of water	Permanent hardness of water
1. It contains bicarbonate salts of calcium and magnesium.	1. It contains chloride and sulphate salts of calcium and magnesium.
2. It can be removed easily by boiling the water.	2. It can be removed by treating the hard water with washing soda and permutit process.

Activity 1

- Collect sample of water from different sources and keep them in separate test tubes.
- Keep a few drops of liquid soap or shampoo in each test tube and stir them with glass rod.

- Observe which sample produces more lather.
- Identify soft water and hard water from the collected sample of water.

Activity 2

- Take a beaker and put some water into it.
- Put some magnesium bicarbonate or calcium carbonate into the beaker and stir it with a glass rod.
- Now, put a few drops of liquid soap or shampoo and stir it. Does it produce lather easily? The water does not produce lather easily. It shows that the water is hard and the hardness is temporary.
- Now, boil the water for a few minutes. Put a few drops of shampoo or liquid soap and stir it with a glass rod.
- The water produces lather with soap or shampoo after boiling.

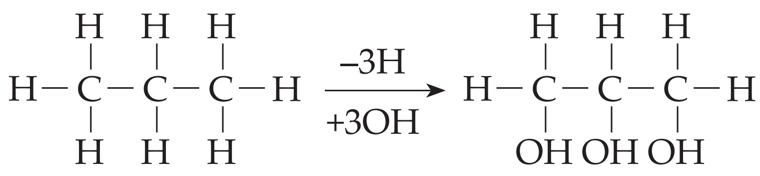
It proves that temporary hardness of water can be removed by boiling.

Activity 3

- Take a beaker with some water in it.
- Put some calcium chloride or calcium sulphate into water and stir it with a glass rod.
- Put a few drops of liquid soap or shampoo and stir with a glass rod. The water does not produce lather easily. It shows that the water is hard and the hardness is permanent.
- Now, put some sodium carbonate (washing soda) into the water and stir it with a glass rod.
- Now, put a few drops of liquid soap and shampoo in the beaker and stir it with a glass rod.
- The water produces lather easily. It shows that permanent hardness of water can be removed by adding washing soda (Na_2CO_3).

Glycerol

Glycerol is a thick organic liquid having a sweet taste of the alcohol group. The molecular formula of glycerol is $C_3H_5(OH)_3$. It is a colourless compound that dissolves in water. It is made by replacing three hydrogen atoms of propane by three hydroxyl groups. It is a trihydric alcohol. Glycerol is also called glycerine.



(Propane) (Glycerol)

Uses of glycerol

1. It is used for making medicines, ink for stamp pads and printing.
2. It is used in sweets.
3. It is used in high quality toilet soap.
4. It is used in face creams and lip guards.
5. It is used as a lubricant.
6. It is used to preserve fruits, tobacco, etc.

Sodium Carbonate

Sodium carbonate is a useful chemical. It is commonly known as washing soda. It is a compound of sodium metal. Its molecular formula is Na_2CO_3. It is basic in nature and found in the form of white powder.

Fig. 15.4 *Sodium carbonate*

Uses of sodium carbonate

1. It is used for making soap.
2. It is used for making paper.
3. It is used for making glass.
4. It is used to remove permanent hardness of water.
5. It is used for making caustic soda in a laboratory.

Sodium Bicarbonate

Sodium bicarbonate is a useful compound made of sodium metal. Its molecular formula is $NaHCO_3$. It is commonly known as edible soda. It is found in the form of white powder. Sodium bicarbonate is mixed with potassium hydrogen tartate to make baking powder. Baking powder is used to increase the size of breads, biscuits, cakes, etc. in bakeries.

Fig. 15.5 *Sodium bicarbonate*

Uses of sodium bicarbonate

1. It is used for making baking powder.
2. It is used for making soft drinks.
3. It is used for reducing hyperacidity.
4. It is used in fire extinguishers.

Activity 4

- Take some glycerol and apply it on hands and legs. Do hands and legs become smooth? Put a few drops of glycerine on tongue and take a taste.

Project Work

- Prepare a list of chemical that are used at your home.
- Also, write down the major uses of each.

Key Concepts

1. Water (H_2O) is a chemical substance formed by a combination of hydrogen and oxygen.
2. Water exists in three different states. They are solid, liquid and gas, w. Water is of two types, viz. (a) soft water and (b) hard water.
4. The water which does not contain chloride, sulphate and bicarbonate salts of magnesium and calcium is called soft water.
5. The water which contains chloride, sulphate and bicarbonate salts of magnesium and calcium is called hard water.
6. The hardness of water due to dissolved bicarbonate salts of magnesium and calcium is called temporary hardness of water.
7. Temporary hardness can be removed by boiling hard water or treating the hard water with lime-water.
8. The hardness of water due to the presence of chloride and sulphate salts of magnesium and calcium is called permanent hardness of water.
9. Permanent hardness of water can be removed by treating hard water with washing soda and permutit process.
10. Glycerol is a thick organic liquid having a sweet taste of the alcohol group.
11. Sodium carbonate is a useful chemical. It is commonly known as washing soda.
12. Sodium bicarbonate is a useful compound made of sodium metal. Its molecular formula is $NaHCO_3$.

Exercise

1. **Put a tick (√) for the correct statement and a cross (×) for the incorrect one.**

   a. Water exists in liquid state only. ☐

   b. Hard water produces more lather with soap. ☐

   c. Pure water is acidic in nature. ☐

   d. Permanent hardness of water can be removed by boiling it. ☐

   e. Glycerol is a thick liquid having a sweet taste. ☐

2. **Fill in the blanks using appropriate words.**

   a. Soft water produces more .... with soap.

   b. Temporary hard water contains bicarbonate salts of .... and ....

   c. The molecular formula of glycerol is ....

   d. .... is used for making baking powder.

   e. ....is used for making soap, glass and paper.

3. **Tick (√) the most appropriate answer from the given alternatives.**

   a. Water covers .... percent of the earth's surface.

   ☐ 60% ☐ 71% ☐ 75% ☐ 17%

   b. Which salt is dissolved in permanent hard water?

   ☐ $CaSO_4$ ☐ $Ca(NO_3)_2$ ☐ NaCl ☐ $Mg(HCO_3)_2$

   c. The temporary hardness of water can be removed by ....

   ☐ using washing soda ☐ using zeolite

   ☐ boiling ☐ using glycerol

   d. The molecular formula of sodium bicarbonate is ....

   ☐ $NaCO_3$ ☐ Na_2CO_3 ☐ $NaHCO_3$ ☐ $NaCO_2$

4. Answer the following questions.

a. Where is water found in nature?
b. Write any three physical properties and two chemical properties of water.
c. Define soft water and hard water with any two examples of each.
d. What is meant by temporary hardness of water?
e. Write any two methods of removing temporary hardness of water.
f. What is meant by permanent hardness of water? How can we remove such type of hardness?
g. What is a glycerol? Write down its molecular formula.
h. How is glycerol prepared?
i. Write any three uses of glycerol.
j. What is sodium carbonate? Write down its molecular formula.
k. Write any two properties and three uses of sodium carbonate.
l. What is the molecular formula of sodium bicarbonate?
m. Write any two physical properties and three uses of sodium bicarbonate.

5. Differentiate between:

a. Soft water and Hard water
b. Temporary hardness and Permanent hardness
c. Sodium carbonate and Sodium bicarbonate

6. Describe the method of removing temporary hardness of water.

7. Name the chemical substances found in permanent hard water.

Biology

UNIT 1

Living Beings

Weighting Distribution (Approximate)	Teaching periods : 9	Marks (in %): 1

Before You Begin

A variety of living organisms are found on the earth. They may be bacteria, viruses, fungi, plants and animals. They may be microscopic or large. Bacteria, viruses, protozoa are some of the microscopic organisms. We cannot see microscopic organisms with our naked eyes. So we use a compound microscope to see them. The very small organisms which cannot be seen through our naked eyes are called microscopic organisms. Most microscopic organisms are unicellular. In this unit, we will study about bacteria, viruses, fungi, modification of root, stem and leaf, seed and dispersal of seed; and life cycle of flowering plants.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce some microscopic organisms like bacteria, viruses and fungi.

ii. explain the structure and functions of modified parts of plants like roots, stems and leaves.

iii. describe the structure and functions of seeds.

iv. describe germination of seed and conditions required for germination of a seed.

v. demonstrate and explain the life cycle of a flowering plant.

Syllabus

- Introduction to microscopic organisms
- Bacteria-Structure and types
- Viruses-Structure and types
- Fungi-Structure
- Modification of different parts of plants (root, stem and leaf)
- Seed-Types and functions
- Dispersal of seed
- Life cycle of a flowering plant

Glossary: A dictionary of scientific/technical terms

primitive	:	very simple
microscopic	:	that can be seen only under the microscope
cluster	:	a group of things of the same type that grow close together
metabolic	:	related to the chemical processes in living beings that change food into energy and materials for growth
tendril	:	a thin curling stem that grows from a climbing plant
embryo	:	very early stage of an organism
zygote	:	a diploid cell formed by the fusion of a male gamete and a female gamete

Living Beings

Bacteria

Bacteria are the most primitive, unicellular and microscopic plant organisms. They are the simplest living organisms. Bacteria are found in air, water, soil and inside the body of plants and animals. They can be found in almost all parts of the earth.

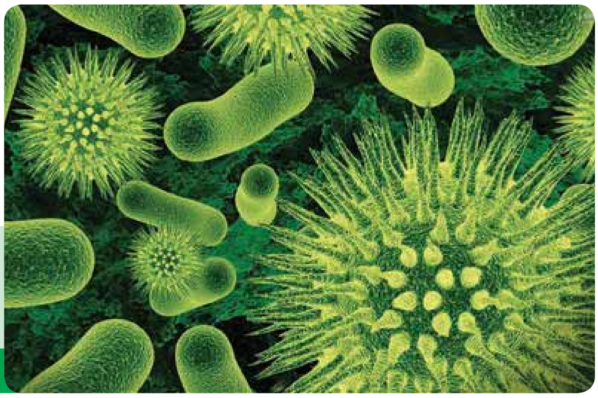


Fig. 16.1

Bacteria

Do You Know

- In 1676 AD, Anton Van Leeuwenhoek discovered bacteria but the term "bacteria" was coined by CG Ehrenberg in 1828 AD.
- The singular of bacteria is bacterium.
- Some bacteria can survive in boiling water and some can survive in ice.

Most bacteria do not have chlorophyll and only a few have chlorophyll. It means most bacteria are saprophytes and only a few are autotrophs.

Structure of Bacteria

Bacteria have a very simple cellular structure. The cell of bacteria consists of a non-living cell wall and a thin living membrane called plasma membrane.

The cell of a bacterium consists of protoplasm and genetic material, i.e. DNA. Some bacteria contain flagella. Membrane bound structures like mitochondria, golgi bodies, etc. are absent in bacteria. The cell of bacteria is called prokaryotic cell as it has a primitive nucleus.

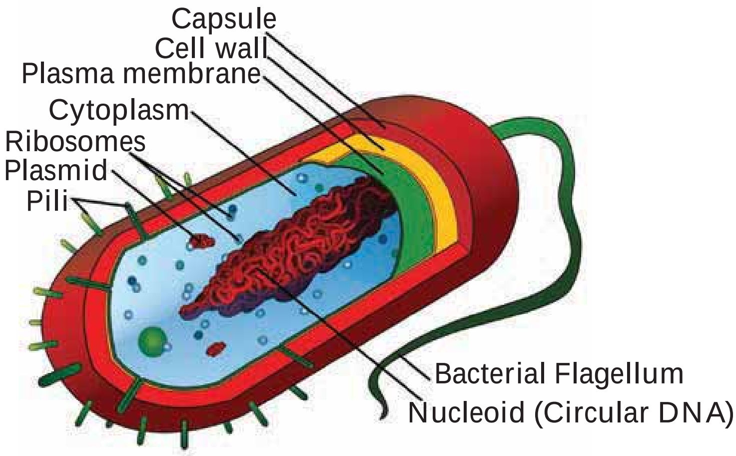


Fig. 16.2

Structure of bacterium

Characteristics of Bacteria

1. They do not have a well developed nucleus.
2. Their size ranges from 0.5 to 5 micrometers.
3. A cell wall is present in them.
4. The mode of nutrition may be heterotrophic or autotrophic.
5. Most bacteria are immotile but some bacteria like spirilla and bacilli are motile.
6. They may live alone or in colonies.
7. They reproduce asexually by fission.

Types of Bacteria

There are four types of bacteria on the basis of shape. They are:

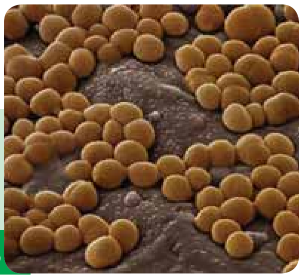
i. Spherical bacteria or coccus, e.g. Diplococci, etc.

ii. Spiral bacteria, e.g. spirillum, leptospira, etc.

iii. Rod-shaped bacteria or Bacillus, e.g. Escherichia coli

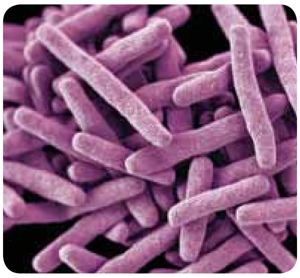
iv. Comma-shaped bacteria or Vibrio, e.g. Vibrio cholera

Fig. 16.3

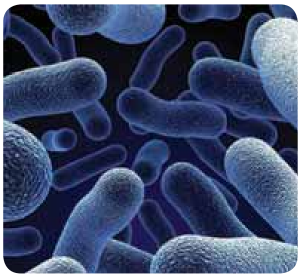


Cocci bacteria

Spirillum bacteria



Bacilli bacteria



Vibrio bacteria

Advantages of Bacteria

1. Some bacteria like Rhizobium increase the fertility of soil by regulating nitrogen cycle.
2. Bacteria are used for making medicines like antibiotics.
3. Many bacteria help in digestion of food.
4. Bacteria act on dead bodies and decompose them which helps in recycling of materials in the environment.
5. Bacteria are used in tanning of leather, curding of milk, cheese making and processing of tobacco, coffee, etc.

Disadvantages of Bacteria

1. Bacteria cause diseases in plants and animals.
2. Some bacteria like Pseudomonas decrease the fertility of soil.
3. Bacteria spoil food, milk, vegetables, fruits, etc.
4. Some bacteria release toxins into food and cause food poisoning.

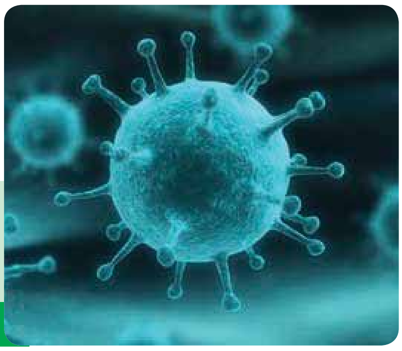
Do You Know

Bacteria cause various diseases in human beings like typhoid, leprosy, scrub typhus, pneumonia, dysentery, tetanus, tuberculosis, etc.

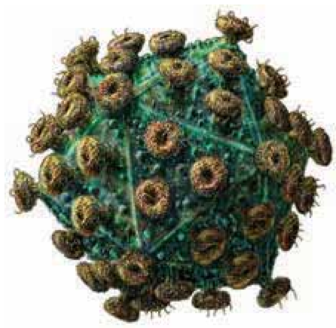
Viruses

Viruses are sub-microscopic, obligatory, parasites that cause various diseases in plants and animals. The word 'virus' has been derived from a Latin word 'venom' which means poison or poisonous fluid. The size of viruses ranges from 25 nanometers to 250 nanometers. They are about 50 times smaller than bacteria. Viruses can only be seen under an electron microscope.

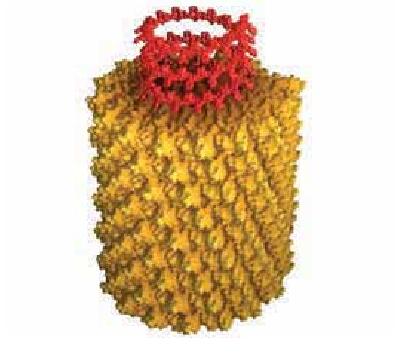
Fig. 16.4



Flu virus



Retro virus (HIV)



TMV (Tobacco Mosaic Virus)

Viruses do not have nucleus and cytoplasm. It means that they do not have a cellular structure. Some viruses contain DNA (Deoxyribonucleic acid) and others contain RNA (Ribonucleic acid). Viruses cause various diseases in plants and animals. Mosaic disease of tobacco, cabbage, mustard; black ring spot of cabbage, leaf roll of tomato, etc. are the viral diseases found in plants. Similarly, common cold, AIDS, rabies, polio, measles, chicken pox, meningitis, etc. are the viral diseases common in human beings.

Viruses have different shapes like hexagonal, cylindrical, spherical, etc. The genetic material, i.e. DNA or RNA of a virus remains surrounded by a coat of protein called capsid. Viruses show the properties of both non-living things and living beings. Therefore, they are kept in the borderline of living beings and non-living things.

Non-living properties of viruses

1. Viruses do not have a cellular structure.
2. They do not perform metabolic activities.
3. They can be crystallized like non-living things.

Do You Know

Viruses can exist outside the living cell for a long period of time but they cannot reproduce outside the living cell. Since the viruses can reproduce only inside the specific cell of the living host, they are called obligatory parasites.

Living properties of viruses

1. Viruses contain genetic material, i.e. either DNA or RNA.
2. They reproduce in a large number inside the host cell.
3. They transmit hereditary characteristics to their offspring.

Types of viruses

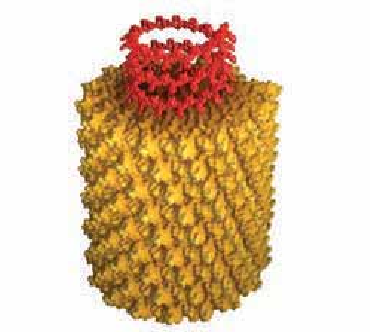
On the basis of type of host, there are three types if viruses. They are:

1. Plant viruses 2. Animal viruses 3. Bacteriophages

1. Plant viruses

The viruses that attack plants are called plant viruses, e.g. tobacco mosaic virus (TMV). It is a rod shaped RNA virus that attacks the leaves of tobacco.

Fig. 16.5

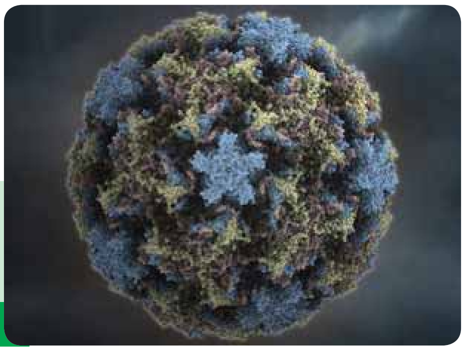


TMV virus

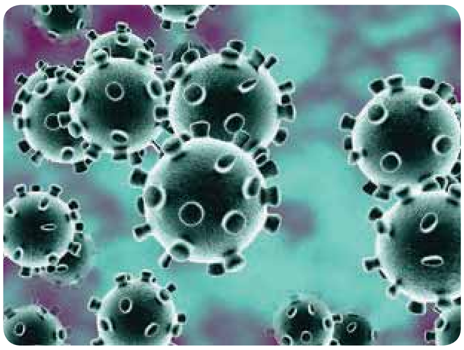
2. Animal viruses

The viruses that attack animals are called animal viruses, e.g. retro virus (HIV), polio virus, flu virus, paramyxo virus, rhino virus, etc.

Fig. 16.6



Rhino virus



Corona virus

3. Bacteriophages

The virus that attacks bacteria is called bacteriophage virus. It consists of two parts, i.e. head and tail. The head is hexagonal which remains covered with a protein coat called capsid. The tail is cylindrical and consists of tail fibres.

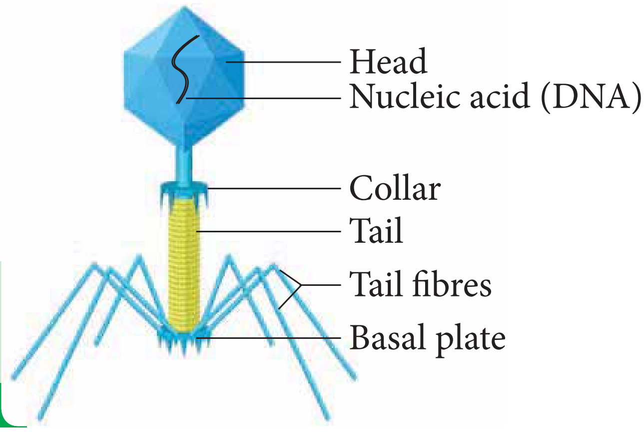


Fig. 16.7 *Bacteriophage virus*

Modes of transmission of viruses

1. Through air, water and food
2. Direct contact with infected organism
3. Through droplets while coughing and sneezing
4. From infected mother to unborn/newly born baby
5. Through vectors like mosquito, houseflies, etc.

Differences between Bacteria and Viruses

Bacteria	Viruses
1. Bacteria are very small in size. They can be seen under a compound microscope.	1. Viruses are smaller than bacteria. They can be seen only under an electron microscope.
2. Bacteria perform metabolic activities.	2. Viruses do not perform metabolic activities.
3. Bacteria are living cellular organisms.	3. Viruses are acellular particles.
4. A bacterial cell is surrounded by distinct wall.	4. Cell wall is absent in viruses.

Fungi

Fungi are plants without chlorophyll. They may be unicellular (yeast) or multicellular (mushroom). They cannot prepare their own food. So, they depend on dead and decaying organic matter. Mushroom, yeast, mucor, etc. are examples of fungi.

Fig. 16.8

Mushroom *Growth of yeasts on bread* *Mucor*

Characteristics of fungi

1. Fungi do not contain root, stem and leaves.
2. They contain eukaryotic cells which may contain many nuclei.
3. Their cell wall is made of fungus cellulose.
4. Chlorophyll is absent in them.
5. Their body is made of hyphae, i.e. mycelia or long filaments.
6. They may be unicellular or multicellular.
7. They reproduce asexually by budding, fragmentation and sporulation.

Do You Know

Fungi cannot prepare their own food due to absence of chlorophyll and depend on dead and decaying organic matter for food. Therefore, fungi are called saprophytes.

Advantages of fungi

1. Fungi act on dead and decaying bodies and help in recycling of materials.
2. Edible fungi like mushroom provide us nutritious food.
3. Some fungi like yeast are used in bakeries and wine industries.
4. Some fungi are used for making medicine, e.g. penicillin.

Disadvantages of fungi

1. Fungi cause various diseases in plants and animals.
2. They attack leather, foods and spoil them.
3. They cause skin infection, vaginal yeast infection, etc. in humans.

Modification of Different Parts of Plants

Different types of plants are found around us. Among them, some are very big and others are medium-sized or small. Flowering plants consists of roots, stem and leaves. These organs of plants perform various functions. The roots, stems and leaves of plants are modified to perform specific functions. This process is called modification of parts of plants.

a. Modification of Roots

The underground part of a plant is called the root system. Flowering plants have two types of root system, viz. (i) Tap root system and (ii) Fibrous root system.

Roots absorb water and minerals from the soil and they fix the plant body to the soil. Besides these major functions, the roots of plants are modified to perform following functions:

i. For storage of food ii. For mechanical support iii. For vital function

i. For storage of food

The roots of some plants like radish, turnip, carrot, etc. are modified to store food. In radish, upper portion of the root is swollen and lower portion of the stem is tapered. In turnip, the upper part of the root is round and swollen and lower part is tapered. In carrot, the upper portion of the stem is flat and lower portion is tapered.

Fig. 16.9

Root of radish *Roots of turnip* *Roots of carrot*

ii. For mechanical support

The roots of some plants like peepal, banyan, maize, bamboo, sugarcane, etc. are modified to provide mechanical support to the plant.

Fig. 16.10

Prop roots of banyan *Supporting roots of bamboo* *Supporting roots of maize*

iii. For vital functions

The roots of plants are modified on the basis of their functions. Roots of aquatic plants have air storage tissues which help them to float easily (e.g. hydrilla, water hyacinth, etc.). The roots of plants that are found in marshy places are modified for breathing. Roots of some plants contain chlorophyll for breathing. Roots of epiphytes are modified to absorb food from other plants.

Fig. 16.11

Roots of water hyacinth | *Roots of epiphytes* | *Roots modified for breathing*

b. Modification of stem

Stem is that part of a plant which is found above the soil. It consists of branches and sub-branches. Leaves, flowers and fruits are attached to the stem. Like roots, stems are also modified to perform special functions such as support, food manufacturing and storage.

i. Underground modification

The underground stems of some plants like potato, ginger, onion, garlic, colocasia, etc. are modified to store food. They have thick and fleshy stems that stores starch.

Fig. 16.12

Potatoes | *Onions* | *Colocasia (arum)*

ii. Sub-aerial modification

The stem of some plants like runner, grass, fern, etc. are modified to reproduce asexually. They contain eyes or buds which grow into new plants.

Fig. 16.13

Runner grass

Runner of plants for reproduction

iii. Aerial modification

The stems of some plants like aloe, cactus, opuntia, etc. have thick and fleshy stems modified for storing food and water. Some plants like rose, orange, lemon, etc. have thorny stems modified for protection. Plants like cucumber, grapes, pumpkin, gourd, etc. have wire-like structures, i.e. tendrils. These tendrils coils round any object and help the plant to climb up. Some stems also contain chlorophyll and help in photosynthesis.

Fig. 16.14

Thick fleshy stem of Aloe vera

Thick fleshy stem of cactus

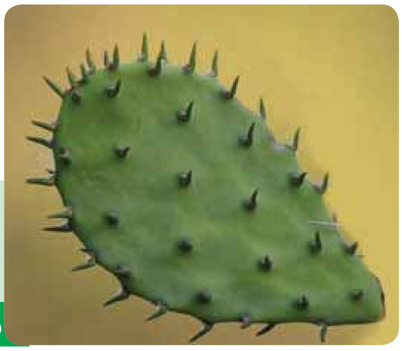
Tendrils of cucumber

c. Modification of Leaf

Leaves are the green and flat parts of plants having chlorophyll. Leaves help in photosynthesis. They also help in breathing and transpiration. Besides these main functions, leaves of plants are modified to perform special functions as follows.

Some plants like cactus, barberry, etc. have thorns in their leaves for protection. Insectivorous plants like pitcher plants, venus fly-trap, etc. have modified leaves for catching insects. In pea plants, leaf is modified into tendril for support. In cactus, prickly pear, etc. leaves are modified into spines to reduce loss of water due to transpiration.

Fig. 16.15



Leaf of cactus with thorns *Pitcher plant* *Tendrils of pea plant*

In this way, the roots, stems and leaves of different plants are modified to perform some additional functions.

Seed

The matured ovule that germinates into a new plant is called a seed. Different plants have different types of seeds. Seeds of some plants are very small. Whereas the seeds of some plants are large. Seeds of different plants have different colours.

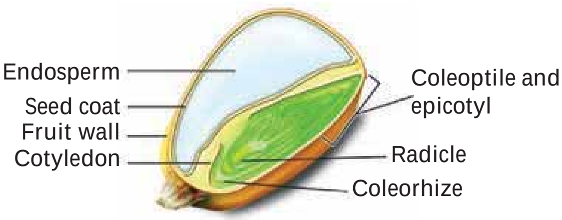
Fig. 16.16

Seed of mango *Seeds of peach* *Seeds of papaya* *Seeds of sesame*

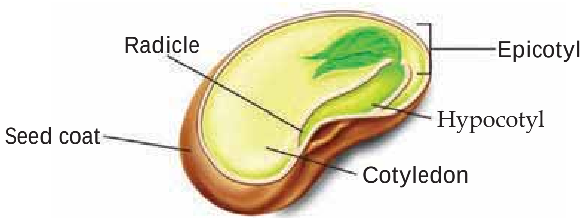
Structure of a seed

Different plants have different types of seeds. They differ in shape and size. However, their basic structure is similar. A typical seed has three main parts. They are (i) embryo (ii) endosperm or cotyledons and (iii) seed coat. The embryo is an immature plant which grows into a new plant on favourable condition. It consists of two parts, viz. radicle and plumule. The radicle develops into root system and plumule develops into shoot system. Seeds store food for the embryo in endosperm or cotyledons. In monocots, only one cotyledon is present in a seed and in dicots two cotyledons are present.

Fig. 16.17



Structure of a monocot seed



Structure of a dicot seed

In monocots, the food storage tissue is called endosperm but in dicots the cotyledons serve as storage tissues. A seed coat is the outer cover which protects a seed. It is essential to protect the embryo from mechanical injury and from drying out.

A seed consists of a small scar on the seed coat called the hilum. It is found where the seed was attached to the ovary wall. There is a small opening near the hilum which is called micropyle. Water enters inside the seed through this opening and helps in germination of seed.

Differences between Radicle and Plumule

Radicle	Plumule
1. The radicle is the embryonic root.	1. The plumule is the embryonic shoot.
2. It grows towards the soil.	2. It grows away from the soil.

Activity 1

- Collect the seeds of some plants and study their structure.
- Identity various parts of those seeds such as embryo, cotyledon, endosperm, hilum, micropule, etc.
- Draw a neat figure of each and label the main parts.

Types of seed

On the basis of number of cotyledons, there are two types of seeds. They are (i) Monocot seed (ii) Dicot seed.

i. Monocot seed

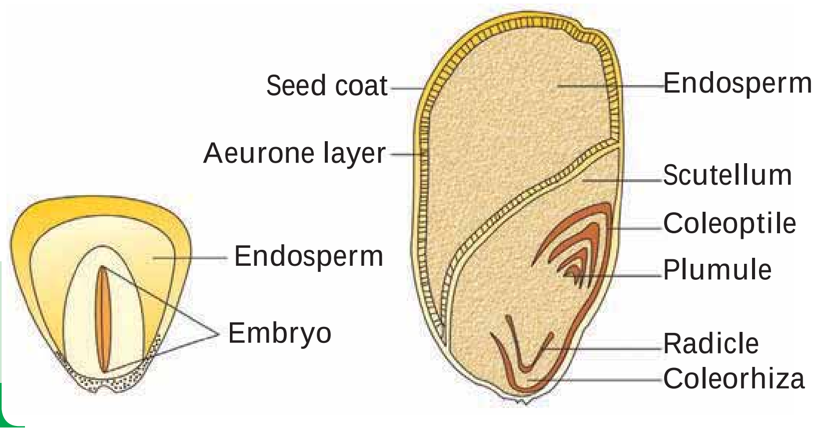


Fig. 16.18 *Detailed structure of a maize seed*

The seed which consists of only one cotyledon or seed leaf is called monocot seed. Maize seed, wheat seed, paddy seed, etc. are examples of monocot seeds. In monocot seeds, endosperm occupies the major portion of a seed. In a maize seed, the broader part contains endosperm which consists of white or yellow reserved food material. The narrower part of the seed contains cotyledon. The cotyledon consists of a small embryo. Endosperm and embryo are separated by a thin membrane. Plumule is present on the broader part of the seed and radicle is present on the opposite side of the plumule.

Seeds of maize, paddy, wheat, millet, barley, etc. are endospermic monocot seeds.

ii. Dicot seeds

A seed having two cotyledons or seed leaves is called dicot seed. Examples: seeds of pea, grams, orange, beans, lentils, etc. In dicot seeds, endosperm is absent. The cotyledons acts as storage tissues in dicot seeds.

In bean seeds, the middle portion of the seed contains embryo. The embryo contains radicle and plumule.

In dicot seeds, micropyle and hilum can be seen with our naked eyes. Dicot seeds are found inside pods.

Differences between monocot seed and dicot seed

Monocot seed	Dicot seed
1. Only one cotyledon is present in a seed.	1. Two cotyledons are present in a seed.
2. Embryo is small.	2. Embryo is large.
3. Micropyle and hilum cannot be seen with our naked eyes.	3. Micropyle and hilum can be seen with our naked eyes.
4. Endosperm is present.	4. Endosperm is absent.
5. Plumule is very small.	5. Plumule is large.

On the basis of presence or absence of endosperm, seeds are of two types. They are:

i. Endospermic seed

ii. Non-endospermic seed

i. Endospermic seed

The seeds in which food is stored in endosperm are called the endospermic seeds. Seeds of wheat, maize, paddy, barley, etc. are examples of the endopsermic seeds. All monocot seeds contain endosperm. But caster seed is a dicot seed which contains endosperm.

Fig. 16.19

Maize

Wheat

Caster

ii. Non-endospermic seeds

The seeds in which food is stored in cotylenods are called non-endospermic seeds. Seeds of pea, bean, lentil, orange, lemon, soyabean, peanut, etc. are examples of non-endospermic seeds. All dicot seeds are non-endospermic except caster seeds.

Fig. 16.20

Pea

Peanut

Bean

Functions of seeds

1. Seeds help in sexual reproduction in flowering plants.
2. Seeds store food materials.
3. The seed coat protects the embryo.

Dispersal of seed

The transport or movement of seeds away from the parent plant is called dispersal of seed. Seeds are dispersed by following method:

1. By wind

Seeds of some plants like cotton, simal, dandelion, grass, etc. are dispersed by wind. Seeds of these plants are light and fluffy having parachute like structure. So these seeds are easily dispersed by wind.

Fig. 16.21


Seeds of simal


Seeds of dandelion flying in air

2. By water

Seeds of some plants like coconut, betel, lotus, water lily, etc. are dispersed by means of water. Seeds of these plants have special protective coat. So they do not decay in water for a long time.

Fig. 16.22


Seed of coconut


Seeds of betel


Seeds of lotus

3. By explosion of fruits

Fruits of plants like sesame, myrtle (Tiuri), linseed, pea, etc. explode with a jerk and seeds get dispersed in the surroundings.

Fig. 16.23


Exploding fruits of pea


Exploding fruits of sesame


Exploding fruits of linseed

4. By animals and birds

Seeds of some plants have hooks and sticky structures which attach to the fur of animals and clothes of humans and get dispersed. Birds and animals eat fruits and swallow their seeds. They pass out dropping away from the parent plant and the seeds get dispersed.

Fig. 16.24

Seeds attach to the fur of animals and get dispersed

Germination of Seed

The process by which an embryo of a seed grows into a seedling is called the germination of a seed. A seed germinates only under favourable conditions. The conditions required for germination of a seed are suitable temperature, adequate water and oxygen. Some seeds require exposure to light before germination.

Activity 2

- Collect seeds of some plants and classify them in terms of:
  i. Monocot seeds and dicot seeds.
  ii. Endospermic seeds and non-endospermic seeds.

Activity 3

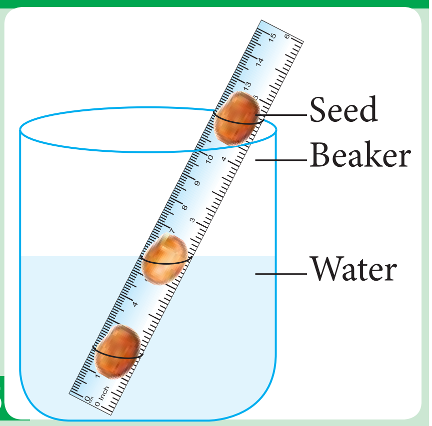
- Collect the seeds of some plants and keep them in moist soil.
- Observe the seeds after 4-5 days. Do all seeds germinate?
- Study the structure of seedling and draw a neat figure of each.

Activity 4

- Take a beaker and keep some water in it.
- Take three seeds of bean and tie them on a scale as shown in the figure.
- Adjust the scale in such a way that one seed gets completely immersed in water, the middle is half-immersed and the uppermost seed is in the air.
- Observe the seeds after 4-5 days.

You can see the germination of half-immersed seed only. What can you conclude from this activity?

Fig. 16.25



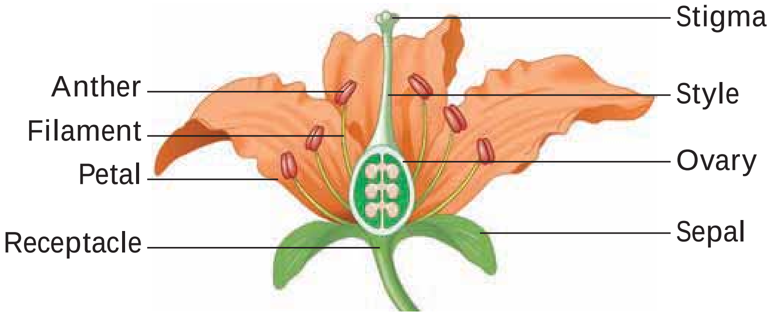
Life Cycle of a Flowering Plants

Different types of plants are found in our surroundings. Among them some produce flowers and other do not. The plants that produce flowers and seeds are called flowering plants. Flowering plants produce seeds which germinate into new plants in favourable condition. It means that flowering plants reproduce by means of seeds. Flower is the sexually reproductive organ of a flowering plant.

Flower

Flower is colourful and the most attractive part of a flowering plant. A complete flower consists of four distinct whorls. They are calyx, corolla, androecium and gynoecium.

Fig. 16.26

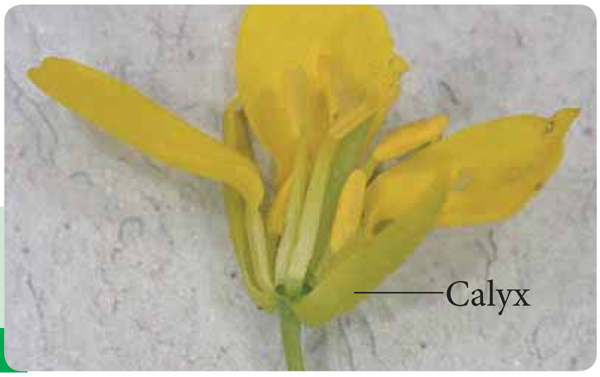


Structure of a bisexual flower

i. Calyx

It is the outermost whorl of a flower. It consists of green leaf like structures called sepals. Calyx protects a flower in the bud stage and helps in photosynthesis.

Fig. 16.27



Calyx of mustard

Calyx of rose

ii. Corolla

It forms the second whorl of a flower. It consists of colourful and attractive structures called petals. Petals protect the reproductive organs of a flower and attract insects for pollination.

Fig. 16.28

Corolla of mustard

Corolla of china rose

iii. Androecium

It forms the third inner whorl of a flower. It consists of a group of male reproductive organs called stamens. Each stamen consists of a filament, connective and a anther. Anthers produce pollen grains at maturity. Pollen grains are fine powdery structures having male gametes.

Fig. 16.29

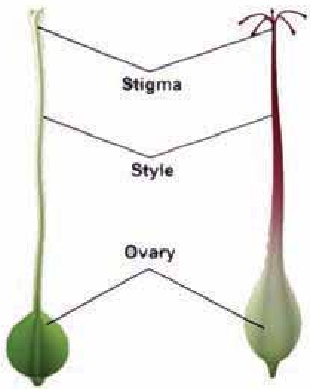
A typical andreocium

Stamen of China rose

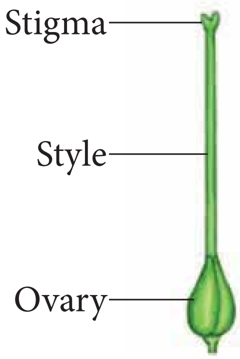
iv. Gynoecium

It forms the fourth innermost whorl of a flower. It consists of one or more female reproductive organs called carpels or pistils. Each carpel or pistil consists of three distinct parts. They are stigma, style and ovary.

Fig. 16.30



Typical carpel (gynoecium)



Gynoecium of mustard

The uppermost spreading part of a pistil is called a stigma, the middle cylindrical part is called a style and the lowermost swollen part is called a ovary. At maturity, an ovary produces ovules containing female gametes.

Pollination

The transfer of pollen grains from anther to the stigma of the same flower or different flower is called pollination. Various external agents like air, water, insects, birds, animals, etc. help in pollination.

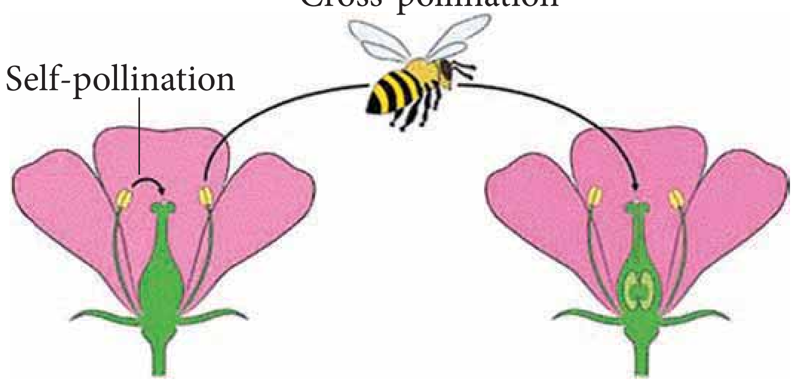


Fig. 16.31

Pollination

Pollination is of two types, viz. self-pollination and cross-pollination.

i. Self-pollination

It is the transfer of pollen grains from the anther to the stigma of the same flower. This process is common in bisexual flowers like pea, chinarose, tomato, etc.

ii. Cross-pollination

It is the transfer of pollen grains from the anther of a flower of one plant to the stigma of a flower of another plant of the same species. This process is common in unisexual flowers like pumpkin, cucumber, gourd, etc. and bisexual flowers.

In flowering plants, pollination is followed by fertilization.

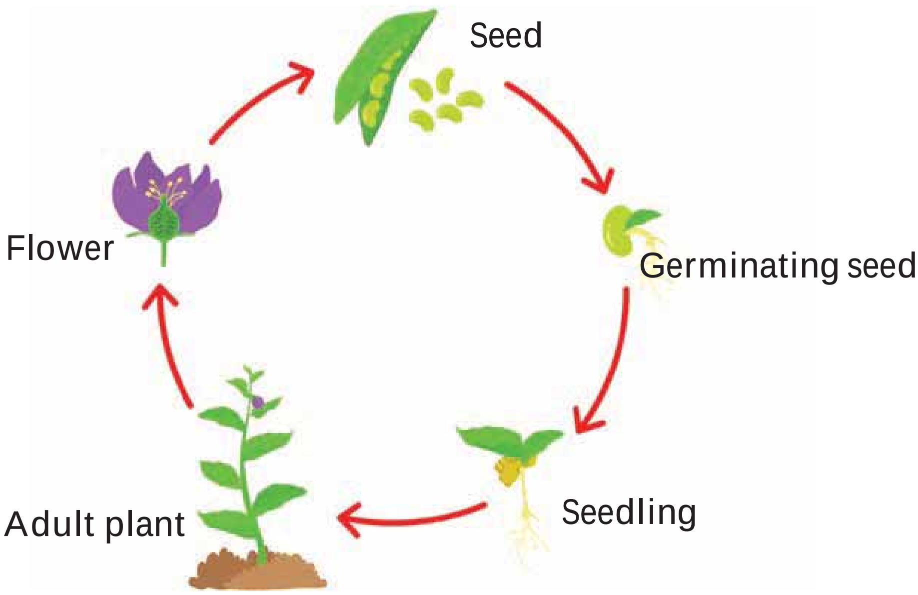


Fig. 16.32

Life cycle of a flowering plant

Differences between Self-pollination and Cross-pollination

Self-pollination	Cross-pollination
1. It is the process of transfer of pollen grains from the anther to the stigma of the same flower or to the stigma of another genetically identical flower of the same plant.	1. It is the process of transfer of pollen grains from anther of a flower of one plant to the stigma of a flower of another plant of the same species.
2. External agents of pollination are not required.	2. External agents of pollination like insects, wind, water, etc. are required.
3. It does not help in variation.	3. It helps in variation.

Fertilization

The process of fusion of a male gamete and a female gamete to form a zygote is called fertilization. After pollination, pollen grains germinate and form pollen tubes which grow towards ovary through style and finally reaches the ovule in the ovary. The ovule consists of female gametes. In ovule, fusion of a male gamete and female gamete takes place which forms a zygote. This process is called fertilization. After fertilization, the zygote divides and forms embryo. The embryo of a seed grows into a new plant on favourable condition.

In this way, the life cycle of a flowering plant is completed.

Activity 5

- Take a flowering plant like mustard, pea, etc. and study its various parts.
- Draw a neat and labelled figure after your observation.

Activity 6

- Collect flowers of different flowering plants and study their structure.
- Draw a neat and labelled figure of each flower after your observation.

Key Concepts

1. Bacteria are the most primitive, unicellular and microscopic plant organisms.
2. Viruses are sub-microscopic, obligatory, parasites that cause various diseases in plants and animals.
3. The roots, stems and leaves of plants are modified to perform specific functions. This process is called modification of parts of plants.
4. The matured ovule that germinates into a new plant is called seed.
5. The transport or movement of seeds away from the parent plant is called dispersal of seed.

6. The process by which an embryo of a seed grows into a seedling is called germination of a seed.
7. Flower is a colourful and the most attractive part of a flowering plant. A complete flower consists of four distinct whorls. They are calyx, corolla, androecium and gynoecium.
8. The transfer of pollen grains from anther to the stigma of the same flower or different flower is called pollination.
9. Pollination is of two types, viz. self-pollination and cross-pollination.
10. The process of fusion of a male gamete and a female gamete to form a zygote is called fertilization.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Bacteria have eukaryotic cells. ☐

b. Viruses show the properties of both living beings and non-living things. ☐

c. Most fungi show saprophytic nutrition. ☐

d. In carrot, roots are modified to store food. ☐

e. Calyx is the second whorl of a flower. ☐

2. Fill in the blanks using appropriate words.

a. The size of bacteria ranges from .... to ....

b. .... do not perform metabolic activities.

c. Fungi reproduce asexually by ...., ... and ....

d. In cactus, ... are modified into spines to reduce the loss of water.

e. .... is the innermost whorl of a flower.

3. Tick (√) the most appropriate answer from the given alternatives.

a. Which of the following is a bacterial disease?

☐ typhoid ☐ polio ☐ AIDS ☐ common cold

b. Which of the following is a plant virus?

☐ rabies virus ☐ TMV ☐ HIV ☐ polio virus

c. Which of the following is an endospermic seed?

☐ pea ☐ grams ☐ maize ☐ soyabean

d. Which of the following is the third whorl of a flower?

☐ calyx ☐ androecium ☐ corolla ☐ gynoecium

4. Answer the following questions.

a. What are microscopic organisms? Give any three examples.

b. What are bacteria? Write any three characteristics of bacteria.

c. Write any three advantages and two disadvantages of bacteria.

d. What are viruses? Write any two living and two non-living properties of viruses.

e. What is meant by bacteriophage virus? Name any three human diseases caused by viruses.

f. Write any three modes of transmission of viruses.

g. What are fungi? Give any two examples.

h. Write any three characteristics of fungi.

i. Write any three advantages and two disadvantages of fungi.

j. What is meant by modification of parts of plants?

k. How are roots of plants modified? Write with examples.

l. How are stems and leaves of plants modified? Write with examples.

m. What is a seed? Describe the structure of a seed in brief.

n. What are monocot seeds and dicot seeds? Write with examples.

o. Write any two functions of seeds.

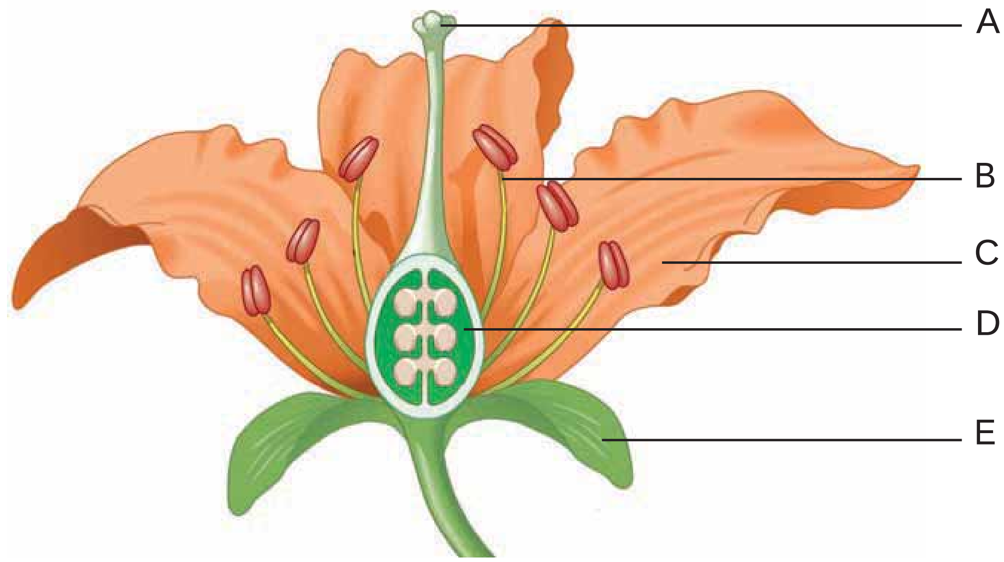
p. Write any three methods of seed dispersal.

q. What is meant by germination of a seed? Write its conditions.

r. What is pollination? State its types.

s. What is fertilization?

5. **Name the parts A to E shown in the given figure. Also, write one major function of each.**



6. **Differentiate between:**
   a. Bacteria and Viruses
   b. Viruses and Fungi
   c. Monocot seeds and Dicot seeds
   d. Self-pollination and Cross-pollination
   e. Endospermic seed and Non-endospermic seed

7. **Give reason.**
   a. Viruses are kept in the borderline of living beings and non-living things.
   b. Corolla is very important for pollination.
   c. Air and water are essential for seed dispersal.

8. **Draw a neat and labelled figure showing the life cycle of a flowering plant.**

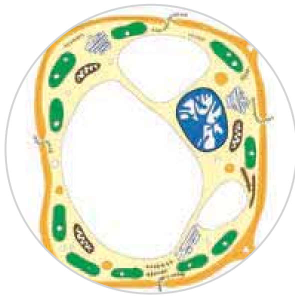
UNIT 1

Cell and Tissue

Weighting Distribution (Approximate)	Teaching periods : 3	Marks (in %): 3

Before You Begin

A cell is the basic, structural and functional unit of a life. The bodies of living organisms are made of cells. Cells are microscopic units of a body which act as building blocks of life. They are broadly classified into plant cell and animal cell. Cells of plants and animals differ from each other. However, the basic structure of plant cell and animal cell is similar. Some organisms contain only one cell in their bodies. These organisms are called unicellular organisms. Most organisms contain many cells in their bodies. They are called multicellular organisms. These organisms have different groups of cells to perform certain functions. These groups are called tissues. A tissue can be defined as a group of cells having a common origin and performing similar functions. In this unit, we will study about cell, tissue and relation between cell, tissue, organ and system in brief.



Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce cell and tissue with examples.

ii. introduce epithelial tissue and meristematic tissue with their types and functions.

iii. explain the relation among cell, tissue, organ and system in brief.

Syllabus

- Introduction to cell and tissue
- Types of animal tissue
- Epithelial tissue, characteristics and function
- Types of epithelial tissue
- Plant tissue: Types
- Meristematic tissue: Types and functions
- Interrelationship among cell, tissue and organs in human body

Glossary: A dictionary of scientific/technical terms

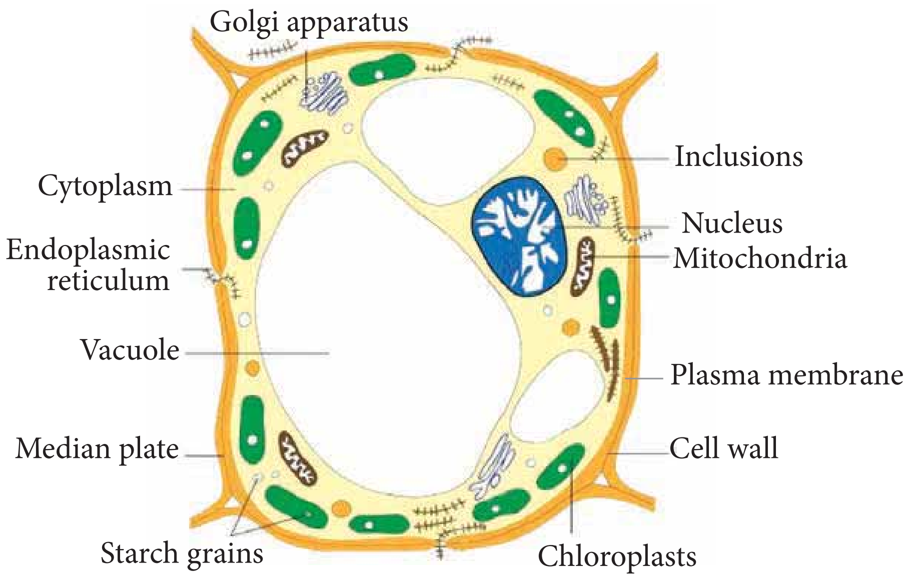
cell	:	the basic, structural and functional unit of a life
tissue	:	a group of cells having a common origin and performing similar functions
epithelium	:	a thin and protective layer that covers the external surface and internal body organs
pavement	:	any area of flat stones or tiles on the ground
columnar	:	a thing shaped like column
glandular	:	related to glands of the body
organ	:	a group of tissues that performs a specific function

Cell and Tissue

Cell

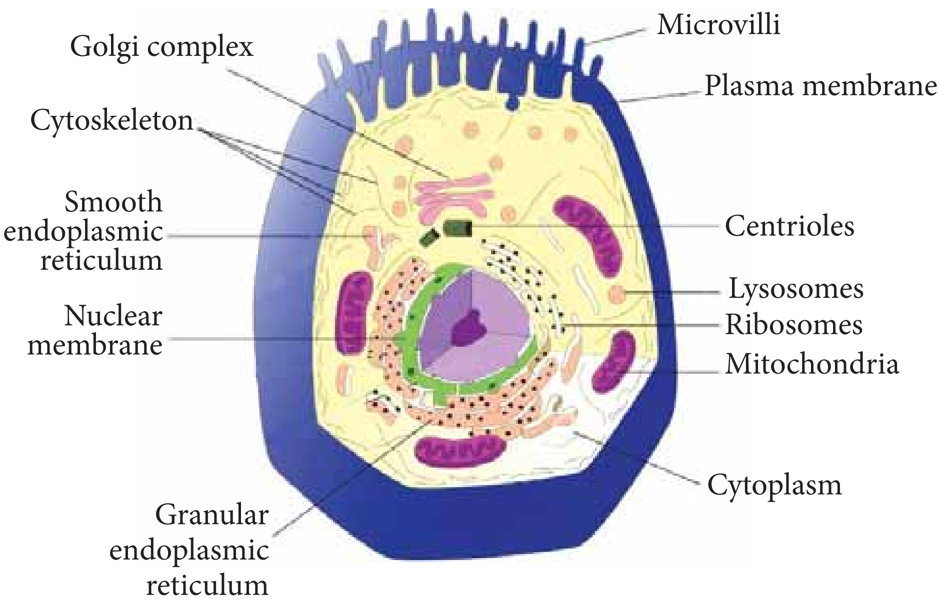
A cell is defined as the basic structural functional unit of a life. A cell is made of life-giving substance called cytoplasm which remains surrounded by cell membrane. Various cell organelles and inclusions are found in a cell. A cell is capable of performing various activities like respiration, digestion, excretion, reproduction, etc.

Fig. 17.1



Plant cell

Fig. 17.2



Animal cell

The body of living organisms is made of one or more cells. The word cell has been derived from the Latin word 'cellula' which means a little room. Cell was discovered by Robert Hooke in 1665 AD. Some organisms like amoeba, paramecium, bacteria, etc. are made of only one cell. These organisms are called unicellular organisms. Multicellular organisms contain many cells in their bodies. A cell is called the functional unit of a life as it is capable of performing different functions like respiration, digestion, excretion, reproduction, transport, growth, etc. Cells are very small in size. So compound microscope is required to see the details of a cell.

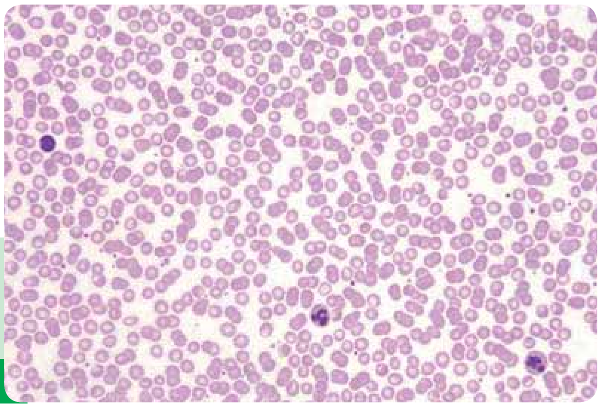
Fig. 17.3 *Compound microscope*

Tissue

In multicellular organisms, a large number of cells work together to perform a certain function. This group of cells is called tissue. A tissue can be defined as the group of cells having a common origin and performing similar functions. In a tissue, the cells are more or less alike in shape, size and performing the same function. Examples: epithelial tissue, muscular tissue, blood, bones, meristematic tissue, etc. Plants and animals have different types of tissues.

Do You Know

The branch of biological science in which we study about tissues and their functions is called histology.



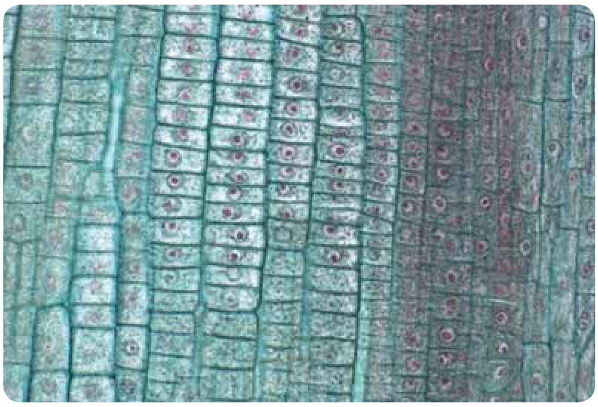


Fig. 17.4 *Blood tissue* *Meristematic tissue*

Animal Tissue

On the basis of structure and function, animal tissues are of four types as follows:

1. Epithelial tissue
2. Muscular tissue
3. Connective tissue
4. Nervous tissue

1. Epithelial tissue

The thin and protective tissue that covers the external surface and internal body organs is called an epithelial tissue. It covers the body cavity and cavities of hollow body organs, ducts and blood vessels.

Fig. 17.5 *Epithelial tissue*

Characteristics of epithelial tissue

1. The lowermost layer of an epithelial tissue is attached to the basement membrane.
2. Cells of this tissue are closely packed without intercellular spaces.
3. Blood vessels are absent.
4. The surface of the cells may be smooth or may have hair-like structures.

Functions of epithelial tissue

1. This tissue protects the underlying tissues.
2. It helps in absorption of digested food and excretion of waste materials.
3. It helps in secretion of hormones and enzymes.
4. It helps in formation of gametes.

Types of Epithelial tissues

There are four types of epithelial tissues. They are:

1. Pavement epithelium
2. Cubical epithelium
3. Columnar epithelium
4. Glandular epithelium

1. Pavement epithelium

It is a single-layered epithelial tissue in which cells are arranged like flat-tiles of a pavement. In this tissue, cells are thin-walled, plate-like and polygonal without inter-cellular spaces.

The pavement epithelium is found in the form of covering layer in skin, lungs, heart, kidneys, oesophagus and blood vessels.

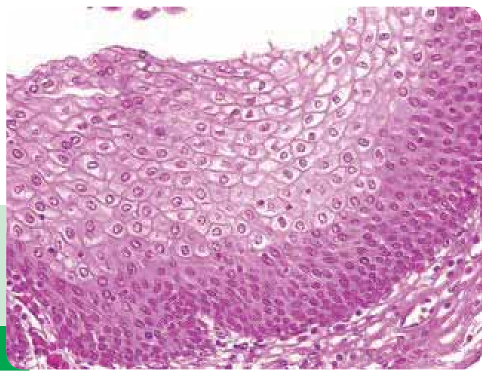


Fig. 17.6 *Pavement epithelium*

Protection, filtration, covering and making passage for flow of liquid and gases are the major functions of pavement epithelium.

2. Cubical epithelium

The epithelial tissue having a single layered cubical cells is called the cubical epithelium. In this tissue, cells are attached with one another by their lateral surfaces.

The cubical epithelium is found in ureters, thyroid gland, bronchioles and inner parts of testes and ovaries. The major functions of a cubical epithelium are protection, secretion and germination.

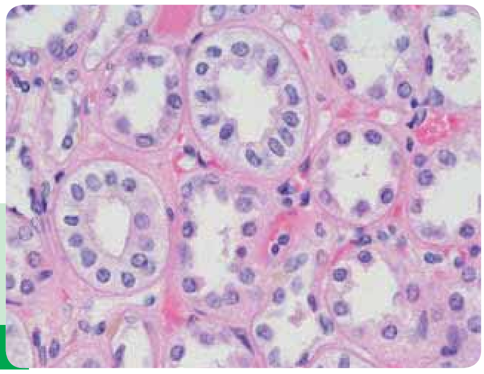


Fig. 17.7 Cubical epithelium

3. Columnar epithelium

The epithelial tissue having a single-layered column like elongated cells is called the columnar epithelium. This type of tissue is found in salivary gland, stomach, intestine and urinogenital organs. The functions of a columnar epithelium are absorption and secretion.


Fig. 17.8 Columnar epithelium

4. Glandular epithelium

The modified columnar epithelium that secretes hormones and enzymes is called the glandular epithelium. This tissue is found in various glands of our body. The major function of this tissue is to secrete hormones, enzymes, sweat, saliva and other digestive juices.

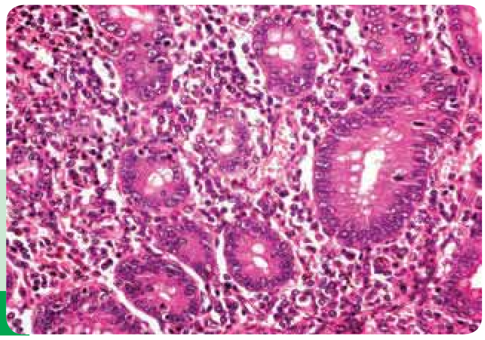


Fig. 17.9 Glandular epithelium

Activity 1

- Take a toothpick and wash it with clean water.
- Scrape the inner lining of your cheek with the toothpick gently.
- Put a drop of iodine and transfer the scraping on the glass slide.
- Cover the scraping with a clean cover slip and observe the slide under the compound microscope.

You will see a tissue which is a pavement epithelium. Draw a neat figure after your observation.

Differences between Pavement epithelium and Cubical epithelium

Pavement epithelium	Cubical epithelium
1. It is a single-layered epithelial tissue in which cells are thin having centrally placed nucleus.	1. It is a epithelial tissue made of single-layered cubical cells.
2. It is responsible for protection, filtration and making passage for flow of liquid and gases.	2. It is responsible for protection, secretion and germination.
3. It is found in the form of lining in skin, lungs, heart, oesophagus and blood vessels.	3. It is found in thyroid gland, terminals of bronchioles, ducts of excretory organs, inner parts of testes and ovaries.

Plant tissue

There are two types of plant tissues on the basis of location and function. They are:

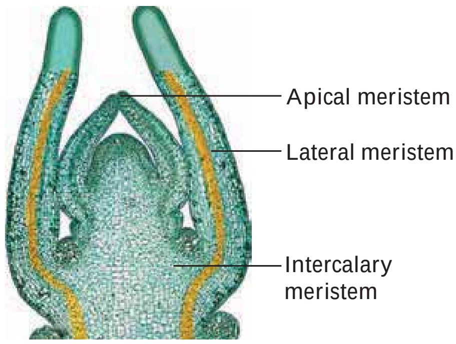
1. Meristematic tissue
2. Permanent tissue

In this unit, we will study meristematic tissue only.

1. Meristematic tissue

The plant tissue in which cells are undifferentiated and divide actively is called the meristematic tissue. In this tissue, the cells are thin-walled and divide actively to from new cells. The cells of this tissue are small with a distinct nucleus and dense cytoplasm. The cells are compactly packed without intercellular spaces.

Fig. 17.10



Meristematic tissue

Meristematic tissues are of three types on the basis of location. They are:

i. Apical meristem
ii. Lateral meristem
iii. Intercalary meristem

i. Apical meristem

The meristematic tissue which is found in the tip of roots, stem and leaves is called the apical meristem. It helps in an axial growth of plants.

ii. Lateral meristem

The meristematic tissue which is found along the side of stems and roots is called the lateral meristem. It increases the girth (thickness) of the plant.

iii. Intercalary meristem

The meristematic tissue which is located at the base of a leaf and fruit is called the intercalary meristem. It increases the length of internodes.

Differences between Epithelial tissue and Meristematic tissue

Epithelial tissue	Meristematic tissue
1. Epithelial tissue is a thin, protective tissue composed of one or more layer of cells covering the external surface and internal body organs.	1. Meristematic tissue is made up of simple undifferentiated cells which continue to divide actively to produce new cells.
2. On the basis of structure and organization of the component cells, epithelial tissues are five types.	2. On the basis of location, meristematic tissues are of three types.
3. It is found in animals body.	3. It is found in plants.

Organ

The group of tissues in animals or plants working together to perform a certain function is called an organ. Eye, ear, nose, heart, lung, kidney, etc. are the organs of animals. Similarly, flower, fruit, root, stem, leaf, etc. are the organs of plants. An organ has a complex structure. The heart pumps blood to different parts of the body. The kidney filters blood and throws waste products in the forms of urine. The liver is the organ in the human body that performs various functions.

System

The group of organs working together to perform a specific function is called the system. The circulatory system, respiratory system, urinary system, digestive system, etc. are the examples of systems in the human body. There are nine system in human body. The different organs work together in a system to perform a certain function. For example, organs like nose, pharynx, wind pipe, lungs, etc. are found in the respiratory system.

Various systems and organs present in them are given below with their functions:

S.N.	System	Organs	Major functions
1.	Skeletal system	Bones and cartilage	To form internal framework of body, helps in locomotion
2.	Muscular system	Various types of muscles	To help in movement, to give shape
3.	Digestive system	Mouth, food pipe, stomach, intestine and glands	Digestion and absorption
4.	Respiratory system	Nose, larynx, lungs	To help in exchange of oxygen and carbon dioxide
5.	Blood circulatory system	Heart, blood and blood vessels	To circulate blood to different body parts
6.	Excretory system	Kidney, liver, urinary bladder	To excrete various waste products
7.	Glandular system	Various endocrine and exocrine glands	To secrete hormones and enzymes
8.	Nervous system	Brain, spinal cord and nerves	To control various activities of body
9.	Reproductive system	Testes, ovaries, penis, vagina	To help in sexual reproduction

Interrelationship among Cells, Tissues, Organs and System in the Human Body

In the human body, there is a close relationship between cells, tissues, organs and systems. The smallest unit of a human body are cells. Cells of the same origin combine together and form a tissue. So, a tissue consists of many cells. Different tissues work together and form an organ to perform a specific function. Various organs work together to perform a certain function. This group of organs is called the system. Various systems work together and form a body. It shows that there is a close relationship among cells, tissues, organ and systems in a body.

Cell + Cell → Tissue

Tissue + Tissue → Organ

Organ + Organ → System

System + System → Body

∴ Cells + Tissues + Organs + Systems → Body

Activity 2

Visit a nearby butcher's shop. Request the butcher to show different organs of a goat.

Key Concepts

1. A cell is defined as the basic structural functional unit of a life.
2. A tissue can be defined as the group of cells having a common origin and performing a similar function. The thin and protective tissue that covers the external surface and internal body organs is called an epithelial tissue.
3. The epithelial tissue having a single layered cubical cells is called the cubical epithelium.
4. The epithelial tissue having a single-layered column like elongated cells is called the columnar epithelium.
5. The modified columnar epithelium that secretes hormones and enzymes is called the glandular epithelium.
6. The plant tissue in which cells are undifferentiated and divide actively is called the meristematic tissue.
7. The group of tissues in animals or plants working together to perform a certain function is called an organ.
8. The group of organs working together to perform a specific function is called the system.
9. In the human body, there is a close relationship between cells, tissues, organs and systems.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. A cell is the basic, structural and functional unit of a life. ☐

b. Animal tissues are of three types. ☐

c. An epithelium tissue forms the protective layers. ☐

d. An apical meristem increases the girth of plants. ☐

e. A system is the group of organs working together to perform a certain function. ☐

2. Fill in the blanks using appropriate words.

a. A cell is made of life giving substance called ....

b. The lowermost layer of an epithelial tissue is attached to ....

c. Plant tissues are of two types. They are .... and ....

d. .... is the group of tissues working together.

e. .... system helps in digestion and absorption.

3. Tick (√) the most appropriate answer from the given alternatives.

a. .... is the basic, structural and functional unit of a life.

☐ cell ☐ tissue ☐ organ ☐ system

b. The tissue that forms the covering layer of the body is called .... tissue.

☐ muscular ☐ epithelial ☐ glandular ☐ connective

c. .... is the organ that performs many functions in human body.

☐ kidney ☐ heart ☐ liver ☐ lung

d. .... epithelium secretes hormones and enzymes.

☐ pavement ☐ cubical ☐ columnar ☐ glandular

4. Answer the following questions.

a. What is a cell? Who discovered the cell?
b. What is a tissue? Give any two examples.
c. Name four types of tissues found in animals.
d. What is an epithelial tissue? Write its any three characteristics and two functions.
e. What is a pavement epithelium? Write its location and functions.
f. What is a cubical epithelium? Write its location and functions.
g. What is a columnar epithelium? Write its location and functions.
h. What is a glandular epithelium? Write its location and functions.
i. Name two types of plant tissues.

j. What is meristematic tissue? Write its types.

k. Draw a neat and labelled figure of meristematic tissue.

l. Define organ and system with any two examples of each.

5. Write down the interrelationship among cells, tissues, organs and systems in human body.

6. Draw a neat and labelled figure of:

a. Plant cell

b. Pavement epithelium

c. Columnar epithelium

d. Cubical epithelium

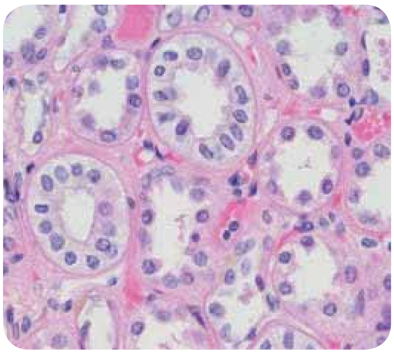
7. Differentiate between:

a. Pavement epithelium and Cubical epithelium

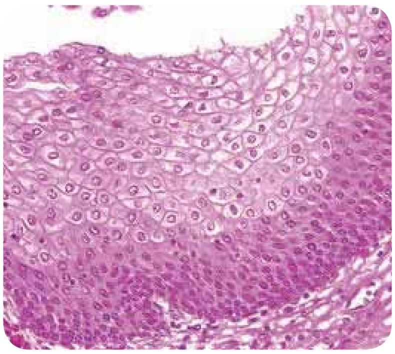
b. Epithelial tissue and Meristematic tissue

8. Name the tissues shown in the given figures.

a.



b.



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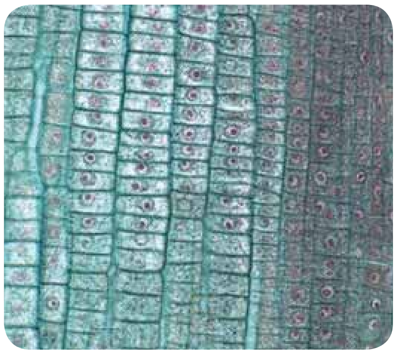


9. A plant does not grow when its apical meristem is cut. Justify this statement.

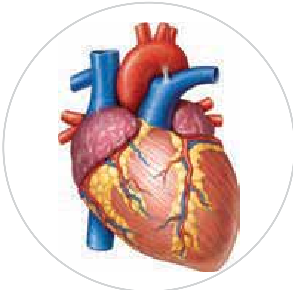
UNIT 1

Life Processes

Weighting Distribution (Approximate)	Teaching periods : 10	Marks (in %): 2

Before You Begin

Various activities like respiration, digestion, excretion, circulation, movement, reproduction, etc. are performed by living organisms throughout their life. These activities are called life processes. Life processes can be defined as activities carried out by living organisms which are necessary to maintain and continue life. Living organisms cannot survive without life processes. In this unit, we will study various life processes that occur in living beings.



Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce life processes with examples.

ii. explain asexual and sexual reproduction that occur in plants and animals.

iii. introduce blood circulatory system in the human body and explain the process of blood circulation.

iv. introduce photosynthesis that occurs in plants and perform experiments based on photosynthesis.

Syllabus

- Introduction to life processes
- Reproduction and its types
- Various methods of asexual reproduction
- Sexual reproduction in plants and animals
- Blood circulatory system in human body - blood, heart and blood vessels
- Process of blood circulation
- Photosynthesis
- Iodine-starch test

Glossary: A dictionary of scientific/technical terms

reproduction	:	a biological process by which living beings produce their ownkinds
fission	:	a process in which a unicellular organism divides into two or more daughter organisms
sporulation	:	a process by which an organism reproduces through spores
regeneration	:	a process of regaining lost body parts
gamete	:	a male or female sex cell
photosynthesis	:	a process of making food by green plants

Life Processes

A. Reproduction

Living organisms on the earth have a certain life span. They cannot survive forever and die after a certain period of time. Therefore, living beings reproduce their own kinds to continue their races on the earth. This process is called reproduction. So, reproduction is a biological process in which living beings produce their ownkinds asexually or sexually.

Fig. 18.1 *Dog with puppies*

Types of Reproduction

1. Asexual reproduction
2. Sexual reproduction

1. Asexual reproduction

A reproduction which takes place without the fusion of a male gamete and a female gamete is called asexual reproduction. This process is common in primitive plants and animals. In asexual reproduction, only one organism can reproduce and the offspring produced are exactly identical to their parent. It is an easy and fast method of reproduction. Examples: budding in hydra, fission in amoeba, sporulation in mucor, etc.

Types of Asexual reproduction

i. Fission	ii. Budding
iii. Sporulation	iv. Fragmentation
v. Regeneration	vi. Vegetative propagation

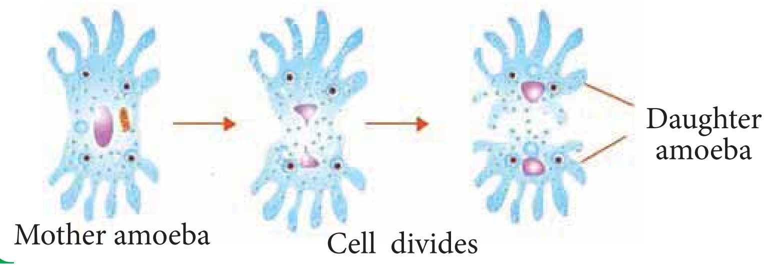
i. Fission

A fission is the method of asexual reproduction in which a unicelluālr organism divides into two or more daughter organisms. This method is common in amoeba, paramecium, bacteria, plasmodium, euglena, etc. A fission is of two types, viz. binary fission and multiple fission.

Binary fission

The method of asexual reproduction in which one unicellular organism divides into two daughter organisms is called a binary fission. Plants like bacteria, diatoms and animals like amoeba, paramecium reproduce by this method.

Fig. 18.2

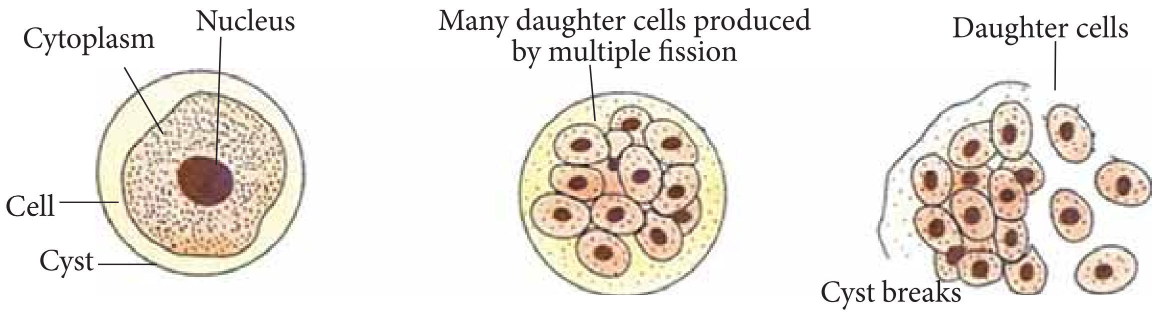


Binary fission in amoeba

Multiple fission

The method of asexual reproduction in which one unicellular organism divides into more than two daughter organisms is called a multiple fission. It is common in Plasmodium, Chlamydomonas, amoeba, etc.

Fig. 18.3



Multiple fission in Plasmodium

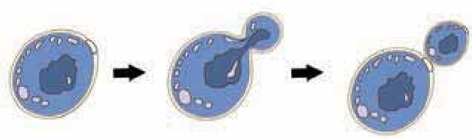
Differences between Binary fission and Multiple fission

Binary fission	Multiple fission
1. The process in which one parent body divides into only two daughter organisms is called binary fission.	1. The process in which ore parent body divides into more than two daughter organisms is called multiple fission.
2. It is common in amoeba, bacteria, etc.	2. It is common in Plasmodium, Chlamydomonas, etc.
3. It is found in animals body.	3. It is found in plants.

ii. Budding

The method of asexual reproduction which takes place with the help of a bud is called budding. Plants like yeast and animals like hydra reproduce asexually by this method.

Fig. 18.4

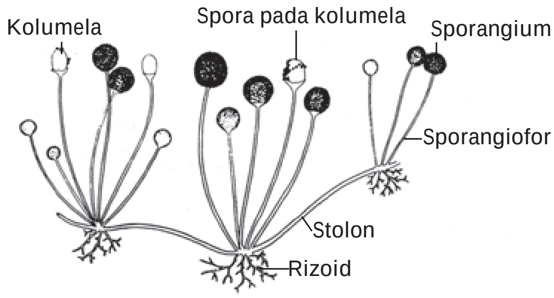


Budding in yeast

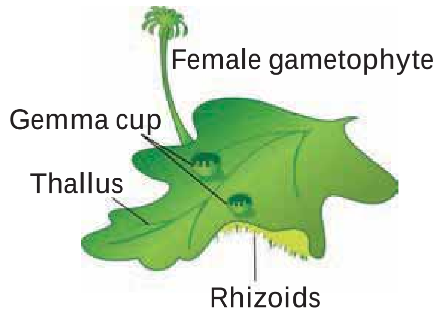
iii. Sporulation

The method of asexual reproduction which takes place by means of spores is called sporulation. This method is common in mucor, marchantia, moss, mushroom, fern, etc. In sporulation, spores are formed inside sporangia. At maturity, sporangia burst and release spores on soil. These spores germinate and form new plants.

Fig. 18.5



Sporulation in mucor

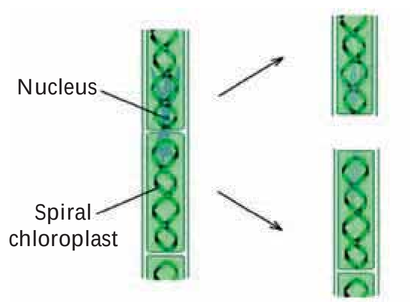


Sporulation in liverwort

iv. Fragmentation

A fragmentation is the method of asexual reproduction in which a multicellular organism splits into two or more fragments and each fragment develops into a new organism. Spirogyra reproduces by this method.

Fig. 18.6

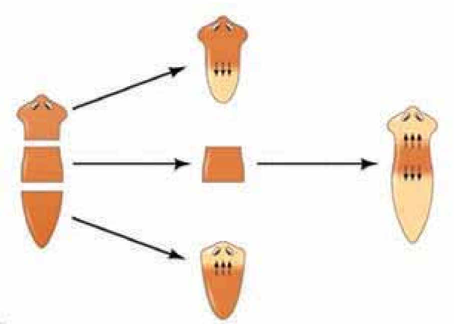


Fragmentation in spirogyra

v. Regeneration

A regeneration is the method of asexual reproduction in which each fragment of an organism regains its lost body parts and develops into a complete organism.

Fig. 18.7



Regeneration in Planaria

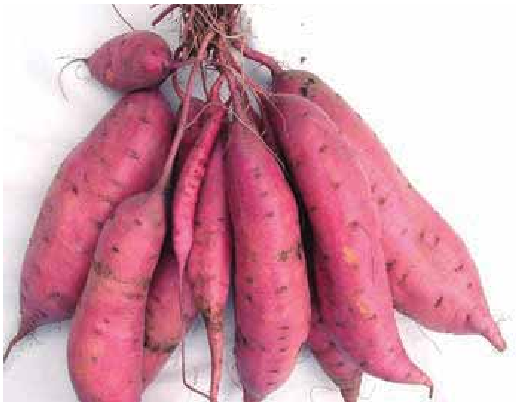
vi. Vegetative propagation

A vegetative propagation is the method of asexual reproduction in which new plants are produced by vegetative parts like roots, stem and leaf. This process occurs in some flowering plants.

Flowering plants like sweet potato, dahlia, mint, etc. reproduce asexually by means of roots.

Fig. 18.8

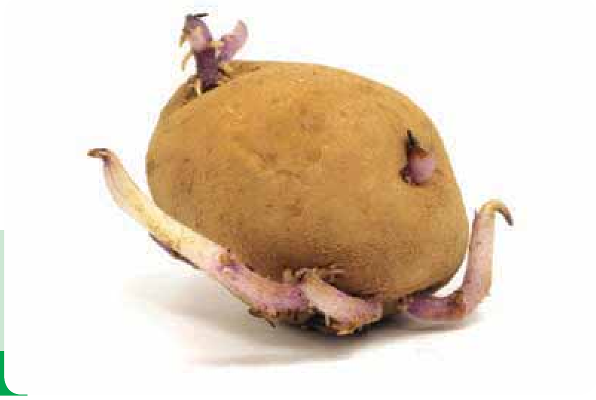
Roots of dahlia



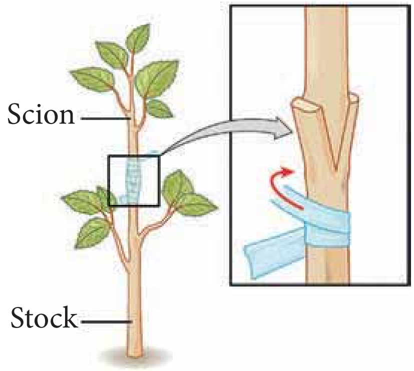
Roots of sweet potato

Flowering plants like potato, rose, sugarcane, bamboo, banana, ginger, etc. reproduce asexually by stem.

Fig. 18.9



Buds in potato



Reproduction in rose by stem

Flowering plants like *Bryophyllum*, Begonia, etc. reproduce asexually by leaf.

Fig. 18.10

Reproduction in Bryophyllum by leaf

Reproduction in Begonia by leaf

Advantages of asexual reproduction

1. It is an easy and a fast method of reproduction.
2. Only one organism can reproduce by this method.

3. The offspring produced by this method are genetically identical to their parents.
4. The plants which do not produce viable seeds like potato, rose, sugarcane, etc. can easily be propagated by this method.

2. Sexual Reproduction

The method of reproduction which takes place by the fusion of a male gamete and a female gamete is called sexual reproduction. Both male and female organisms are involved in sexual reproduction. Flowering plants and developed animals reproduce by sexual reproduction. Some animals produce only one types of gametes (either male or female). These animals are called unisexual animals. Examples: human, birds, reptiles, amphibians, fishes, etc. Some animals produce both male and female gametes in the same body. These animals are called bisexual or hermaphrodite animals. Examples: hydra, tapeworm, liverfluke, etc. Similarly, flowering plants also have unisexual and bisexual flowers. Pumpkin, cucumber, papaya, gourd, etc. produce unisexual flowers whereas mustard, pea, tomato, orange, etc. produce bixsexual flowers.

Sexual Reproduction in Plants

Most flowering plants reproduce sexually by means of seeds. A flower is the sexually reproductive part of flowering plants. A bisexual flower consists of four whorls, viz. calyx, corolla, androecium and gynoecium.

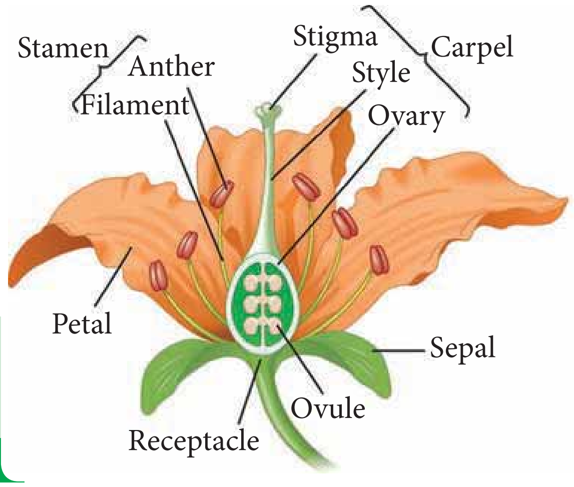


Fig. 18.11 *Bisexual flower*

At maturity, anther produces pollen grains and ovary produces female gametes. The anthers begin to dry and burst open releasing pollen grains. These pollen grains are transferred to the stigma of a flower by various agents like wind, insects, water, etc. This process is called pollination. It may be self-pollination and cross-pollination. After pollination, fertilization, i.e. fusion of male gamete and female gamete, takes place which forms a zygote. After fertilization, the ovule develops into seed and ovary into the fruit. The seed grows into a new plant on favourable condition.

In this way, flowering plants reproduce by means of seeds.

Activity 1

- Collect different types of flowers from the school garden.
- Identify calyx, corolla, androecium and gynoecium in these flowers.
- Also, separate unisexual and bisexual flowers.

Sexual Reproduction in Animals

Vertebrate animals reproduce sexually by means of gametes. However, invertebrates like arthropods, molluscs, annelids, round worms, flatworms, etc. reproduce by sexual method. Male organisms produce male gametes and female organisms produce female gametes. On favourable condition, fusion of a male gamete and female gamete takes place to form a zygote.

Do You Know

- The fusion of a male gamete and a female gamete to form a zygote is called fertilization. It is of two types, viz. external fertilization and internal fertilization.
- The process by which gamete are formed is called gametogenesis.

This process is called fertilization. In animals, fertilization is of two types, i.e. external fertilization and internal fertilization. If the fusion of a male gamete and a female gamete takes place outside the body of a female organism, it is called external fertilization. It occurs in fishes and frogs. If the fusion of a male gamete and female gamete takes place inside the body of a female organism, it is called internal fertilization. It occurs in insects, reptiles, birds and mammals.

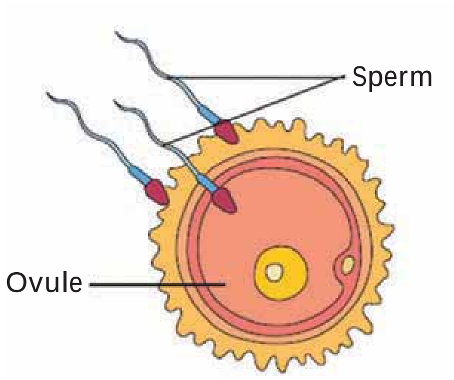


Fig. 18.12 *Fertilization in animals*

After formation of a zygote, it divides repeatedly and forms embryo which finally develops into a new organism. In this way, animals reproduce by sexual method.

Advantages of Sexual Reproduction

1. It gives continuity to the generations of a species.
2. It brings out variation among the members of the same species.
3. It helps in evolution of organisms.

Differences between Asexual reproduction and Sexual reproduction

Asexual reproduction	Sexual reproduction
1. The reproduction which takes place without the fusion of a male gamete and a female gamete is called asexual reproduction.	1. The reproduction which takes place by the fusion of a male gamete and a female gamete is called sexual reproduction.
2. This process is common in primitive plants and animals.	2. This process is common in higher plants and animals.

B. Blood Circulatory system in Human Body

The system formed by heart, blood and blood vessels which transports various materials from one part of the body to another is called the blood circulatory system.

The blood circulatory system transports digested food, oxygen, etc. to various parts of the body. It also transports waste materials like carbon dioxide, urea, uric acid, etc. to the excretory organs for their removal from the body.

The human blood circulatory system consists of three main parts. They are: (i) Blood, (ii) Heart and (iii) Blood vessels.

i. Blood

The blood is a red fluid connective tissue. It consists of plasma (55%) and blood corpuscles (45%).

Plasma

A plasma is a straw-coloured liquid which occupies 55% of the blood volume. It contains about 90% water, 8% proteins and 2% other dissolved substances like carbohydrates, respiratory gases, waste products, etc.

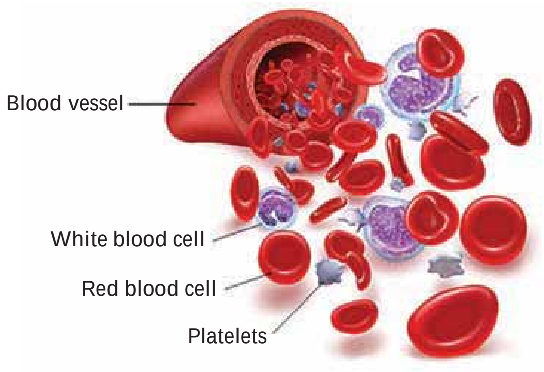


Fig. 18.13 *Fertilization in animals*

Functions of plasma

1. It transports digested food and hormones to different parts of the body.
2. It transports waste materials like urea, carbon dioxide, etc. for their removal from the body.
3. It regulates body temperature and amount of water and minerals in the body.

Blood corpuscles

The blood corpuscles are solid particles that remain immersed in plasma. They occupy 45% of the blood volume. There are three types of blood corpuscles. They are (i) Red blood cells, (ii) White blood cells and (iii) Platelets.

i. Red blood cells (RBCs)

The red blood cells or erythrocytes are red-coloured blood cells having biconcave shape. They do not have nucleus. They appear red due to the presence of an iron-containing pigment called haemoglobin. They are smaller than white blood cells and larger than platelets.

The red blood cells are produced in bone marrow, live for about 120 days and also are destroyed in liver and spleen.

The red blood cells absorb oxygen from lungs and transport to various tissues. Similarly, they transport carbon dioxide from various tissues to the lungs.

Do You Know

- A person suffers from anaemia due to lack of RBCs or haemoglobin in blood.
- A person suffers from blood cancer leukaemia due to enormous increase in the number of WBCs in the blood.

ii. White blood cells (WBCs)

The white blood cells (leucocytes) are colourless with irregular blood cells having a nucleus. They are the largest blood cells. They are produced in bone marrow and lymph nodes. They live for a few hours to few days. They are destroyed in liver, spleen and at the site of infection.

WBCs fight against micro-organisms and protect us from various diseases.

iii. Platelets

The platelets or thrombocytes are colourless, oval or round blood cells without nucleus. They are the smallest blood cells. They are formed in bone marrow, live for 2 to 3 days and are destroyed in the spleen.

The platelets play an important role in clotting of blood and prevent the loss of blood from cuts or wounds.

Differences between RBCs and WBCs

RBCs	WBCs
1. RBCs don't have nucleus.	1. WBCs have nucleus.
2. Haemoglobin is present.	2. Haemoglobin is absent.
3. They are biconcave in shape.	3. They are irregular in shape.
4. They transport oxygen and carbon dioxide.	4. They fight against microorganisms.

Heart

The heart is a powerful and hollow organ made of cardiac muscle. It is conical in shape and is about the size of the fist of the individual. The heart is located near the middle of the thoracic cavity between two lungs. About two-third of the heart is located on the left side and one-third is located on the right side of the thoracic cavity. The average weight of the heart is about 300 grams in adults.

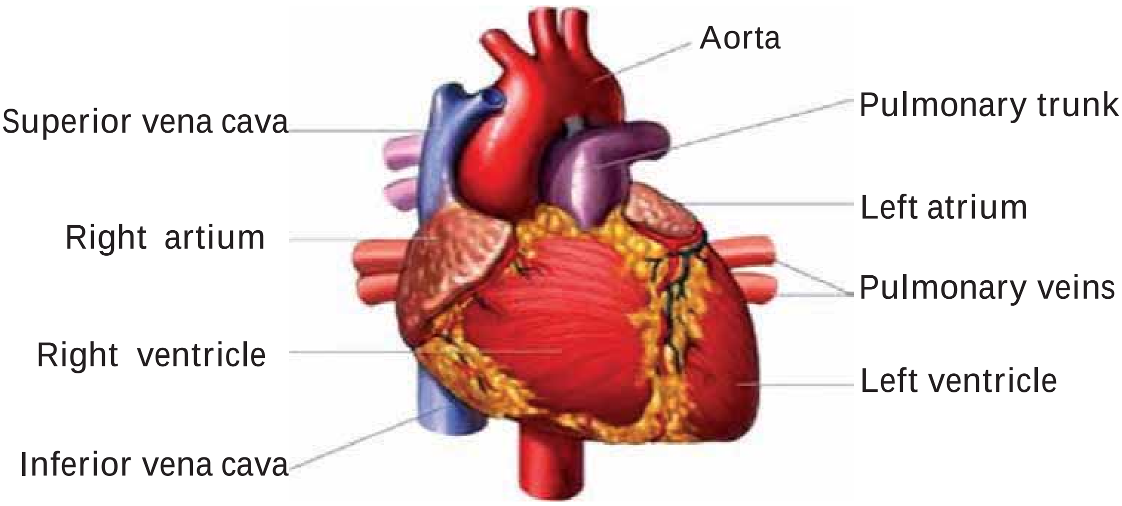


Fig. 18.14 *External morphology of human heart*

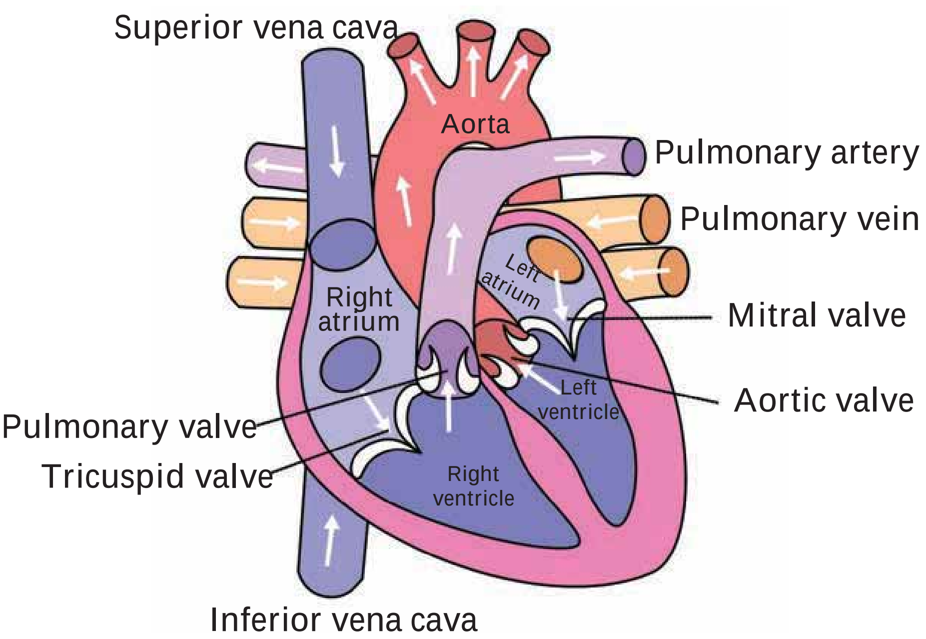


Fig. 18.15 *Internal morphology of human heart*

The human heart is surrounded by a double-layered membrane called the pericardium. The space between two layers of pericardium is filled with a slippery fluid called the pericardial fluid. This fluid enables the heart contract smoothly and also protects the heart from mechanical injury.

The human heart consists of four complete chambers, viz. two upper chambers called auricles and two lower chambers called ventricles. The auricles are separated into right and left auricles by a muscular septum. Similarly, the ventricles are divided into right and left ventricle by a muscular septum. The auricles are thin-walled small chambers whereas ventricles are thick-walled large chambers.

The wall of the right ventricle is thicker than that of the auricles as it pumps blood to a much farther distance to the lungs for purification. Similarly, the wall of left ventricle is the thickest of all as it pumps blood to different parts of the body.

The various blood vessels enter and leave the heart. Superior vena cava and inferior vena cava are connected to the right ventricle whereas four pulmonary veins are connected to the left auricle. The pulmonary artery originates from the right ventricle and aorta is originated from the left ventricle.

Do You Know

Ventricles of the heart pump blood to different parts of body. For this, a large force is required. Therefore, the wall of ventricle is thicker than that of auricle to exert the force required for pumping blood.

Four different types of valves are present in the human heart. They are aortic valve, pulmonary valve, tricuspid valve and bicuspid or mitral valve. The aortic valve is located at the base of aorta inside the heart. It regulates the flow of blood from left ventricle to different parts of the body and prevents the backflow of blood. The pulmonary valve is located at the base of pulmonary artery. It regulates the flow of blood from right ventricle to the lungs and prevents the back flow of blood. The tricuspid valve is located between the right auricle and the right ventricle. It has three muscular flaps or cusps. It regulates the flow of blood from the right auricle to the right ventricle and prevents the backflow of blood. Similarly, bicuspid or mitral valve is located between the left auricle and the left ventricle. It has two muscular flaps or cusps. It regulates the flow of blood from the left auricle to the left ventricle and prevents the backflow of blood.

Differences between Auricles and Ventricles

Auricles	Ventricles
1. Auricles are thin walled upper chambers of heart.	1. Ventricles are thick walled lower chambers of heart.
2. Auricles receive blood from different parts of body.	2. Ventricles pump blood to various parts of body.

Differences between Tricuspid valve and Mitral valve

Tricuspid valve	Mitral valve
1. The tricuspid valve guards the right auriculo ventricular aperture (i.e. the opening of the right auricle into the right ventricle).	1. The mitral valve (or biscupid valve) guards the opening of the left auricle into the left ventricle.
2. The valve consists of three membranous flaps or cusps.	2. This valve consists of two membranous flaps cusps.

Blood vessels

The muscular tubes or pipes through which blood flows are called blood vessels. There are three types of blood vessels. They are (i) Arteries, (ii) Veins and (iii) Capillaries.

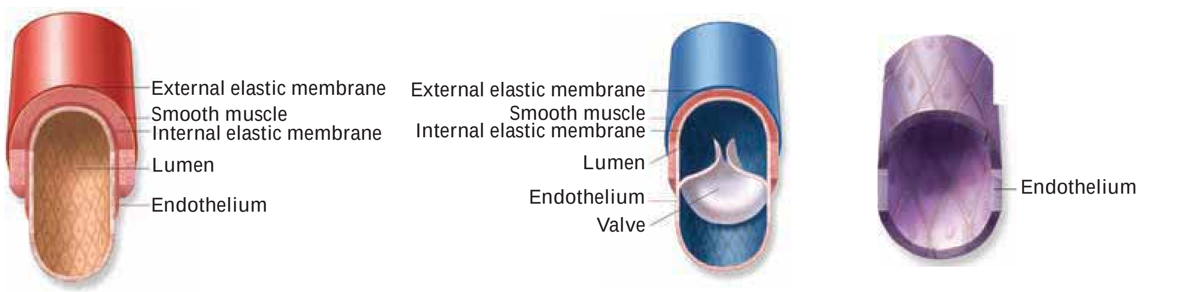
i. Arteries

The thick-walled blood vessels that carry blood away from the heart are called arteries. They are deep-seated inside the muscles. All arteries carry pure blood except the pulmonary artery. Inside the arteries, blood flows with a high speed and under high pressure. Therefore, their wall is thicker than that of veins. The branches of arteries are called the arterioles. An artery has a narrow lumen and a thick wall. Valves are absent in arteries. Examples: aorta, pulmonary artery.

Do You Know

Arteries carry blood away from the heart to different parts of the body which flows with high speed and under high pressure. For this, a great force is required, which is provided by its thick wall but veins stop the reverse flow of blood as the blood moves against the gravity and is under low pressure. For this, a greater force is not required. So, the wall of artery is thicker than that of vein.

Fig. 18.16



Structure of an artery *Structure of an vein* *Structure of a capillary*

ii. Veins

The thin-walled blood vessels that carry blood towards the heart are called veins. They are situated on the surface of muscles. All veins carry impure blood except pulmonary veins. Inside the veins, blood flows with a low speed and under low pressure. Therefore, veins have a thin wall. The branches of veins are called venules. A vein has a wide lumen and a thin wall. The valves are present in the veins to prevent the reverse flow of blood. Examples: vena cava, pulmonary veins.

iii. Capillaries

The capillaries are extremely narrow and microscopic blood vessels. They connect the arterioles to the venules and can penetrate every part of the body. The wall of the capillary consists of a single layer of cells. The capillaries help in exchange of materials between the blood and body cells.

Differences between Arteries and Veins

Arteries		Veins	
1.	Arteries are thick-walled blood vessels.	1.	Veins are thin-walled blood vessels.
2.	They carry blood away from the heart.	2.	They carry blood towards the heart.
3.	Valves are absent.	3.	Valves are present.
4.	They have a narrow lumen.	4.	They have a wide lumen.

Process of Blood Circulation in the Human Body

In a human body, blood flows twice through the heart before the pure blood is supplied to various parts of the body. Superior vena cava and inferior vena cava collect impure blood from different body parts to the right auricle. The right auricle passes impure blood to the right ventricle. When the right ventricle contracts, impure blood is supplied to the lungs through the pulmonary artery. The impure blood combines with oxygen and becomes pure (oxygenated). Then the pure blood from the lungs is brought to the left auricle through the pulmonary veins.

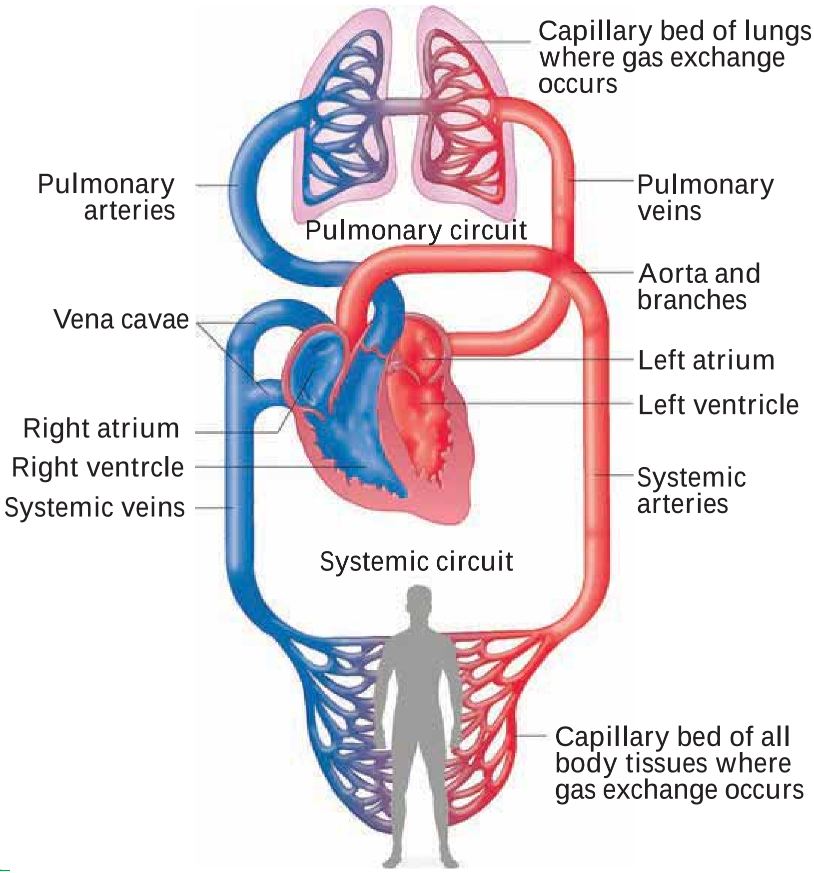


Fig. 18.17 *Schematic figure of blood cirulation in human body*

The left auricle contracts and passes pure blood to the left ventricle. The left ventricle contracts and pumps pure blood to the aorta. The aorta supplies pure blood to various body parts through the arteries, arterioles and capillaries.

In this way, the circulation of blood takes place in a human body.

Heart beat

The heart beat is the rhythmic beat which is produced due to contraction and relaxation of the heart muscles. The average heart beat rate of a healthy young person is about 72 times per minute. The rate of heart beat increases with tension, physical exercise, emotion, fear, fever, etc. The rate of the heart beat may vary with age, sex and condition of the body.

C. Photosynthesis

The process of making food by green plants in the presence of sunlight is called photosynthesis. Green plants use water and carbon dioxide gas in the presence of sunlight to prepare their food, i.e. starch. The chemical equation involved in photosynthesis is given below.

Do You Know

Green plants are called autotrophs because they can prepare their own food by photosynthesis.

$$\text{Carbon dioxide + water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Glucose (starch) + Oxygen}$$

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

The process of photosynthesis takes place in the leaves of plants. Green plants can prepare their own food due to the presence of chlorophyll as chlorophyll traps the sunlight. The roots of plants absorb water and minerals from roots and xylem tissue conducts water and minerals to the leaves. Leaves absorb carbon dioxide present in the atmosphere through stomata present on leaves. During photosynthesis, green plants use carbon dioxide gas and release oxygen gas.

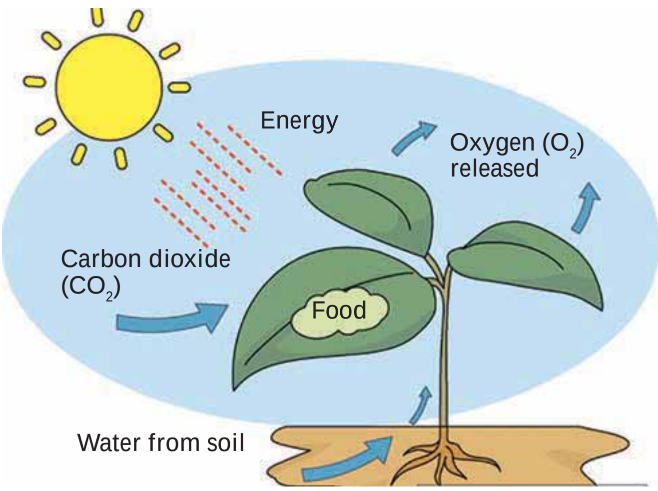


Fig. 18.18

The materials required for photosynthesis are as follows:

i. Sunlight
ii. Carbon dioxide
iii. Chlorophyll
iv. Water and minerals

Experiments on Photosynthesis

Experiment: 1

Iodine-starch test

To test the presence of starch in green leaf [Iodine -starch Test]

Requirements

Iodine solution, beaker, burner, a fresh green leaf, petridish, alcohol, test tube, foreceps, stand, water

Procedure

- Go to a sunny place and pluck a fresh green leaf from a plant.
- Take a test tube and put some alcohol in it. Now, immerse the leaf in the alcohol.
- Place the test tube in a beaker containing water.
- Heat the water in the beaker with a burner till the alcohol in the test tube boils.

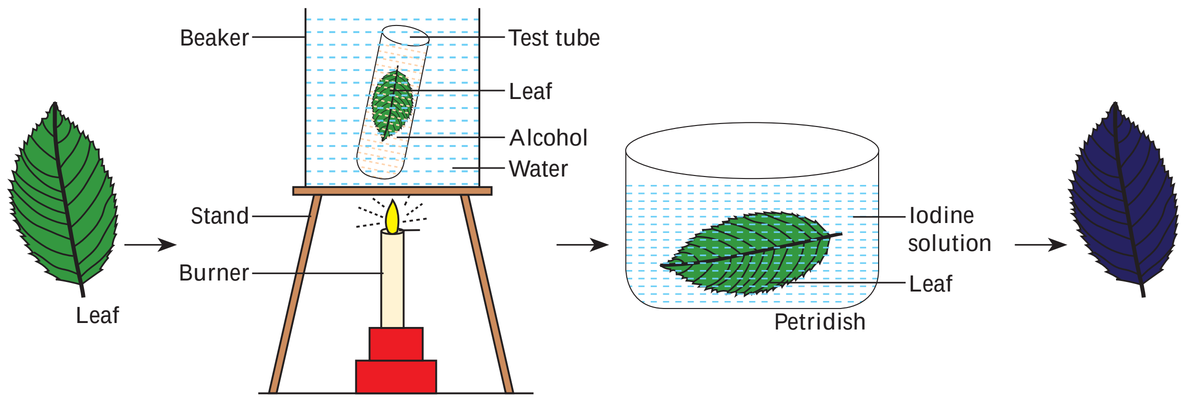


Fig. 18.19

- As the alcohol boils, the chlorophyll dissolves in alcohol and the leaf becomes pale.
- Remove the leaf from the test tube and wash it with warm water.
- Now, put the leaf in a petri dish and put a few drops of iodine and observe the change in colour.

Observation

In iodine solution, the leaf changes into blue-black due to the presence of starch.

Conclusion

This experiment proves that starch is produced during photosynthesis.

Experiment: 2

To demonstrate that sunlight is necessary for photosynthesis

Requirements

A potted plant with large leaves, materials for iodine-starch test, black paper, cello tape

Procedure

- Take a potted plant with large leaves and keep it in a dark room for 3-4 days to make the leaf starch free due to absence of photosynthesis.
- Now, select a leaf and cover its both sides with a black paper and cello tape.
- Keep the plant in the sunlight for 4-5 hours.
- After 4-5 hours, pluck the covered leaf and remove the tape.
- Perform iodine-starch test of the experimental leaf and observe the change in colour.

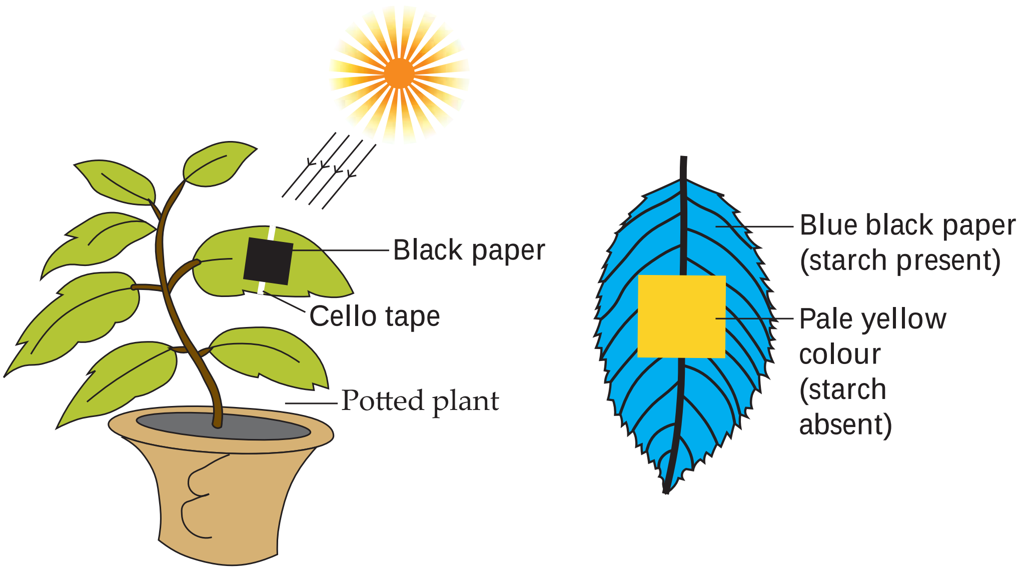


Fig. 18.20

Observation

The uncovered portion of the leaf turns blue-black in iodine solution which shows the presence of the starch whereas the covered portion of the leaf remains pale yellow which shows the absence of starch as it does not get the sunlight.

Conclusion

This experiment shows that sunlight is essential for photosynthesis.

Experiment: 3

To prove that carbon dioxide is essential for photosynthesis

Requirements

A potted plant with broad leaves, materials for iodine-starch test, a bottle with a wide mouth, cork, potassium hydroxide solution

Procedure

- Take a potted plant with broad leaves and keep it in a dark room for 3-4 days to make it starch free.
- Take a bottle with a wide mouth and keep some KOH solution as it absorbs carbon dioxide present in the bottle.
- Insert half-portion of the leaf inside the bottle with the help of a cork as shown in the figure. Make the lid of the bottle air tight.

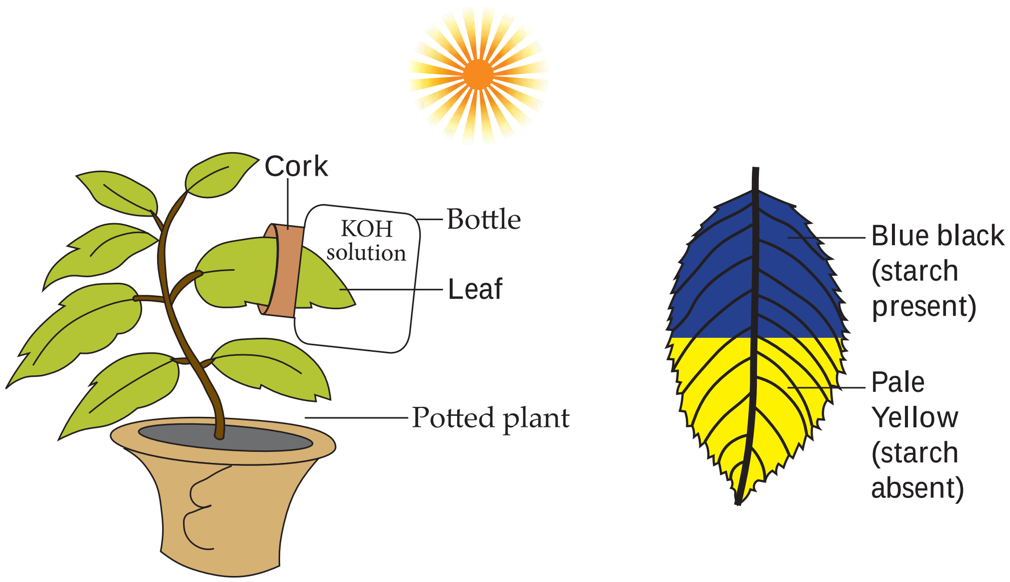


Fig. 18.21

- Now, leave the potted plant in the sunny place for 5-6 hours.
- Remove the experimental leaf and carry out iodine-starch test. Observe the change in colour of the leaf.

Observation

The portion of the experimental leaf that remains outside the bottle changes into blue-black as it gets carbon dioxide. But the portion of the leaf inside the bottle does not show the presence of starch as it does not get carbon dioxide. Please note that KOH solution absorbs carbon dioxide present in the bottle.

Conclusion

This experiment shows that carbon dioxide is essential for photosynthesis.

Experiment: 4

To prove that oxygen is released during photosynthesis

Requirements

Beaker, test tube glass funnel, stand, water, fresh twigs of hydrilla, matchbox, sodium bicarbonate.

Procedure

- Take a beaker and fill it with water.
- Take a few twigs of fresh hydrilla and cover the twigs with a glass funnel and arrange the materials as shown in the given figure. Keep some sodium bicarbonate in the beaker as the source of carbon dioxide.
- Leave the apparatus in a sunny place for 3-4 hours.

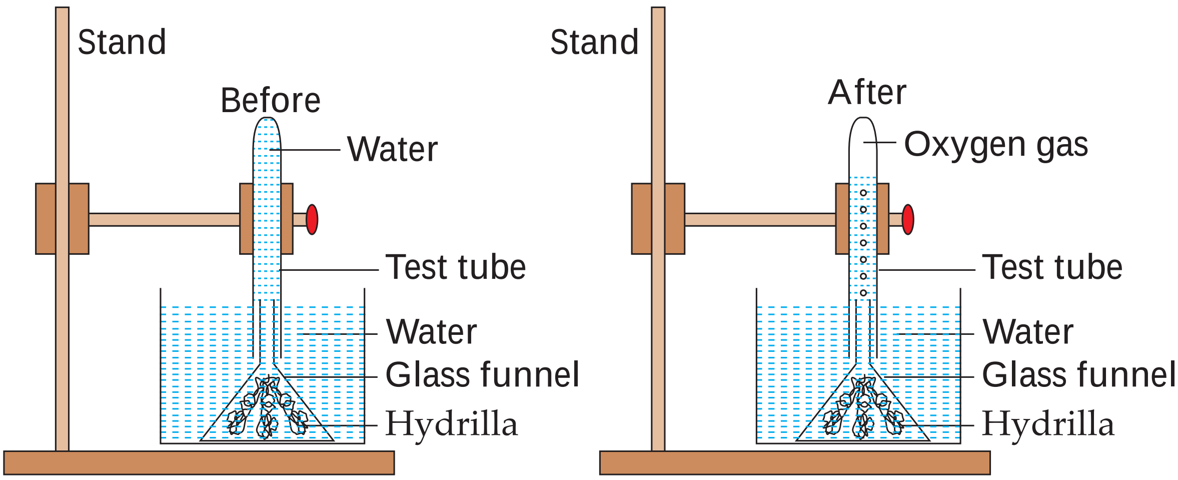


Fig. 18.22

Observation

After a few minutes, a stream of gas bubbles can be seen. This gas gets collected in the test tube by displacing water downwards.

When a burning match stick is inserted inside the test tube, it burns with a brighter flame. It shows that the gas produced is oxygen.

Conclusion

This experiment shows that oxygen is released during photosynthesis.

Project work

- Select two potted plants of the same size. Keep one of them in a dark room and another in open place.
- Observe both plants after one week. What do you observe? What can you conclude from this activity?

Key Concepts

1. Life processes can be defined as activities carried out by living organisms which are necessary to maintain and continue life.
2. Reproduction is the biological process in which living beings produce their ownkinds asexually or sexually.
3. The reproduction which takes place without the fusion of a male gamete and a female gamete is called asexual reproduction.
4. A fission is the method of asexual reproduction in which a unicellualr organism divides into two or more daughter organisms.
5. The method of asexual reproduction which takes place with the help of a bud is called budding.
6. The method of asexual reproduction which takes place by means of spores is called sporulation.
7. A fragmentation is the method of asexual reproduction in which a multicellular organism splits into two or more fragments.
8. Regeneration is the method of asexual reproduction in which each fragments of an organism regains its lost body parts and develops into a complete organisms.
9. A vegetative propagation is the method of asexual reproduction in which new plants are produced by vegetative parts like roots, stems and leaves.
10. The method of reproduction which takes place by the fusion of a male gamete and a female gamete is called sexual reproduction.
11. A bisexual flower consists of four whorls, viz. calyx, corolla, androecium and gynoecium.
12. The fusion of a male gamete and a female gamete to form a zygote is called fertilization.
13. The process by which gamete are formed is called gametogenesis.
14. The system formed by the heart, blood and blood vessels which transports various materials from one part of a body to another is called the blood circulatory system.
15. The blood corpuscles are solid particles that remain immersed in plasma.
16. The red blood cells or erythrocyes are red-coloured blood cells having biconcave shape.
17. The white blood cells (leucocytes) are colourless with irregular blood cells having a nucleus.
18. The platelets or thrombocytes are colourless, oval or round blood cells without nucleus.
19. The heart is located near the middle of the thoracic cavity between the two lungs.

20. The muscular tubes or pipes through which blood flows are called blood vessels.
21. The thick-walled blood vessels that carry blood away from the heart are called arteries
22. The thin-walled blood vessels that carry blood towards the heart are called veins.
23. The capillaries are extremely narrow and microscope blood vessels.
24. The heart beat is the rhythmic beat which is produced due to contraction and relaxation of the heart muscles.
25. The process of making food by green plants in the presence of sunlight is called photosynthesis.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Digestion, respiration and excretion are the examples of life processes. ☐

b. Amoeba reproduces asexually by binary fission. ☐

c. Androecium is the female organ of a flower. ☐

d. WBCs transport oxygen and carbon dixoide. ☐

e. Green plants release oxygen during photosynthesis. ☐

2. Fill in the blanks using appropriate words.

a. Moss reproduces asexually by ....

b. .... reproduces asexually by leaf.

c. The plasma occupies .... of blood by volume.

d. .... supply pure blood from lungs to the left auricle.

e. The process of making food by green plants is called ....

3. Tick (√) the most appropriate answer from the given alternatives.

a. Which of the given animals reproduces by budding?

☐ amoeba ☐ hydra ☐ yeast ☐ moss

b. Which of the following is a unixesual animal?

☐ tapeworm ☐ earthworm ☐ liverfluke ☐ frog

c. Which of the blood cells fight against microbes?

☐ RBCs ☐ WBCs ☐ platelets ☐ Erythrocytes

d. Which of the given gases is released during photosynthesis.

☐ hydrogen ☐ nitrogen ☐ oxygen ☐ carbon dioxide

4. Answer the following questions.

a. Define life processes with any four examples.
b. What is reproduction? Name two types of reproduction.
c. Define asexual reproduction.
d. What is meant by fission? Name its types.
e. Name any two animals that reproduce by regeneration.
f. What is vegetative propagation? Name any two plants that reproduce asexually by stem.
g. Write any three advantages of asexual reproduction.
h. What is sexual reproduction?
i. Define external and internal fertilization.
j. What are unisexual animals? Write any three examples of bisexual animals.
k. Write any two advantages of sexual reproduction.
l. What is a circulatory system?
m. What is blood? Draw a neat and labelled figure showing the structure of human heart.
n. What are arteries and veins?
o. What is meant by heart beat?
p. What is photosynthesis? Write down the materials required for photosynthesis.

5. **Given reason.**

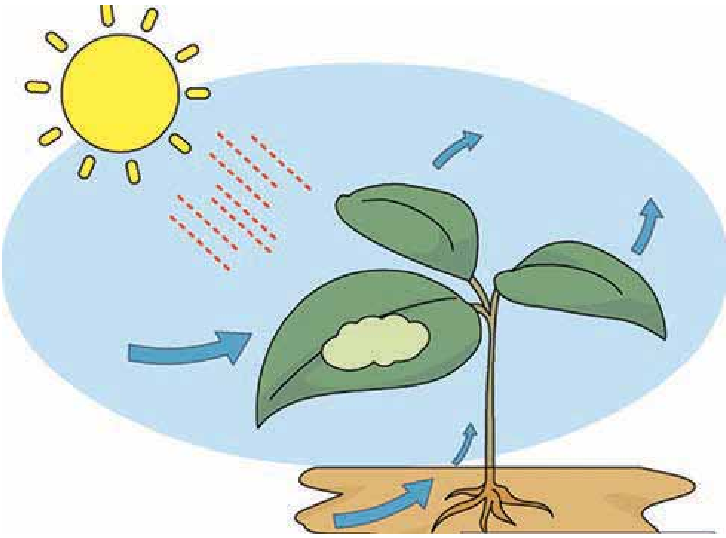
   a. Budding is called asexual reproduction.
   b. The wall of ventricles is thicker than that of auricles.
   c. The wall of arteries is thicker than that of veins.

6. **Differentiate between:**

   a. Asexual and Sexual reproduction
   b. RBC and WBC
   c. Auricle and Ventricle
   d. Arteries and Veins

7. **Describe the process of blood circulation in a human body in brief.**

8. **What is shown in the given figure?**



9. **How is iodine-starch test carried out? Describe in brief.**

10. **Describe an experiment to demonstrate that:**

   a. Oxygen is released during photosynthesis.
   b. Carbon dioxide is essential for photosynthesis.
   c. Sunlight is essential for photosynthesis.

Geology and Astronomy

UNIT 1

Structure of the Earth

Weighting Distribution (Approximate)	Teaching periods : 6	Marks (in %): 1

Before You Begin

The earth is our home planet. Different types of plants and animals live on the earth. Among the planets of the solar system, the earth is the only planet having all the conditions necessary for survival of living organisms. The earth's crust is formed by rocks, soil, sand, etc. Different types of minerals like limestone, sandstone, mica, granite, lead, rock salt, slate, etc. are found in the rocks. The uppermost layer of the earth's crust is covered with soil and rocks . Soil is made of humus, minerals and small particles of sand. Soil is formed by weathering of rocks. Soil is a very important natural resource for all plants and animals living on the earth. We all should try to conserve soil.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce minerals and explain their physical properties and advantages.

ii. introduce major minerals (iron, copper, lead, zinc, limestone and graphite) found in Nepal.

iii. describe the process of soil formation and make soil profile.

iv. explain soil erosion and deposition.

v. explain the methods of soil conservation.

Syllabus

- Introduction to the earth
- Minerals and their types
- Characteristics and uses of minerals
- Some important minerals found in Nepal
  - Iron - Copper - Lead
  - Zinc - Limestone - Graphite
- Process of soil formation. Composition of soil
- Soil profile, erosion and deposition.
- Conservation of soil

Glossary: A dictionary of scientific/technical terms

minerals	:	the natural materials which contain metals, non-metals and their compounds
humus	:	a substance made from dead leaves and plants
weathering	:	the action of the sun, rain or wind on rocks, making them change their shape or colour
lustre	:	the shining quality of a surface
erosion	:	a process of carrying away the weathered particles by wind, water, etc.
deposition	:	a process of depositing materials taken away during erosion
afforestation	:	a process of planting trees in large numbers on bare land

Structure of the Earth

Minerals

Minerals are non-renewable natural materials which contain metals, non-metals and their compounds. They are found in rocks. Iron, copper, lead, zinc, mica, limestone, graphite, etc. are examples of minerals. They are found in the form of elements as well as compounds. However, most minerals are found in the form of compounds. Minerals like gold, sulphur, diamond, etc. are found in the form of elements whereas minerals like haematite, bauxite, cuprite, magnetite, chalcopyrite, etc. are found in the form of compounds.

Fig. 19.1

Copper *Gold* *Sulphur* *Bauxite*

Types of Minerals

There are two types of minerals. They are as follows:

1. Metallic minerals
2. Non-metallic minerals

1. Metallic minerals

Metallic minerals are those minerals which contain a large amount of metals. Most of them are compounds of metals with some impurities. Metals like iron, copper, aluminium, silver, gold, etc. can be extracted from metallic minerals that contain a high percentage of these metals. The minerals from which metals can be extracted profitably and conveniently are called ores. Haematite, argentite, etc. are some examples of ores.

Do You Know ?

- Magnetite and haematite are the ores of iron.
- Cuprite and chalcopyrite are the ores of copper.
- Bauxite is the ore of aluminium.
- Argentite is the ore of silver.

Fig. 19.2

Haematite *Cuprite* *Bauxite* *Argentite*

2. Non-metallic minerals

The minerals that do not have metals are called non-metallic minerals. They may contain very less amount of metals like sodium, potassium, calcium, etc. Examples: coal, slate, granite, petrol, graphite, sulphur, limestone, galena, etc. Metals cannot be extracted from non-metallic minerals. We use non-metallic minerals for making houses, bridges, roads, chemical fertilizers, cement, fuels, idols, sculptures, etc.

Fig. 19.3

Limestone *Mica* *Graphite* *Galena*

Differences between Metallic and Non-metallic minerals

Metallic minerals	Non-metallic minerals
1. Metallic minerals are the minerals that contain metal in a large amount.	1. Non-metallic minerals are the minerals that do not contain significant amount of metal.
2. Metallic minerals are used to extract metals.	2. Non-metallic minerals are used for making cement, houses, bridges, roads, chemical fertilizers, etc.

Characteristics of Minerals

1. Generally, minerals are hard.
2. They have their own colour. For example, haematite ore is red or brown and chalcopyrite is bright-green.
3. Minerals are lustrous.
4. The molecules of minerals are crystalline.

Use of Minerals

1. Minerals are used to extract metals.
2. They are used for making houses, roads, bridges, etc.
3. They are used for making fuels.
4. They are used for making chemical substances.
5. They are used for making decorative items.
6. They are used for making idols, sculptures, valuable gems and ornaments.

Some Important Minerals Found in Nepal

Minerals are the most important natural resource for the development of a country. Minerals play a great role for industrial development. The establishment of industries depends on the stock of minerals in a country. A brief description of major minerals found in Nepal is given below:

1. Limestone

Limestone is a non-metallic mineral which is being used from ancient time in Nepal. The mines of limestone are found in different parts of Nepal. The major mines of limestone are located in Udaypur, Makawanpur, Chobhar, Surkhet, Arghakhanchi, Dhading, Kabhre, Dang, Sindhuli, Godawari, etc.

Fig. 19.4

Limestone

In Nepal, cement industries and lime industries are the industries based on limestone. Limestone is used in houses, building, temples, etc. It is also used for making cement, limestone,sculptures, idols, etc.

2. Iron

Iron is one of the most useful metals essential for industrial development. It is a grey coloured metal. It is being used from ancient times to make household utensils and weapons. In the past, people of Rolpa, Ramechhap and Baitadi, used to extract iron by traditional methods. The main ores of iron are haematite and magnetite. Iron is used for making rods, pipes, vehicles, bridges, household utensils, weapons, buildings, etc. The ores of iron are found in different parts of Nepal such as Phulchoki of Lalitpur. Those of Ramechhap, Labdi of Tanahun and Jeekhabang of Chitawan.

Fig. 19.5

Iron rods and pipes

3. Copper

Copper is a reddish-brown metal which is mainly extracted from cuprite and chalcopyrite ores. Copper mines in different parts of Nepal were the main source of income of local people in the past. Copper is used for making electric wire, household cooking utensils, coins, roofs of temples, sculptures, etc. In Nepal,

Fig. 19.6

Copper

the mines of copper are located in Kalitar of Makawanpur, Dhading, Solukhumbu, Udaypur, Baglung, Tanahun, Bhojpur and Dadeldhura districts.

4. Graphite

Graphite is a soft and lustrous non-metallic mineral. It is greyish-black in colour. It is used for making pencil leads, lubricants, electrodes, colours, etc. The mines of graphite are located in Ilam, Dhankuta, Sindhupalchok and Sankhuwasabha districts.

Fig. 19.7 *Graphite*

5. Zinc

Zinc is a bluish-white metal which is extracted from zinc sulphide ore. It is used for making bags of dry cells, alloys like brass, etc. It is also used for coating iron sheets to prevent rusting. In Nepal, zinc mines are found in Ganesh Himal, Phulchoki, Makawanpur and Sankhuwasabha districts.

Fig. 19.8 *Zinc*

6. Lead

Lead is a soft bluish-white metal. It is extracted from the ore galena. Lead is being used by people of the Himalayan region from ancient time. Lead is used for making bullets and lead-acid cells. It is also used in construction works. In Nepal, the mines of lead are found in Ganesh Himal, Phulchoki of Lalitpur, Khairabang of Makawanpur and Solukhumbu district.

Fig. 19.9 *Lead*

Do You Know

Galena is the chief ore of land. It contains 86.6% of lead by weight.

Soil

Most part of the earth is covered with soil. It provides habitat for plants and animals. Green plants get water and minerals from the soil for making food. Crawling insects, bacteria, fungi, etc. complete their life cycle in soil. Human beings depend on soil for various purposes. Soil provides favourable environment for survival of living beings on the earth. Soil is the mixture of weathered rock particles, sand, minerals and dead remains of plants and animals.

Fig. 19.10 Soil

Formation of soil

Soil is formed by a very slow and gradual process. The process by which formation of soil takes place is called weathering. Soil is formed by various methods. Some of them are given below:

Do You Know

- Weathering is a slow and gradual process in which large rocks break down into fine particles.
- Weathering of rocks is a very slow but continuous process.

1. During rainy season, big rocks from the hilly region are carried away by rivers, streams, etc. These rocks break into small pieces due to collision. When this process continues for a long time, large rocks change into fine particles. As a result, soil is formed.
2. The rocks expand due to heat of the sun and contract due to cold at night. As this process continues, cracks are formed on rocks and finally these rocks break into fine particles. As a result, soil is formed.
3. Strongly blowing wind carries minute rock particles away and these rock particles are deposited somewhere. As a result, soil is formed due to blowing wind.
4. Frost also helps in weathering of rocks which finally results in the formation of soil.
5. Various activities of human beings and other animals also help in weathering of rocks. Similarly, some plants grow on the cracks of rocks and break the rocks into pieces. Likewise, some lichens (plants) produce acids which corrode the rocks and produce fine particles. As a result, soil is formed.

Composition of Soil

Soil is formed by fine rock particles, minerals and organic matter. Soil also consists of air, water and dead remains of plants and animals. The substances found in soil differ from place to place. The soil consists of various layers. The uppermost layer of soil contains more humus or organic matter than the second layer of soil. The third inner layer of soil contains minerals like iron, aluminium, etc. Similarly, the lowermost layer of soil contains pebbles and bed rock. Therefore, soil consists of humus, dead remains of plants and animals, minerals, pebbles and bed rock.

Soil Profile

The arrangement of various layers of soil vertically down from the surface of the soil is called soil profile. A soil profile can be seen by digging a trench vertically down at a place. A soil profile has various layers or horizons. Top soil, sub-soil and bed rock are the three main horizons or layers of soil profile.'

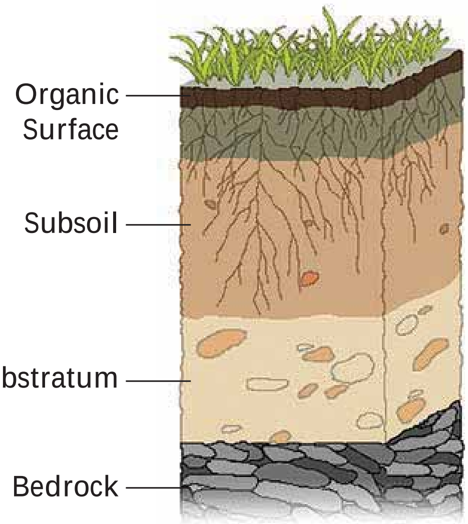


Fig. 19.11

The uppermost layer of soil profile is called the top soil. It is rich in humus and dark in colour. In this layer, living organisms like earthworm, insects, bacteria, fungi, etc. are found. It also consists of roots of small plants. The soil is soft, porous and holds enough water.

The sub-soil is the layer of soil found below the top soil. It is hard, compact and rich in minerals. Humus and dead remains of organisms are not found in this layer.

The bed rock is the lowermost layer of the soil profile. This layer cannot be easily dug up as it contains pieces of rocks.

Soil Erosion and Deposition

Various agents like water, wind, air, storm, hurricane, etc. and human activities carry away the land surface or weathered particles. This process is called erosion. It removes the top fertile soil and reduces the fertility of the soil. So, the removal of fertile soil by running water, wind and human activities is called soil erosion. Soil erosion is a very common process in the mountains and hilly regions of Nepal.

The materials taken away during erosion get deposited at other places. This process is called deposition. So, the process of depositing materials taken away during erosion is called deposition. Soil erosion is followed by deposition. Therefore, we can say that soil erosion and deposition occur side by side. Various agents like air, water, rain, river, ocean, etc. are responsible for soil erosion and deposition.

Fig. 19.12

Soil erosion

Deposition

Causes of Soil Erosion

1. In the deforested areas, the soil particles become loose and can be easily carried away by rain water and wind. So deforestation is one of the causes of soil erosion.
2. Floods and heavy rainfall cause a lot of damage to the top soil and cause soil erosion.
3. Overgrazing makes the top soil weak and helps in soil erosion.
4. Improper agricultural pratices in slopes also cause soil erosion.

Effects of Soil Erosion and Deposition

1. Soil erosion causes landslides.
2. It reduces the fertility of soil.
3. Deposition covers fertile lands and vegetation.
4. Soil erosion and deposition form dunes, plateaus, etc.

Soil erosion and deposition occur side by side

Soil erosion is the process of carrying away of land surface or weathered particles by the agents like wind, air, storm, hurricane, etc. It is caused by wind, water, river, glaciers and even human activities like construction works. Deposition is the process that the materials taken away during erosion are deposited at any other places. This means erosion is followed by deposition. If soil erosion occurs in one place, the eroded material get deposited on another place. Deposition is not possible without erosion. So, erosion and deposition occur side by side.

Soil Conservation

Soil is one of the most important natural resources. Therefore, we should conserve soil. Some methods of soil conservation are given below:

Fig. 19.13 *Terrace farming*

1. Deforestation should be discouraged and afforestation should be encouraged.
2. Terrace farming should be done in slopes.
3. Shelter belts should be constructed in dry places and deserts.
4. Crops rotation should be done to protect the fertility of the land.
5. Embankment should be done on the sides of rivers, streams, etc.
6. Overgrazing should be controlled.
7. Explosions should be stopped while constructing roads in the hilly regions.
8. Plants having strong roots like bamboo should be planted on river sides.

Project work

- Visit the school garden and dig a small trench. Observe the soil profile and draw a neat and labelled figure.
- Visit a nearby place having soil erosion. Observe the eroded area and find out the causes of soil erosion. Suggest the measures that should be adopted to reduce soil erosion in that area.

Key Concepts

1. Minerals are non-renewable natural materials which contain metals, non-metals and their compounds.
2. Metallic minerals are those minerals which contain a large amount of metals.
3. The minerals from which metals can be extracted profitably and conveniently are called ores.
4. The minerals that do not have metals are called non-metallic minerals.
5. Zinc is a bluish-white metal which is extracted from zinc sulphide ore.
6. Soil provides favourable environment for survival of living beings on the earth. Soil is the mixture of weathered rock particles, sand, minerals and dead remains of plants and animals.
7. The arrangement of various layers of a soil vertically down from the surface of the soil is called soil profile.
8. The removal of the fertile soil by running water, wind and human activities is called soil erosion.
9. The process of depositing materials taken away during erosion is called deposition.

Exercise

1. **Put a tick (√) for the correct statement and a cross (×) for the incorrect one.**
   a. Minerals like gold and sulphur are found in the form of compounds. ☐
   b. Metals cannot be extracted from minerals. ☐
   c. Chalcopyrite is the ore of copper. ☐
   d. Soil erosion and deposition occur side by side. ☐

2. **Fill in the blanks using appropriate words.**
   a. The minerals that contain a large amount of metals are called ....
   b. Haematite and magnetite are the ores of ....
   c. Graphite is ....in colour.
   d. The arrangement of various layers of soil vertically downwards is called ....

3. **Tick (√) the most appropriate answer from the given alternatives.**
   a. Which of the following is a non-metallic mineral?
      ☐ cuprite ☐ gold ☐ graphite ☐ magnetite
   b. Which of the following is the ore of silver?
      ☐ haematite ☐ chalcopyrite ☐ argentite ☐ cuprite
   c. Which of the given minerals is used for making pencils?
      ☐ graphite ☐ limestone ☐ sulphur ☐ lead
   d. Which of the following is the main cause of soil erosion?
      ☐ wind ☐ air ☐ overgrazing ☐ heavy rainfall

4. Answer the following questions.

a. What are minerals? Give any four examples.

b. Name the two types of minerals.

c. What are metallic minerals? Give three examples.

d. Define non-metallic minerals with any three examples.

e. Write any four characteristics and four uses of minerals.

f. Name any four minerals found in Nepal. Also, write any one use of each.

g. Where are following minerals found in Nepal?

i. Limestone ii. Iron iii. Lead

Also, write any two properties and one use of each.

h. What is soil profile? Write any three methods of formation of soil.

i. Draw a neat and labelled figure showing soil profile.

j. Define soil erosion and deposition.

k. Write any three causes and three effects of soil erosion.

5. Give reason.

a. Minerals are very important natural resources.

b. Soil erosion and deposition occur side by side.

c. Afforestation should be done to reduce soil erosion.

6. Differentiate between:

a. Metallic minerals and Non-metallic minerals

b. Lead and Sulphur

c. Soil erosion and Deposition

7. Describe the composition of soil in brief.

8. Write any five methods of soil conservation.

UNIT 2

Weather and Climate

Weighting Distribution (Approximate)	Teaching periods : 5	Marks (in %): 1

Before You Begin

Most days are sunny, some are cloudy and other may be rainy or foggy. Similarly, some days are hot and other days are cold. It may be sunny in the morning, cloudy in the noon and rainy in the evening. Weather and climate both refer to the condition of the atmosphere in a certain place. The condition of the atmosphere at a particular place and time is called weather. Sunny, cloudy, foggy, rainy, hot, cold, etc. are some states of weather. The weather of a place keeps on changing from time to time. Similarly, the weather varies from place to place. Climate is the average atmospheric condition over a long peroid of time. The totality of existing temperature, atmospheric pressure, humidity, rainfall, etc. is called the climate.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce weather and climate.

ii. explain the factors affecting climate.

iii. give general introduction to the climate of Nepal.

iv. introduce monsoon, its formation and monsoon of Nepal.

v. explain the effects of monsoon.

Syllabus

- Introduction to weather and climate
- Factors affecting climate
- - Distance from equator
- - Altitude and slope
- - Distance from the sea
- Climate of Nepal
- Monsoon and its formation
- Effects of monsoon

Glossary: A dictionary of scientific/technical terms

weather	:	a condition of the atmosphere at a particular time and place
climate	:	a average atmospheric condition of a place over a long period of time
tundra	:	very cold
leeward	:	the side that is sheltered from the wind
windward	:	on the side from which the wind is blowing
deciduous	:	that loses its leaves every year
westerly	:	the wind that flows from the west

Weather and Climate

Weather can be defined as the specific atmospheric condition of a particular place at a particular time. Weather varies from place to place and time to time. The weather may be sunny, windy, cloudy, rainy, etc. On the same day, the weather in the morning, at noon and in the evening may be different.

Fig. 20.1

Sunny weather   Cloudy weather   Rainy weather

Climate can be defined as the average atmospheric condition of a place over a long period of time. It is the average weather pattern of a place throughout the year. The climate of some places may be hot and wet and in other places it may be hot and dry. Similarly, it may be cold and humid in some other places.

The earth has been divided into three main climatic regions. They are (i) tropical, (ii) sub-tropical and (iii) cold or tundra. These climatic regions are further divided into many sub-regions. These sub-regions are called climate belts. The natural vegetation, animals and mode of human life and their activities are determined by the climate of their habitat.

Differences between Weather and Climate

Weather	Climate
1. The specific atmospheric condition of a particular place at a particular time is called weather.	1. Climate is the average atmospheric condition of a place over a long period of time.
2. The atmospheric condition of a place in the morning, at noon and in the evening may be different.	2. The atmospheric condition of a place remains the same throughout the year.

Factors Affecting Climate

Different factors affect the climate. Various factors like distance from the equator altitude, slope, distance from sea, forests, local wind, river, lake and various human activities are responsible for changing climate. Among these factors, three major factors that change the climate are described below:

1. Distance from the equator

The imaginary line which passes from east to west through the centre of the earth is called equator. It divides the earth into two equal halves. Equator lies at 0° latitude where the sun rays are direct and straight. So, it is hot in the equatorial region through out the year. When the distance from the equator increases, the rays of the sun tilt and in the poles which lie at 90° latitudes the rays of the sum are most tilted. Therefore, it is very cold in the polar region.

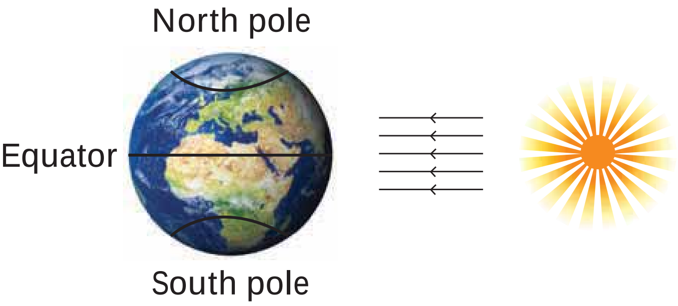


Fig. 20.2

Do You Know

Latitude is the angular distance to the north and south of the equator.

2. Altitude and slope

The height of a place from the sea level is called altitude. Due to greenhouse effect and atmospheric pressure, the temperature decreases when the altitude increases.

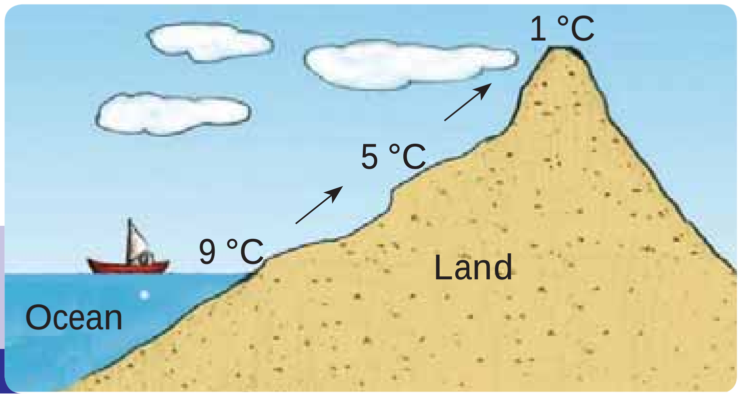


Fig. 20.3

In every 160–165 metre altitude, temperature decreases and vice-versa. Due to this reason, we feel hot in the terai region, cold in the hilly region and very cold in the Himalayan region.

The slope of a place also affects the climate. The slopes of a mountain towards the monsoon winds are called windward slopes. These slopes get more rainfall. Similarly, the slopes in the opposite side are called leeward slopes. These slopes often remain dry. In our country, Pokhara lies in the windward slope of the Annapurna range. So, heavy rainfall occurs in Pokhara. But Manang and Mustang lie in the leeward slopes. So, very less rainfall occurs in Manang and Mustang.

3. Distance from the sea

Distance from the sea is another factor that affects the climate. The climate of a place near the sea remains moderate due to influence of sea breeze during the day and land breeze during the night. But the influence of sea breeze is less at distant places. So, the climate of a place that remains far away from the sea is more extreme, i.e. very hot during summer and very cold during winter. In this way, the distance from the sea also affects the climate of a place.

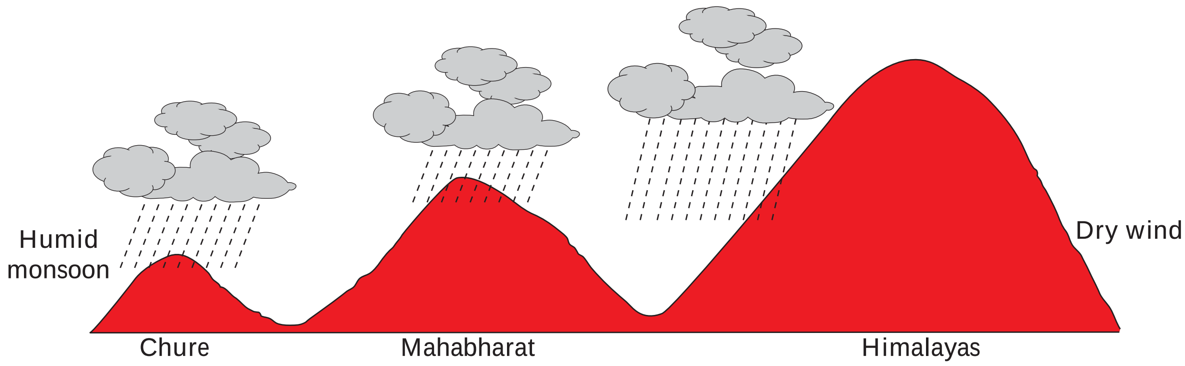


Fig. 20.4

Climate of Nepal

The climate of Nepal is of "Tropical monsoon type" as it lies approximately between 26° and 30° latitudes in the northern hemisphere in South-Asia. So, Nepal lies in the tropical monsoon climate region but the climate varies due to difference in altitude.

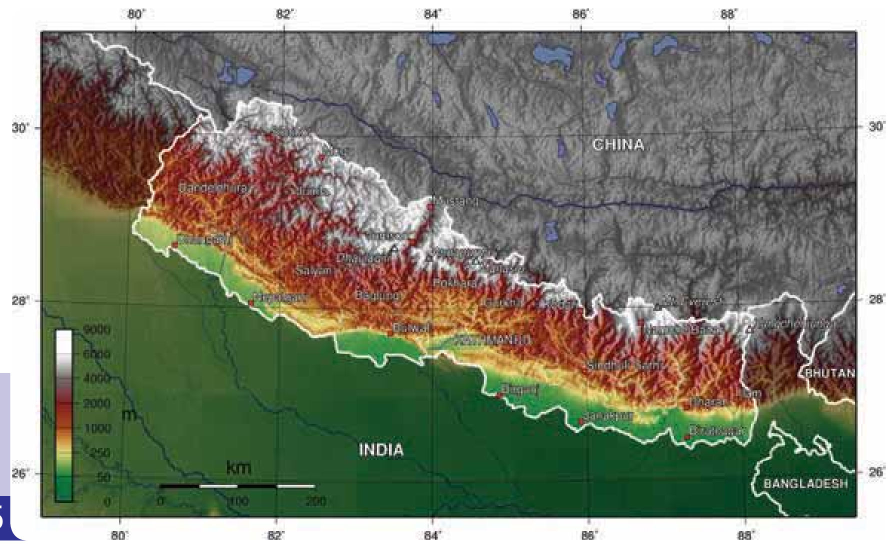


Fig. 20.5

The altitude of Nepal ranges between 60m to 8848 m from the sea level and the places that lie in different places have different climatic condition. The Terai belt lies in between 60 m to 1200 m in the south. The climate of Terai is annual rainfall. In the Terai of Nepal, the maximum summer temperature reaches upto 40 °C and the minimum temperature in winter falls around 6 °C. It is mostly hot in summer though it is very cold in winter due to *sheetlahar*, i.e. cold wave. The tropical evergreen forest is found in this region.

Between 1200 m and 2100 m from the sea level, a moderate climate is found. It is warmer in the valleys and river basins. In this climatic belt, the maximum summer temperature reaches upto 30 °C and the minimum temperature in winter falls below 0 °C. The plants in this region shed their leaves in winter. Such type of vegetation is called the deciduous vegetation.

Between 2100 m and 3300 m altitude in the mid-hilly region cold temperate climate is found. In this climatic belt, the maximum temperature reaches upto 20 °C in summer and in winter, the temperature falls below 0°C. Coniferous forest of pines are found in this region.

Above 5000 m, the climate is very cold with the average temperature below 0 °C. In this climatic belt, snowfall occurs throughout the year. No vegetation is found in this region due to extreme cold climate. This region is commonly known as the tundra.

Winds also affect the climate of Nepal. In summer, rainfall occurs due to the influence of moist summer monsoon winds that come from the Bay of Bengal. Similarly, winter is dry due to the influence of dry winter monsoon winds that blow from Central Asia. Sometimes little rainfall occurs in Nepal due to the influence of westerlies that come from the Mediterranean sea. In winter, more rain fall occurs in the western parts and less in the eastern part of Nepal.

The Thar desert of India and the Arabian desert of the Middle-East lie in the west from Nepal and the hot wave of air coming from these desert makes the climate in the West of Nepal hot. But the climate in the east of Nepal is comparatively more moderate due to nearness to the Bay of Bengal. Big and permanent river systems like Saptakoshi, Saptagandaki, Karnali spring up from the Himalayas. These rivers systems help to keep the climate of Nepal mild and moderate. Similarly, the Himalayan range in the northern part of Nepal prevents cold wave of air that comes from Central Asia.

Monsoon

Monsoon can be defined as a period of heavy rain in summer in south Asia. The term 'Monsoon' refers to a season or a period of seasons. The monsoon climate is characterized by season change. In Nepal, the monsoon begins with rainfall. Chaitra, Baisakh and Jestha are the months of pre-monsoon

Do You Know

Summer monsoon winds blow from sea to land in summer and winter monsoon winds blow from land to sea in winter. These winds are called seasonal winds or periodic winds.

whereas Asar, Shrawan and Bhadra are the months of mid-monsoon. Similarly, Aswin and Kartik are the months of late monsoon.

During winter, it is cold and dry. Land remains cold but water bodies remain warm. During winter, cold air blows from Nepal to the Bay of Bengal which is called the winter monsoon wind. The winter monsoon wind is dry and does not cause rain. But in the summer, moisture bearing summer monsoon winds blow from the Bay of Bengal to Nepal which causes heavy rainfall. Therefore, it is rainy in summer and dry in winter in Nepal.

The Bay of Bengal lies to the south-east from Nepal. The summer monsoon winds coming from the Bay of Bengal bring heavy rain fall in Nepal during the summer. So, more rainfall occurs in the east and gradually decreases in the west. Similarly, summer rain occurs more in the southern slopes of the mountains and receives the highest amount of rainfall in Nepal. But, very less or no rain fall occurs in the northern slopes which are leeward slopes. Such places are known as the rain shadow area. In Nepal, Manang and Mustang lie in the rain shadow area.

Activity 1

- Identify the types of vegetation found in your locality. Study the climate condition of your locality and prepare a short report.

Differences between Winter monsoon and Summer monsoon

Winter monsoon	Summer monsoon
1. In Nepal, the Indian winter monsoon is not dominant.	1. In Nepal, the Indian summer monsoon is dominant.
2. During winter monsoon, there is dry and no rainfall.	2. During summer monsoon, there is heavy rainfall.

Effects of Monsoon

In Nepal, most of the people are involved in farming. So, monsoon is very essential for crops. In our country, monsoon is the main source of water for irrigation. It is very useful for farmers as it provides sufficient rain water for irrigation. It also increases the level of underground water. Rivers contain large amount of water is the monsoon. It helps to generate hydroelectricity. The monsoon also

Do You Know

- In winter, warm air moves from the ocean to the land in summer and cold air moves from the ocean to the land. So, lands nearby the sea and ocean experience less hot in summer and less cold in winter. Therefore,moderate climate is found in the places near the sea.
- Pokhara lies in windward slope of mountain and receives the highest amount of rainfall but Manang lies in leeward slope of mountain and receives no rainfall.

makes the summer climate cool. The monsoon may cause excessive rain, rivers overflow and causes floods, landslides, etc. The adverse effects of monsoon can be reduced by afforestation, embankment on riversides, adopting scientific agricultural practices and conserving forest resources.

Key Concepts

1. Weather can be defined as the specific atmospheric condition of a particular place at a particular time.
2. Climate can be defined as the average atmospheric condition of a place over a long period of time.
3. The earth has been divided into three main climate regions. They are (i) tropical, (ii) sub-tropical and (iii) cold or tundra.
4. Various factors like distance from the equator, altitude, slope, distance from sea, forests, local wind, river, lake and various human activities are responsible for the changing climate.
5. The monsoon can be defined as a period of heavy rain in summer in South Asia.
6. The summer monsoon winds blow from the sea to land in summer and winter monsoon winds blow from the land to sea in winter. These winds are called seasonal winds or periodic winds.
7. The adverse effects of monsoon can be reduced by afforestation, embankment on riversides, adopting scientific agricultural practices and conserving forest resources.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Weather varies from place to place and time to time. ☐

b. Climate is the average weather pattern of a place throughout the year. ☐

c. Distance from the equator does not affect the climate. ☐

d. Nepal lies in the tropical monsoon climatic region. ☐

e. The monsoon is a period of heavy rain in the summer in South Asia. ☐

2. **Fill in the blanks using appropriate words.**

a. The specific weather condition of a place at a certain time is called ....

b. The earth has been divided into .... climate regions.

c. The height of a place from the sea level is called ....

d. .... climate is found between 2100 m to 3300 m altitude.

e. .... and .... are the months of pre-monsoon.

3. **Answer the following questions.**

a. What is meant by weather?

b. Define climate. Name any three factors that affect climate.

c. How does distance from the equator affect climate? Explain in brief.

d. What is altitude? How do altitude and slope affect the climate?

e. How does the distance from the sea affect climate?

f. Why is it hot in the equatorial region and cold in the polar region?

g. What is the climate like in the terai region of Nepal?

h. What is meant by monsoon? Write the months of mid-monsoon in Nepal.

4. **Give reason.**

a. More rainfall occurs in Pokhara but rainfall is low in Manang.

b. Paddy production is more in Jhapa than that in Kanchanpur.

c. Winter crops grow better in Western Nepal.

5. **Write a short note on "Monsoon of Nepal".**

6. **Describe in brief about the climate of Nepal.**

7. **Write any two effects of monsoon.**

8. **How can we reduce the adverse effects of monsoon?**

UNIT 21

Earth and Space

Weighting Distribution (Approximate)	Teaching periods : 5	Marks (in %): 2

Before You Begin

The earth is the third inner planet of the solar system. There are eight planets in the solar system. Among them, only the earth has suitable condition for the existence of plants and animals. It is estimated that the age of the earth is about 4.5 billion years. Many scientists have put forward their own hypothesis regarding the origin of the earth. However, no universal theory of the origin of the earth has been propounded so far. In this unit, we will study some hypotheses regarding the origin of the earth, causes of evolution of life on the earth, change in the position of the earth, change in season and phases of the moon in brief.

Learning Objectives

After completing the study of this unit, students will be able to:

i. describe the hypotheses regarding the origin of the earth.

ii. describe the change in position of the earth in different seasons.

iii. explain the change in seasons on the earth.

iv. describe the phases of the moon.

Syllabus

- Introduction to earth and space.
- Hypotheses about the origin of the earth.
- Causes of evolution of life on the earth
- Change in the position of the earth
- Change in seasons
- Phases of the moon

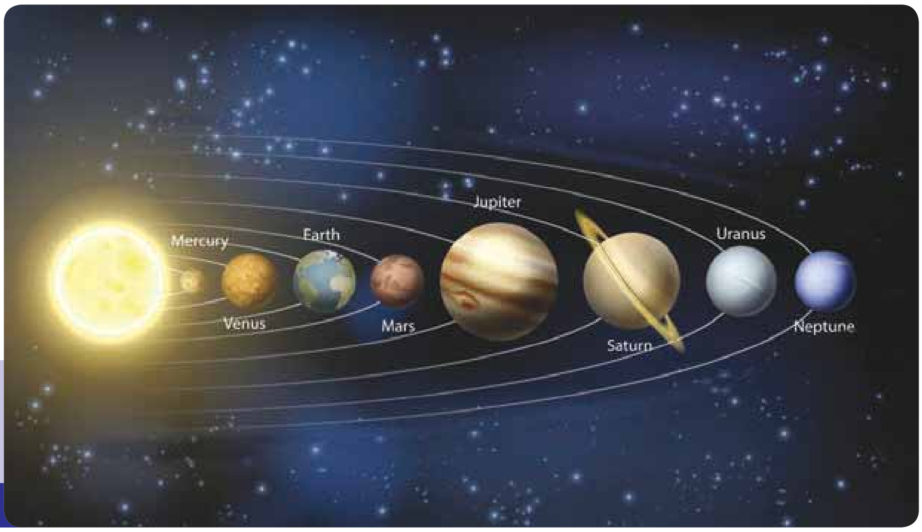
Glossary: A dictionary of scientific/technical terms

hypothesis	:	an assumption or concession made for the sake of argument
nebula	:	an extremely large mass of gas and dust particles
galaxy	:	any of the very large groups of stars and associated matter that are found throughout the universe
comet	:	a mass of ice and dust that moves around the sun and looks like a bright star with a tail
asteroid	:	any one of the many small planets which go around

Hypotheses About the origin of the Earth and solar system

Different scientists have propounded different hypotheses regarding the origin of the earth and the solar system. Some of the hypothesis regarding the origin of the earth and the solar system are given below:

Fig. 21.1



Solar System

1. Tidal Hypothesis or Jeans and Jefferey's Hypothesis

This hypothesis was propounded by Jeans and Jefferey in 1917 AD. According to this hypothesis, a big star revolving round the sun finally approached the sun. A large mass was ejected from the sun in the form of a tide. The tidal matter fragmented into small pieces in the course of cooling and formed planets, satellites and other heavenly bodies including the earth.

2. Nebular Hypothesis

According to the Nebular hypothesis, the whole of our solar system including other heavenly bodies was in the form of a nebula. The nebula began to contract due to its own gravity. As this process continued, an outer ring was detached from the central core, which started to revolve around the central core. The masses collided with one another and broke into small pieces. The central core became the sun and the other revolving bodies became the planets, satellites, asteroids, etc. including the earth.

Do You Know

- Nebula is an extremely large mass of gas and dust particles.
- The nebular hypothesis was propounded by a German philosopher Kant in 1755 AD and this hypothesis was modified by a French mathematician Laplace in 1796 AD.

3. Planetesimal Hypothesis or George Buffon's Hypothesis

In 1749 AD, a French scientist George Buffon propounded a hypothesis regarding the origin of the earth. This hypothesis is called the planetesimal hypothesis. According to this hypothesis, the earth along with other planets and satellites were formed when revolving around the universe the collided with the sun billions of years ago.

4. Formation of Solar system from the Milky Way

According to this hypothesis, the sun was formed by the accumulation of small dust particles present in the Milky Way galaxy due to gravitation. Other members of the solar system like planets, satellites, asteroids, comets, etc. were formed by the same process as the formation of the sun.

Fig. 21.2

Milky way

Do You Know

Gravitation or gravitational force is the force of attraction between any two bodies due to their masses. It is measured in N.

Causes of Evolution of life on the Earth

It is estimated that the age of the earth is about 4.5 billion years. In the beginning, there was unfavourable condition for the existence and survival of living organisms. Later, various changes took place on the earth's surface due to which life evolved on the earth millions of years ago. The main causes of evolution of life on the earth are given below:

1. The earth has sufficient amount of life supporting gases like oxygen, carbon dioxide, nitrogen, etc. in the air.
2. The earth has sufficient amount of water required for survival of plants and animals.
3. The earth has suitable temperature for the survival of living beings.

Changes in the Position of the Earth and the Sun

The shape of the earth is like an orange. It is spherical but not a perfect sphere. The earth is bulging at the equator and flat at the poles. The earth revolves around the sun in an elliptical orbit. This motion of the earth is called revolution. The earth takes 365 days to complete one revolution around the sun from west to east.

The earth spins in its own axis. This motion of the earth is called rotation.

The earth takes 24 hours to complete one rotation in its own axis. The imaginary line passing through the north and south pole of the earth is called axis. The axis of rotation of the earth is tilted at an angle of 66.5° with its orbital plane. It has following effects on the earth.

1. Days and nights are not equal except in the equatorial region. Some days are longer than nights and some nights are longer than days.
2. The sunrise and sunset do not always take place from the same place.
3. The change of seasons take place on the earth.
4. The height of the sun from the earth in the afternoon changes every day.
5. The rays of the sun do not fall perpendicularly in a place all the time. It affects the climate of that place.

Change of Seasons

The earth completes one revolution around the sun in 365 days. The earth revolves around the sun in an elliptical orbit and the axis of rotation of the earth is tilted at an angle of 66.5°. Due to these reasons, the earth is not always at the same distance from the sun which results in the change in seasons on the earth. The duration of one year, i.e. 365 days is divided into four seasons. They are:

i. Summer season
ii. Autumn season
iii. Winter season
iv. Spring season

The tilted axis of rotation of the earth always lies in the same direction. Due to this, the position of the northern and southern hemispheres of the earth towards the sun keeps on changing throughout the year. When the northern hemisphere is tilted towards the sun, we experience summer and the people in the southern hemisphere experience winter. Spring and autumn seasons occur when the earth lies in between these two extreme positions in its orbit.

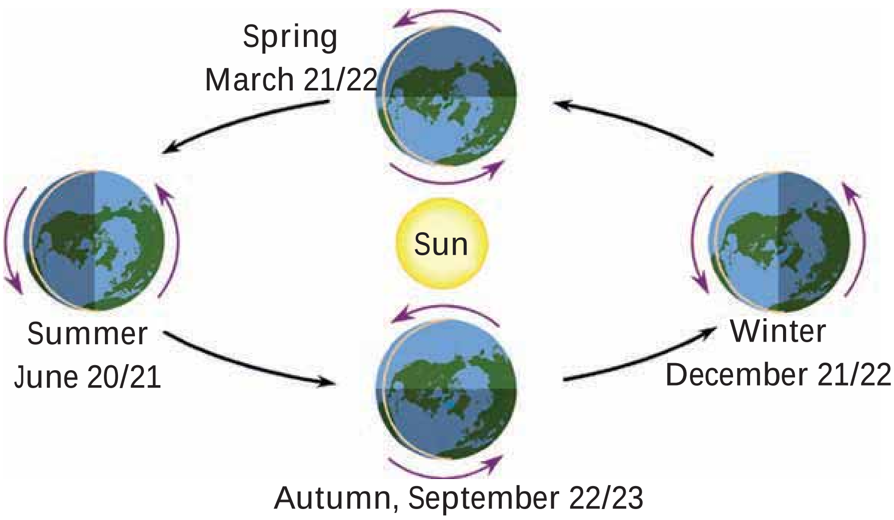


Fig. 21.3 *Formation of seasons on the earth*

On June 21, i.e. 8th of Asar, the earth lies the farthest from the sun in the southern hemisphere, but the nearest from it in the northern hemisphere. So, the northern hemisphere experiences the longest day and the southern hemisphere experiences the shortest day on June 21. At this time, the summer season occurs in the northern hemisphere and the winter season occurs in the southern hemisphere.

On December 22, i.e. Poush 7, the northern hemisphere has the shortest day and the southern hemisphere has the longest day. At this time, the winter season occurs in the northern hemisphere and the summer season occurs in the southern hemisphere.

On March 21, i.e. Chaitra 8, the sun lies above the equator and the days and nights are equal in all parts of the earth. At this time, the spring season occurs in the northern hemisphere and the autumn season occurs in the southern hemisphere.

On September 23, i.e. Asoj 7, the rays of the sun fall perpendicularly on the equator. So, day and night are equal in both hemispheres. At this time, the autumn season occurs in the northern hemisphere and the summer season occurs in the southern hemisphere.

Differences between Summer season and Winter season

Summer season	Winter season
1. It is the hottest season of the year.	1. It is the coldest season of the year.
2. It has longer days and shorter nights.	2. It has longer nights and shorter days.

Phases of the Moon

Different shapes of moon can be seen every day when viewed from the earth. What is the reason behind this fact? Have you seen different shapes of the moon or not?

Fig. 21.4 *Phases of moon*

The planets and satellites do not have their own source of light for shining. They shine by reflecting the light from the sun. The moon is the natural satellite of the earth. It does not have its own source of light. The moon always presents its same face towards the earth. When the reflected light of the moon reaches the earth, the moon becomes visible. We see only that part of the moon which reflects the sunlight towards the earth.

When the moon lies in between the sun and the earth, the reflected light from the moon does not reach the earth and the moon is not visible. This day is called the new moon day. The dark side of the moon faces the earth on the new moon day.

Fig. 21.5 New moon

On the night just after the new moon day, a crescent moon can be seen. The other part of the moon is only faintly visible. The crescent goes on increasing till the 15th day from the new moon day when the full bright face of the moon is visible. The day is called the full moon day.

The gradual increase in the bright disc of the moon is called waxing of the moon. The bright disc of the moon increases for 15 days after the new moon day. This duration is called the bright half. After the full moon, the bright face of the moon goes on decreasing every day for 15 days. This duration is called the dark half. The gradual decrease in the bright disc of the moon is called waning of the moon. So, the waxing and waning of the disc of the moon, as the moon revolves around the earth, is called the phases of the moon.

Fig. 21.6 Full moon

On the full moon day, the moon rises in the eastern sky and it rises 50 minutes later the next day. The moon revolves around the earth in its own orbit. The moon completes one revolution around the earth in $27\frac{1}{3}$ days. This duration is called the sidereal month.

Do You Know

When the earth lies between the moon and the sun, the full bright face of the moon is seen from the earth. This day is called the full moon day.

Similarly, the duration between two consecutive new moons or full moons is $29\frac{1}{2}$ days. This duration is called the synodic month.

Differences between New moon and Full moon

New moon	Full moon
1. When the moon lies between the sun and the earth, the reflected light from the moon does not reach the earth and hence the moon is not visible. This phase of moon is called new moon.	1. When the earth lies between the moon and the sun, the full bright face of the moon is seen from the earth. This phase of moon is called full moon.
2. Night of new moon is dark.	2. Night of full moon is bright.

Differences between Synodic month and Sidereal month

Synodic month	Sidereal month
1. It is the duration between two consecutive full moons or new moons.	1. It is the duration that the moon completes one revolution around the earth.
2. Its duration is 29.5 days.	2. Its duration is 27 days, 7 hours, 43 minutes and 11 seconds.

Key Concepts

1. The earth is the third inner planet of the solar system. There are eight planets in the solar system.
2. The earth revolves around the sun in an elliptical orbit. This motion of the earth is called revolution.
3. The imaginary line passing through the north and the south pole of the earth is called axis.
4. The earth revolves around the sun in an elliptical orbit and the axis of rotation of the earth is tilted at an angle of 66.5°. Due to these reasons, the earth is not always at the same distance from the sun which results in the change in seasons on the earth.
5. The tilted axis of rotation of the earth always lies in the same direction. Due to this, the position of the northern and the southern hemispheres of the earth towards the sun keeps on changing throughout the year.
6. The moon is the natural satellite of the earth. It does not have its own source of light.
7. The gradual increase in the bright disc of the moon is called waxing of the moon.
8. The gradual decrease in the bright disc of the moon is called waning of the moon.

9. The waxing and waning of the disc of the moon, as the moon revolves around the earth is called the phases of the moon.
10. The moon completes one revolution around the earth in 27 1/3 days. This duration is called the sidereal month.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. The age of the earth is about 4.5 million years. ☐

b. The tidal hypothesis was propounded by Jeans and Jeffery. ☐

c. The days and nights are equal in the equatorial region. ☐

d. Four seasons can be observed on the earth. ☐

e. The moon appears as a full circular disc on the new moon day. ☐

2. Fill in the blanks using appropriate words.

a. .... hypothesis was propounded by Kant and Laplace.

b. The earth takes .... to complete one rotation in its own axis.

c. On December 22, the .... hemisphere has the shortest ....

d. The gradual increase in the bright disc of the moon is called ....

e. The duration of synodic month is .... days.

3. Answer the following questions.

a. What is the estimated age of the earth?

b. State the hypothesis propounded by Jeans and Jeffery regarding the origin of the earth.

c. State nebular hypothesis regarding the origin of the earth.
d. State the planetesimal hypothesis regarding the origin of the solar system.
e. Write down the conditions required for existence of life on the earth.
f. Write any four effects on the earth due to its tilted axis.
g. What are the causes of change in the seasons on the earth?
h. What is meant by phases of the moon?
i. What is synodic month?
j. What is sidereal month?
k. What is meant by the bright half?
l. What is meant by the dark half?

4. Differentiate between:

a. New moon and Full moon
b. Bright half and Dark half
c. Summer season and Winter season

5. Draw a neat and labelled figure showing the phases of the moon.

UNIT 22

Environment and Its Balance

Weighting Distribution (Approximate) | Teaching periods : 12 | Marks (in %): 3

Before You Begin

Environment is the natural world around us. It consists of living beings and non-living things. The living things present in the environment include different types of plants and animals. Similarly, the non-living things present in the environment include sunlight, air, water, soil, temperature, humidity, rainfall, etc. There is a close relationship between living beings and non-living things of an environment. The interaction among various living beings and non-living things helps to maintain a balance in the environment. However, various human activities affect the natural environment adversely.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce environment and explain the dependence of human beings on food, habitat, medicinal plants and other natural resources.

ii. introduce and list national parks, wildlife reserves and conservation areas of Nepal.

iii. describe the need and importance of forest resource of Nepal.

iv. list timbers and important medicinal plants found in Nepal.

v. describe the need and importance of fuana and list the endangered species of Nepal.

vi. introduce some conserved fuana of Nepal.

Syllabus

- Natural resources and human dependency - food - habitat - medicinal plants - air - water - land
- National parks, wildlife reserves, hunting reserves and conservation areas
- Status of forest in Nepal
- Need and importance of forests
- Forest products - timbers and medicinal plants
- Protected plants
- Endangered animals of Nepal

Glossary: A dictionary of scientific/technical terms

habitat	:	a place where plants and animals live and reproduce
medicinal	:	tending or used to cure disease or relieve pain
extinction	:	a situation in which a plant, an animal, etc. stops existing
coniferous	:	plants having cones and naked seeds
endangered	:	which is in the verge of extinction

Natural Resources and Human Dependency

The resources like sunlight, air, water, minerals, forests, etc. that are found in nature are called natural resources. Human beings use natural resources for economic gain. The earth is the common habitat of human beings and different types of organisms. All living beings obtain food and habitat from the earth. Human beings get air, water, food, habitat, medicinal plants, etc. from nature to survive. It shows the relation and dependency of human beings on natural resources. The relation and dependency of human beings and natural resources is described below:

1. Food

Plants and animals cannot survive without food. They need energy to live. They get energy from the food that they eat. Human beings cultivate crops, vegetables and fruits. They also raise different types of animals like cows, buffaloes, sheep, chicken, goat, etc. to get milk, meat and eggs. All plants and animals are also natural resources. It shows that human beings depend on natural resources for food.

2. Habitat

Habitat is the place where plants and animals live and reproduce. Land is the natural habitat of human beings. Human beings construct houses to live. They use timbers, stones, bricks, sand, marble, pebbles, etc. to construct houses. These materials are also natural resources. It shows that human beings depend on natural resources for habitat.

3. Medicinal plants

The plants which are used for making medicines are called medicinal plants. Harro, Barro, Amla, Bojho, Yarshagumba, Panchaule, Sarpagandha, Jatamashi, Timur, etc. are examples of medicinal plants. These plants are used for making medicines to cure various diseases. Medicinal plants are also natural resources. It shows the dependency of human beings on natural resources to get medicines.

4. Air

Air is a mixture of various gases like oxygen, carbon dioxide, nitrogen, etc. Living beings cannot survive without air. Oxygen gas is essential for breathing, carbon dioxide gas is essential for photosynthesis. Similarly, nitrogen gas is essential for making protein. Human beings also use carbon dioxide gas for extinguishing fire and making chemical fertilizer like urea. It shows that human beings depend on air, which is also a natural resource.

5. Water

Water is one of the most important natural resources. Living beings cannot survive without water. Human body consists of 60% water. Plants and animals get affected adversely in the absence of water. Human beings use water for drinking, washing, bathing, cooking, irrigating, etc. Big cities have been constructed near the sources of water. It shows the dependency of human beings on water which is also a natural resource.

6. Land

Human beings depend on lands for various purposes. Human beings use land for making houses, industries, road, cities, etc. Human beings grow crops, vegetables, fruits, etc. on land. We get different types of minerals from land. It shows the dependency of human beings on land which is also a natural resource.

A brief Description of National Parks, Wildlife Reserves and Conservation Areas of Nepal

In order to conserve natural resources, the government of Nepal has established various protected areas and conservation areas. The protected areas include National parks and Wildlife reserves. The government of Nepal has established ten national parks, three wildlife reserves, one hunting reserve and six conservation areas.

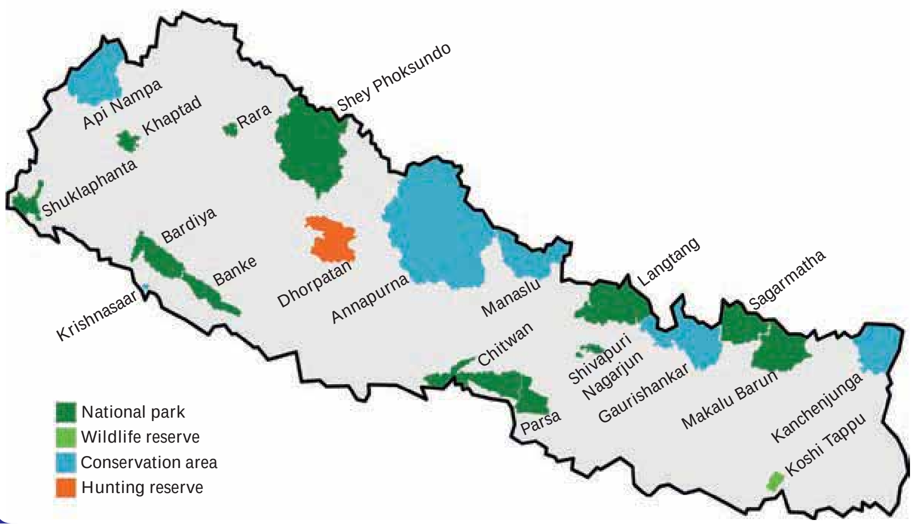


Fig. 22.1 *Protected Areas of Nepal*

National Parks

An area set aside for the conservation and management of natural environment including wild animals, plants and landscape together with their proper utilization is called national park. We can visit, entertain and conduct scientific research inside the national parks by taking permission from the concerned authorities.

The government of Nepal has established 12 national parks in different parts of the country. They are as follows:

1. Chitwan National Park

Chitwan National Park was established in 2030 BS. It covers an area of 932 km^2. It occupies parts of Chitwan, Makawanpur and Parsa Districts. Dense sal forest is found in this national park. Wild animals like Tiger, One horned rhinoceros, Elephant, Bear, Leopard, Ghariyal, Crocodile, Marsh mugger crocodile, Python, Sambar deer, Ratuwa, Laguna, Rhesus monkey, etc. are found in this national park.

Do You Know

- Chitwan National Park is the first National Park of Nepal.
- It was listed in the World Heritage Site in 1984 AD, i.e. 2041 BS.

2. Sagarmatha National Park

The Sagarmatha National Park was established in 2032 BS. It covers an area of 1148 km^2. It is located in the Solukhumbu district. Some high peaks like Lhotse, Nuptse, Pumori, Amadablam, Thamserku and Mt. Everest also lie in this national park. This national park was inscribed as a World Heritage Site in 1979 AD. Plants like Gobre salla, Thigre salla, Dhupi, Bhojpatra, Rhododendron, etc. and animals like Musk deer, Himalayan bear, Tahr, Ghoral, Jharal, etc. are found in this national park. Different types of birds like Lhophophorus, Chilime, Koklas, Himkukhura, Lalchuchche, Himchuchche bird, etc. are found in this national park.

3. Langtang National Park

The Langtang National Park was established in 2032 BS. It occupies an area of 1710 km^2. It occupies part of Rasuwa, Nuwakot and Sindhupalchok districts. The famous religious site Gosainkunda is also located in this national park. Plants like Khote salla, Lauth salla, Langtang salla, Gobre salla, Khashru, Gurans, etc. are found in this national park.

4. Rara National Park

The Rara national park was established in 2032 BS. It covers an area of 106 km^2. This national park lies in the Mugu and Jumla districts of the Karnali zone. The famous Rara lake lies in this national park. This lake is the largest lake of Nepal. Coniferous forest is found around the Rara lake. It is a suitable place for different types of birds. In this national park, birds migrate from Siberia and Mansarobar. Animals like Himalayan bear, Tahr, Ghoral, Musk deer, Badel, etc. are found in this national park.

5. Bardiya National Park

The Bardiya National Park was established in 2032 BS. It occupies an area of 968 km^2. It lies in Bardiya district of the Bheri zone. Most part of this national park is covered with sal forests and grasslands. Wild animals like Tiger, Leopard, Krishnasar (black buck), Neelgai, Deer, Laguna, Stag, Gharial, Crocodile, Marsh mugger, Dolphin, Wild elephant, etc. and different types of birds are found in this national park.

6. Shey-Phoksundo National Park

This national park was established in 2040 BS. It occupies an area of 3355 km^2. It is extended in the Dolpa and Mugu districts. It is the largest national park in Nepal. Shey-phoksundo lake lies in this national park. The park also contains many gompas and other religious sites. Wild animals like Snow leopard, Tibet rabbit, Himalayan bear, Tahr, Ghoral, Nayan, Musk deer, etc. are found in this national park.

Do You Know

Shey-phoksundo lake is the deepest lake in Nepal.

7. Khaptad National Park

This national park was established in 2040 BS. It occupies an area of 255 km^2 in the Bajhang, Bajura, Doti and Achham districts. Plants like salla, khasru, nigalo, etc. and grasslands add beauty to this national park. Wild animals like Ratuwa, Musk Deer, Ghoral, Leopard, Wild dog, Wild cat, Rhesus monkey, etc. and beautiful birds like Danphe and Monal are found in this national park.

8. Makalu Barun National Park

This national park was established in 2049 AD. It covers an area of 2330 km^2 of the Sankhuwasabha and Solukhumbu districts. In this national park, Sunpati, scented herbs, wild flowers, orchid, wild rose, gobre salla, thigre sallo, bhojpatra, rhododendron, arkhauli, phirphire, champ, etc. are found. Similarly, wild animals like Panda, Snow leopard, Tibet rabbit, Himalayan bear, Tahr, Leopard etc. are found in this national park.

9. Shivapuri Nagarjun National Park

This national park was established in 2058 BS. It covers an area of 159 km^2 of the Kathmandu, Nuwakot, Dhading and Sindhupalchok districts. Different types of mushrooms and butterflies are found in this national park. It is a watershed for the Kathmandu valley. Wild animals like Clouded leopard, Leopard, different species of salak, Wild cat, Himalayan bear, Ghoral, Rhesus monkey, Langur, Mongoose, Bandel, Ratuwa, Deer, etc. and different types of birds are found in this national park.

10. Banke National Park

This national park was established in 2067 BS. It covers an area of 550 km^2 in the Banke district. It consists of dense forest of sal, sisso and khayer and grassland. Animals like Tiger, Gharial crocodile, Elephant, Leopard, Bandel, Deer, Stag, Neelgai, Laguna, etc. are found in this national park.

11. Sukla Phanta National Park

Do You Know

The congregation of swamp deer (of about 2000 in a group) in the grassland of Shuklaphanta National Park is the largest in the world.

This national park was eatablised in 2032 BS. It covers an area of 305 km^2 in the Kanchanpur district of Far West Nepal. This national park is rich in grassland and dense forests of sal, sissoo and Khayer. Wild animals like Bengal tiger, Swamp deer, Sloth bear, Leopard, Elephant, One horned rhinoceros, Hispis hare, etc. and birds like Bengal florican, Owl, Eagle, Hornbill, Peacock, Woodpecker, Vulture, Saras crane, Flycatcher, etc. are found in this national park. There are big lakes like Rani tal, Shikari tal and other small lakes where many Marsh mugger crocodiles are found.

12. Parsa National Park

This national park was established in 2040 BS. It covers an area of 499 km^2 in the Chitwan, Makawanpur, Parsa and Bara districts. This national park contains Sal forests and grasslands. Wild animals like Tiger, Wild elephant, Gaur, Wild boar, Leopard, Deer, etc. and different types of birds are found in this national park.

Wildlife Reserve

A wildlife reserve is a separate reserved area for protection and proper management of endangered wildlife. Endangered animals are conserved in wildlife reserves by protecting their habitats. Hunting, grazing, cutting down of trees, etc. are prohibited in wildlife reserves. The government of Nepal has established three wildlife reserve in eastern part of Nepal which is given below:

Koshi Tappu Wildlife Reserve

This wildlife reserve was established in 2032 BS. It covers an area of 176 km^2 in the Sunsari, Saptari and Udaypur districts. This wildlife reserve is surrounded by Saptakoshi river from east and west. The main objective of establishing this wildlife reserve is to conserve and promote wild water buffaloes. This wildlife reserve consists of forests of Sisso and Khayar, grassland and marshy vegetation. Different types of wild animals like Bandel, Laguna, Gharial, Marsh mugger crocodile and different types of birds are found in this wildlife reserve.

Differences between National Park and Wildlife Reserve

National Park	Wildlife Reserve
1. It is an area set aside for conservation and management of natural environment including wild animals, plants and landscapes together with their utilization.	1. It is a separate reserved area for protection and proper management of endangered wildlife.
2. By taking permission from the concerned authorities, we can visit, entertain ourselves and conduct scientific research inside the National Parks.	2. By taking permission from the concerned authorities, we can visit and conduct scientific research inside the wildlife research but no permission for entertainment.

Dhorpatan Hunting Reserve

A hunting reserve is the reserved area established for licensed hunting. The Dhorpatan Hunting Reserve is only one hunting reserve of Nepal. It was established in 2041 BS. It covers an area of 1325 km^2 in Rukum, Baglung and Myagdi districts. Wild animals like Snow leopard, Blue sheep, Musk deer, Jharal, Nayan, Himalayan bear, Himalayan tahr, etc. and birds like Koklas pheasant, Cheer pheasamt, Impeyam pheasant, etc. are found in this hunting reserve. Animals like Himalayan tahr, Wild boar, Blue sheep, Muntjack, etc. can be hunted in this hunting reserve.

Conservation Areas

A conservation area is defined as a protected area which is managed according to the plans for conservation of natural resources, wildlife and their habitat, sustainable development and use of natural resources. The government of Nepal has established six conservation areas in different parts of the country. They are given below:

1. Annapurna Conservation Area
2. Manaslu Conservation Area
3. Kanchenjunga Conservation Area
4. Api-Nampa Conservation Area
5. Gauri Shankar Conservation Area
6. Krishnasaar Conservation Area

Do You Know

The main goal of a conservation area is to achieve sustained balance between nature conservation and socio-economic improvement and to conserve cultural, religious and economic resources of the local people.

1. Annapurna Conservation Area

The Annapurna Conservation Area was established in 2043 BS. It is situated in the north-west side of Pokhara city. It covers an area of 7629 km^2 in the Annapurna range of the Himalayas across the Manang and Lamjung districts. It is being managed by the National Trust for Nature Conservation. This conservation area is rich in biodiversity and is the most popular Trekking destination in Nepal. The National Trust for Nature Conservation is conducting various activities like conservation of resources, community development, tourism management, education and extension for conservation in this area.

2. Kanchenjunga Conservation Area

This conservation area was established in 2054 BS. It covers an area of 1650 km^2 in the Taplejung district and comprises two peaks of Kanchenjunga. In the north, it adjoins Tibet and in the east it adjoins Sikkim of India. It is the habitat of endangered species. It comprises forests, rivers, lakes, glaciers and cultivated land. Plants like Himali larch, Gobre sallo, Thingre sallo, Dhupi sallo, Rhododendron, etc. are found in this conservation area. Among the 30 species of Rhododendron, 24 species are found in this conservation area. Wild animals like Snow leopard, Musk deer, Himalayan black bear, Wolf, Nayan, Ghoral, etc. and different types of birds are found in this conservation area.

Do You Know

The Kanchenjunga Conservation Area is being developed by the WWF in Nepal in partnership with the ICIMOD (International Centre for Integrated Mountain Development).

3. Manaslu Conservation Area

This conservation area was established in 2055 BS. It covers an area of 1633 km^2 in the Gorkha district. Tibet lies in the north and Annapurna conservation lies in the west of this conservation area. Wild animals like musk deer, snow leopard, himalayan tahr, nayan, etc. different types of birds, reptiles and flowering plants are found in this conservation area. The Manaslu Himal is the centre of attraction of this conservation area.

4. Api -Nampa Conservation Area

This conservation area was established in 2067 BS. It covers an area of 1903 km^2 in the Darchula district. Two high peaks Api and Nampa lie in this conservation area. It consists of high peaks, Himalayan medicinal plants and different types of birds. Wild animals like Musk deer, Snow leopard, Himalayan tahr, Nayan, Himalayan black bear, Wolf, Clouded leopard, etc. are found in this conservation area.

5. Gaurishankar Conservation Area

This conservation area was established in 2066 BS. It covers an area of 2179 km^2 in the Dolakha, Sindhupalchowk and Ramechhap districts. It is the origin of rivers like Khimti, Bhotekoshi, Sunkoshi, Tamakoshi, etc. Different types of birds and animals like Snow leopard, Red panda, Brown wolf, Musk deer, Python, etc. and different types of plants and medicinal herbs are found in this conservation area.

6. Krishnasar Conservation Area

This conservation area was established in 2065 BS. It covers an area of 16.95 km^2 in the Bardiya district. This conservation area has been established to conserve Krishnasar, i.e. Black buck.

Project Work

- Pay a visit to a nearby protected area (National park or wildlife reserve or conservation area) in your locality along with your science teacher. Prepare a report after your observation.

Status of Forest in Nepal

"Green forest is the wealth of Nepal." This slogan was very common in Nepal in the past. Upto 2026-27 BS, more than 50% land of Nepal was covered with forests. At present, forests cover about 29% of the land and shrubs cover about 11.6% of the land of Nepal. About 11% of the forest is found in the Terai and Himalayan region whereas more than 50% of the forest is found in the hilly region. People cut down trees for making agricultural land, houses, firewood, furniture, etc. Uncontrolled deforestation for settlement, overgrazing and cutting down of trees for firewood, fodder and illegal logging are the main causes behind decrease in forest in Nepal.

Need and Importance of Forest

Forest is one of the most important natural resources. Human beings get timber, fodder, grass, medicinals plants, fruits, etc. from the forest. Wild animals and birds get food and shelter from the forest.

Forests conserve the soil of the hilly regions and prevent soil erosion. Forests make land fertile and moist which increases the productivity of soil. Forests regulate rain cycle and maintain a balance in the amount of oxygen and carbon dioxide in nature. Different types of wild animals and birds are found in the forests. It helps to attract tourists to earn money. Therefore, forests are very important in the context of Nepal.

Forest Products

Forest products are very important natural resources. Human beings get timbers, firewood, medicines, fodder, fibre, grass, fruits, etc. from the forests. Forests absorb water and prevent soil erosion. Plants help to maintain balance in the amount of oxygen and carbon dioxide in nature. Forests provide habitat to wild animals and birds. Forests help to maintain a balance in the environment.

Timber Trees

Geographically, Nepal can be divided into three regions, viz. the terai, hills and mountain regions. These regions have different landscape and climatic conditions. Therefore, different types of timbers are found in different geographical regions. Timber like Sal, Sissoo, Simal, Jamun, Saj, Harro, Barro, Haldu, Bijaysal, etc. are found in the terai region and plants like Baanjh, Phalant, Katus, Champ, Okhar, Chilaune, Salla, etc. are found in the hilly region. Similarly, plants like Rai Sallo, Thingure Sallo, Bhojpatra, etc. are found in the Himalayan region. Timber plants are used for making houses, furniture, bridges, etc. Weak plants are used for making firewood, fodder, etc. We should not cut down trees and try to conserve forest resources.

Activity 1

- What types of timber plants are found in your locality? Ask your seniors and write down the names and major uses of these timber plants.

Medicinal Plants

The plants which are used for making different types of medicines are called medicinal plants. Different types of medicinal plants are found in the forests of Nepal. About 800 species of medicinal plants are found in the different regions of Nepal. Medicinal plants like Harro, Barro, Amla, Rajbrikshya, Sarpagandha, Asuro, etc. are found in the terai region. Medicinal plants like Chutro, Dhaturo, Chiraito, Bojho, Sugandhawal, Timur, etc. are found in the Mahabharat range and the hilly region. Medicinal herbs like Panchaule, Padamchal, Jatamashi, Yarshagumba, etc. are found in the Himalayan region of Nepal. About 70 types of medicinal plants are exported from Nepal. Medicinal plants like Sarpagandha, Jatamashi, Laghupatra, Panchaule, Bhyakur, Aklebir, etc. are exported from Nepal. Many medicinal plants in Nepal are on the verge of extinction due to deforestation and human activities.

Activity 2

- Prepare a list of medicinal plants that are found in your locality.
- Ask your seniors and write down the uses of these plants.

Protected Plants in Nepal

Those plants which are found less in number and are on the verge of extinction if not protected are called rare plants. Champ, Jatamashi, Yarshagumba, etc. are examples of rare plants. Plants like Sal, Simal, Satisal, Kutki, Jatamashi, Panchaule, Sugandhakokila, Sugandhwal, Lauthsalla, Yarshagumba, Khayar, Bijaysal, etc. are banned for export from Nepal.

Animals and Birds of Nepal

Forest is the habitat of wild animals. Many birds and animals are in a state of extinction due to deforestation. About 170 species of wild animals including Tiger, Rhinoceros, Elephant, Snow leopard, Musk deer, Bear, Water Buffalo, Bandel, Hispid hare, Wolf, Deer, Black Buck, Ghoral,etc. are found in the forests of Nepal. About 860 species of birds including Titra, Danphe, Monal, Kalij, Luinche, Chyakhura, Lamphuchhre, Dhukur, Nyauli, Koili, Mayur, Eagle, Dhanesh, Saras, Vulture, Myna, etc. are found in the forests of Nepal.

The habitat of birds and animals is being destroyed day by day due to human activities. The number of wild animals like Tiger, Snow leopard, Rhinoceros, Elephant, deer, Musk deer, etc. is decreasing day by day due to poaching and encroachment. Similarly, animals like Black buck, Hispid hare, etc. are on the verge of extinction. Therefore, we should conserve forests to conserve wild animals and birds.

Wild animals and birds play an important role to maintain environmental balance. They attract tourists and contribute in the economic development of Nepal. Wild animals and birds provide raw materials for industries. They help to provide employment. Therefore, we should conserve wild animals and birds.

Some Rare Animals and Birds in Nepal

Many species of animals and birds are on the verge of extinction due to deforestation and human activities. These animals and birds are called endangered animals. Similarly, rare animals are those animals which are found less in number and may get extinct from nature if not conserved. In Nepal, many species of birds and mammals are rare. In Nepal, 26 species of mammals, 9 species of birds and 3 species of reptiles are listed as endangered species. Some of them are described below:

1. Giant Pied Hornbill

The Giant Pied Hornbill is found in the forest of the Terai. It has a long beak with a yellowish flattened crest above the beak. Its body colour is brownish black. It has a long tail with white colour. It is an endangered bird of Nepal. Its number is decreasing due to illegal hunting for fat and bones.

Fig. 22.2

Giant Pied Hornbill

2. One-horned Rhinoceros

The One-horned rhinoceros is an endangered mammal found in the Chitwan and Bardiya National Parks. It lives in swampy grasslands and Sal forests. It feeds on grass and shrubs. It gives birth to one calf at a time. It is poached for its valuable horn, hide and hooves.

Fig. 22.3

One-horned Rhinoceros

3. Asiatic Elephant

It is the largest land animal found in the Terai region of Nepal. The habitat of elephant ranges from Jhapa to Parsa, Chitwan, Bardia and Shuklaphanta. Its height is about 3.5 meters. It feeds on leaves, grass, bamboo, crops, etc. It gives birth to one baby at a time. It has a long trunk and two tusks. It is an endangered mammal of Nepal. It is poached for tusks.

Fig. 22.4

Asiatic Elephant

4. Bengal Tiger

The Bengal tiger is an endangered mammal found in the terai region of Nepal. It is found in the Chitwan National Park, Parsa Wildlife Reserve, Bardiya National Park and the Shuklaphanta National Park. It is found in dense forests, grasslands and swamps. It feeds on Deer, Bandel, Jarayo, Laguna, Ratuwa, etc. It produces two to six cubs at a time. It is poached for its hide.

Fig. 22.5

Bengal Tiger

5. Red Panda

The Red panda is an attractive wild animal which is slightly larger than cat. It is found in the temperate bamboo forest at an altitude of 3500 m. It feeds on leaves of bamboo, nigalo, fruits and grasses. Its body colour is rusty red. It is mainly found in Kanchenjunga and Taplejung. It is an endangered animal. It is poached for its attractive furry skin.

Fig. 22.6

Red Panda

6. Asiatic Rock Python

It is a large non-poisonous snake. Its body is white-black and spotted. It is about 7 meter long. It has a series of dark brown and circular spots. It has small eyes and wide head. It is found in the dense forest of the terai region. It hides itself in wooden logs and dry leaves. It feeds on small mammals, birds and reptiles. It is also an endangered species. Its number is being decreased as it is poached for skin.

Fig. 22.7 *Asiatic Rock Python*

Key Concepts

1. There is a close relationship between living beings and non-living things of an environment.
2. The resources like sunlight, air, water, minerals, forests, etc. that are found in nature are called natural resources.
3. Habitat is the place where plants and animals live and reproduce.
4. The plants which are used for making medicines are called medicinal plants.
5. Air is a mixture of various gases like oxygen, carbon dioxide, nitrogen, etc. Living beings cannot survive without air.
6. Human beings use water for drinking, washing, bathing, cooking, irrigating, etc.
7. An area set aside for the conservation and management of natural environment including wild animals, plants and landscape together with their proper utilization is called national park.
8. A wildlife reserve is a separate reserved area for protection and proper management of endangered wildlife.
9. A hunting reserve is a reserved area established for licensed hunting. the Dhorpatan Hunting Reserve is the only hunting reserve in Nepal.
10. A conservation area is defined as a protected area which is managed according to the plans for conservation of natural resources, wildlife and their habitat, sustainable development and use of natural resources.
11. Uncontrolled deforestation for settlement, overgrazing and cutting down of trees for firewood, fodder and illegal logging are the main causes behind decrease in forest in Nepal.
12. Forest products are very important natural resources. Human beings get timbers, firewood, medicines, fodder, fibre, grass, fruits, etc. from the forests.
13. The plants which are used for making different types of medicines are called medicinal plants.
14. About 800 species of medicinal plants are found in the different regions of Nepal.
15. Those plants which are found less in number and are on the verge of extinction if not protected are called rare plants.

16. The habitat of birds and animals is being destroyed day by day due to human activities.
17. Wild animals and birds play an important role to maintain environmental balance. They attract tourists and contribute to the economic development of Nepal.
18. Many species of animals and birds are on the verge of extinction due to deforestation and human activities. These animals and birds are called endangered animals. Similarly, rare animals are those animals which are found less in number and may get extinct from nature if not conserved.
19. In Nepal, 26 species of mammals, 9 species of birds and 3 species of reptiles are listed as endangered species.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Human beings do not depend on environment. ☐

b. The Chitwan National Park is the first national park of Nepal. ☐

c. There are six wildlife reserves in Nepal. ☐

d. The Red Panda is poached for its furry skin. ☐

e. The Bengal tiger is an endangered mammal. ☐

2. Fill in the blanks using appropriate words.

a. .... is the place where living beings live and reproduce.

b. The plants which are used for making medicines are called ....

c. The area of the Bardiya National Park is ....

d. The Shuklaphanta Wildlife Reserve is located in ....

e. .... is the largest land animal.

f. Elephant is found in ....

3. **Answer the following questions.**

   a. What is an environment?

   b. What are natural resources? Write with examples.

   c. What are protected areas? Give examples.

   d. What is a national park? What is the number of national parks established in Nepal so far?

   e. What are conservation areas? Write down the main objectives of conservation areas.

   f. What is a hunting reserve? Name the hunting reserve in Nepal.

   g. What are endangered species? Give examples. Name any four endangered species of Nepal.

4. **Differentiate between:**

   a. National Parks and Wildlife Reserves

   b. Timbers and Medicinal plants

5. **Give reason:**

   a. There is a close relationship between human beings and environment.

   b. We should conserve wild animals.

   c. Human activities affect wild animals.

   d. Protected areas help to conserve wildlife.

   e. Red Panda is an endangered species.

6. **Write a short note on:**

   a. Bengal Tiger

   b. One-horned rhinoceros

   c. Red Panda

   d. Python

7. **What types of medicinal plants are found in Nepal? Describe the importance of medicinal plants in brief.**

8. **Explain the status of wildlife in Nepal.**

9. **Prepare a list of protected areas and conserved areas of Nepal.**

10. **How can you conserve the habitat of wildlife in your locality? Write any three points.**

UNIT 23

Environmental Degradation and Its Conservation

Weighting Distribution (Approximate)	Teaching periods : 6	Marks (in %): 1

Before You Begin

Environment is the natural world around us. It consists of living beings and non-living things. Human beings depend on environmental components like air, water, soil, sunlight, etc. They get food and shelter from the environment. Human beings construct roads, buildings, houses, factories, etc. on the land. They cut down trees to make land for settlement and agriculture. Various human activities and natural disasters degrade the quality of environment and damage its quality. The damage or disturbance in any aspect of the environment due to human activities and natural disasters is called environmental degradation. Degradation in the quality of air, water, soil and fertile land, deforestation, etc. are examples of environmental degradation.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce environmental degradation and explain environmental pollution (air, water, land and sound pollution) and its effects.
ii. describe greenhouse effect and its impact on environment due to global warming.
iii. introduce climate change, its effects and describe local efforts to reduce climate change.
iv. introduce acid rain and state its causes and effects.
v. explain measures of environment conservation.
vi. introduce different natural disasters and state their causes.
vii. describe the measures of disaster management and reduction.
viii. introduce and explain the role of NTNC, IUCN, WWF, UNEP and ICIMOD.

Syllabus

- Introduction to environmental degradation
- Effects of human activities in environment
- Environment pollution
  - Air pollution -Water pollution
  - Land pollution - Sound pollution
- Greenhouse effect
- Climate change and its effects
- Acid rain- causes effects and control measures
- Disaster and disaster management
- Methods of environment conservation
- Introduction to national and international organizations involved in environment conservation

Glossary: A dictionary of scientific/technical terms

degradation	:	the damage or disturbance to any aspect of something
conservation	:	a careful preservation and protection of something, planned management of natural resources to prevent exploitation, destruction, etc.
monument	:	a building, column, statue, etc.
canopy	:	a layer that spreads over an area like a roof
pathogenic	:	related to things that cause diseases

Environmental Degradation and Its Conservation

Environmental Degradation

Various human activities like deforestation, industrialization, urbanization, etc. and natural disasters like flood, landslide, earthquake, soil erosion, etc. degrade the quality of the environment. The disturbance or damage to any aspect of the environment due to human activities and natural disasters is called environmental degradation.

Effects of Human Activities on Environment

Human beings use natural resources to fulfill their needs. They exploit natural resources like land, air, water, timbers, etc. to meet the demand of increasing population. Various natural resources are used to conduct development activities. These activities affect the environment adversely. The environment is being polluted day by day due to human activities.

Environment Pollution

Environment pollution can be defined as the contamination of the environment due to mixing of waste materials that make the environment impure. It degrades the quality of air, water, soil, etc. Environmental pollution can be classified into the following four types.

1. Air pollution
2. Water pollution
3. Land pollution
4. Noise pollution

1. Air pollution

Air is a mixture of different gases like nitrogen (78.1%), oxygen (20.9%), carbon dioxide (0.03%), etc. The quality of air is being degraded day by day due to mixing of harmful gases and dust particles. The contamination of air with unwanted and harmful substances is called air pollution.

Fig. 23.1 Air pollution

Major causes of air pollution

i. The smoke released from automobiles causes air pollution.

ii. The smoke and harmful gases released from factories and industries cause air pollution.

iii. The smoke produced by burning plastics, firewood, etc. causes air pollution.

iv. The mixing of harmful gases like sulphur dioxide, carbon monoxide, nitrogen oxide, etc. causes air pollution.

v. The harmful gases released from dead and decaying materials also cause air pollution.

vi. The mixing of dust particles in air causes air pollution.

Effects of air pollution

i. Air pollution affects human health adversely. Various diseases like asthma, bronchitis, lung cancer, eye infection, etc. are caused due to air pollution.

ii. It affects plants and cultural resources.

iii. Air pollution causes global warming.

iv. Air pollution causes acid rain.

v. Air pollution reduces visibility which may lead to accidents.

2. Water Pollution

Water covers about 71% of the earth's surface. Rivers, ponds, lakes, underground water, etc. are the sources of water. Various human activities are responsible for water pollution. The contamination of water with unwanted and harmful substances is called water pollution. Polluted water becomes unfit for drinking, cooking, bathing, etc.

Fig. 23.2 *Water pollution*

Causes of water pollution

1. The mixing of sewage and garbage in the sources of water causes water pollution.

ii. The mixing of untreated wastes like industrial wastes, hospital wastes, etc. causes water pollution.

iii. The excessive use of insecticides and chemical fertilizers causes air pollution.

iv. The excessive use of synthetic detergents causes water pollution.

v. The washing of clothes and utensils near the sources of water causes water pollution.

vi. The bursting or cracking of drinking water pipes and drainage pipes causes water pollution.

Effects of water pollution

i. Polluted water causes various water borne diseases like typhoid, cholera, diarrhoea, dysentery, hepatitis, etc.

ii. Polluted water affects aquatic plants and animals.

iii. Polluted water affects photosynthesis in plants.

iv. Polluted water spreads bad smell and causes air pollution.

3. Land pollution

Land is that part of the earth which is made of soil and rocks. The quality of soil is being destroyed day by day due to human activities. The contamination of land due to mixing of waste materials is called land pollution.

Fig. 23.3 *Land pollution*

Causes of land pollution

i. The excessive use of chemical fertilizers and insecticides causes land pollution.

ii. The mixing of non-degradable wastes in soil causes land pollution.

iii. The disposal of industrial and agricultural wastes in soil causes land pollution.

iv. The disposal of households wastes and plastics on soil causes land pollution.

Effects of land pollution

i. Land pollution decreases the productivity of crops.

ii. Polluted land affects the organisms in soil.

iii. Polluted land spreads bad smell and causes air pollution.

iv. Polluted land causes water pollution.

v. Polluted land contaminates the crops.

4. Noise pollution

The production of unwanted loud sound is called noise pollution. Vehicles, loudspeakers, crowd, musical instruments, machineries, etc. are the sources of noise.

Fig. 23.4 *Noise pollution*

Causes of noise pollution

i. Automobiles like trucks, buses, cars, motorcycles, aeroplanes, etc. cause noise pollution.

ii. Various machines in industries and construction sites cause noise pollution.

iii. Use of loudspeakers, tape recorders, etc. causes noise pollution.

iv. Playing musical instruments in high volume and blowing pressure horns in vehicles also cause noise pollution.

Effects of noise pollution

i. Noise pollution weakens hearing capacity.

ii. It increases irritability and loss of concentration.

iii. It increases blood pressure and mental tension.

iv. It causes insomnia, migraine and headache.

v. It may rupture the ear drum and cause deafness.

vi. Noise pollution results in psychological disorders.

Differences between Environmental degradation and Environmental pollution

Environmental degradation	Environmental pollution
1. The damage or disturbance in any aspect of the environment due to human activities and natural disasters is called environmental degradation.	1. The contamination of the environment due to mixing of harmful and unwanted substances which make environment impure is called environmental pollution.
2. Flood, landslide, earthquake, deforestation, urbanization, etc. are the major causes of environmental degradation.	2. Air pollution, water pollution, land pollution, noise pollution, etc. are the major causes of environmental pollution.

Greenhouse Effect

The earth is surrounded by a thick layer of air called atmosphere. Various gases like carbon dioxide, carbon monoxide, methane, ozone, nitrous oxide, sulphur dioxide and water vapour surround the earth. These gases are called greenhouse gases.

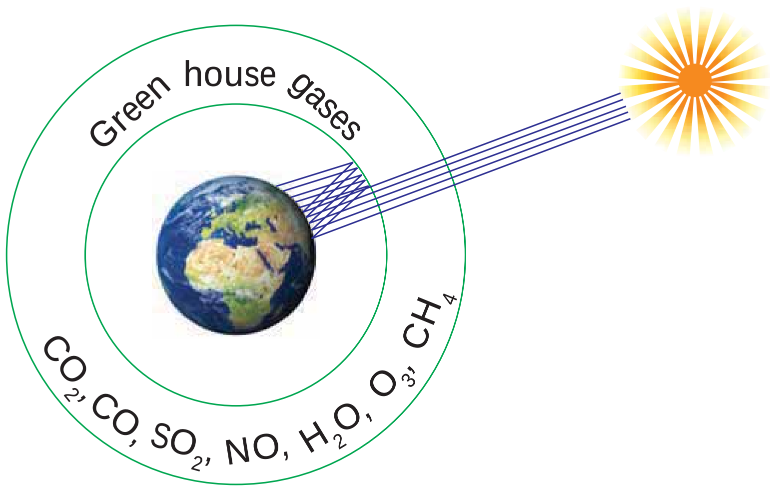


Fig. 23.5 *Greenhouse effect*

The greenhouse gases cover the earth's surface making dense canopy as in the glass frame of an artificial greenhouse. This canopy allows the solar radiations to enter to the earth's surface but does not allow them to escape out after reflection. As a result, the temperature of the earth's surface increases. This process is called greenhouse effects. So, greenhouse effect can be defined as the phenomenon of increasing temperature of the earth due to greenhouse gases. The temperature of the earth is increasing gradually due to greenhouse effect. This process is called global warming.

Due to global warming, the ice of the Himalayas in the polar region melts which increases the level of the sea. It affects the people in coastal regions. If there were no greenhouse gases in the atmosphere, all the solar radiations entering the earth's surface would escape into the space. Due to this, the temperature of the earth would be less by –18°C than earth's surface. Ice would cover the earth's surface and there would not be any organism on the earth. It shows that limited amount of green house effect is essential for survival of living beings. Due to human activities, greenhouse effect is increasing day by day on the earth. It is responsible for increase in temperature on the earth's surface and change in climate.

Causes of increase in greenhouse gases in the atmosphere

i. The increase in the amount of carbon dioxide and carbon monoxide released by burning of substances.

ii. The mixing of harmful gases like CO_2, CO, SO_2, NO, etc. in the atmosphere released from industries, factories, etc.

iii. The mixing of harmful gases released by automobiles in the atmosphere.

iv. The mixing of greenhouse gases produced by dead and decaying substances in the atmosphere.

v. The mixing of water vapour in the atmosphere.

vi. Deforestation and forest fire.

Effects of greenhouse effects

i. It increases the temperature on the earth's surface.

ii. It changes the climate on the earth's surface.

iii. It affects the water cycle.

iv. It increases the level of the sea and affects the people of coastal regions.

v. It decreases the thickness of ice in the Himalayas.

Climate Change

Climate change is a natural process. Human activities and natural disasters are the main causes of climate change. The change in the earth's global climate over time is called climate change. Increase in the amount of greenhouse gases in the atmosphere is the main cause of climate change. Deforestation, industrialization, overuse of fossil fuels, forest fire, etc. are responsible for climate change.

Effects of climate change

i. It melts the ice of the Himalayas and the polar region.
ii. It increases the level of the sea.
iii. It causes loss of biodiversity.
iv. It changes the pattern of rainfall and weather condition.
v. It affects the pattern of cultivation and harvesting periods which affects the productivity of crops.
vi. It decreases the amount of fresh water.
vii. It causes improper distribution of rainfall.
viii. It affects the health of human beings.

Acid Rain

Acid rain is the rain containing small amount of acids like sulphuric acid, nitric acid, carbonic acid, etc. Industrial gases like carbon dioxide, carbon monoxide, sulpur dioxide, nitric oxide, etc. mix with rain water and form different acids like carbonic acid, sulphuric acid, nitric acid, etc. The acidity of acid rain water is more than that in the normal rain.

Causes of acid rain

Various toxic gases like sulphur dioxide, carbon dioxide, carbon monoxide, nitrous oxide, etc. are released from industries and these gases move up in the atmosphere. Gases like carbon dioxide, carbon monoxide, etc. react with rain water and form carbonic acid. Sulphur dioxide reacts with rain water and forms sulphuric acid. Similarly, nitrous oxide and nitric oxide react with rain water and form nitric acid. In this way, different types of acids are formed in the atmosphere and they fall down along with rain.

Fig. 23.6 *Effect of acid rain*

Effects of acid rain

i. Acid rain causes different types of skin diseases in human beings and other animals.
ii. It decreases the fertility of soil and affects the productivity of crops.
iii. Acid rain damages historical monuments, sculpture, idols, etc.
iv. It corrodes rocks and metals.
v. It increases the acidity of water which affects aquatic organisms.
vi. It affects the growth and development of plants.

Disaster and Disaster Management

We have experienced a variety of disasters like earthquake, flood, landslide, fire, etc. An event that occurs suddenly and affects life and property is called a disaster. Disasters seriously disrupt the function of a community or a society involving economic and environmental losses.

Fig. 23.7

Flood

Landslide

Earthquake

Disasters can be divided into two types. They are (i) natural disasters and (ii) human induced disasters.

i. Natural disasters

The natural events that occur suddenly and cause loss of life and property are called natural disasters, eg. earthquake, flood, landslide, cyclone, volcanic eruption, etc.

ii. Human induced disasters

The disasters that occur due to human activities are called human induced disasters, e.g. road accident, aircraft accident, fire, bomb explosion, oil spills, etc.

Fig. 23.8

Road accident

Aircraft accident

Bomb explosion

Causes of disasters

Disasters like flood, landslide, etc. occur every year in Nepal. Slopes and fragile geological structure, deforestation, unmanaged industrialization, population growth, unmanaged settlement, unmanaged urbanization, unscientific agricultural practices in slopes, unmanaged construction, misuse of fire, etc. are the major causes of occurrence of disasters in Nepal. The disasters that commonly occur in Nepal are flood, landslide, forest fire, storm, glacier lake outburst, epidemics, lightning, earthquake, etc.

Management and Mitigating Measures of Disasters

Disasters occur due to various causes. We should select disaster management and mitigating measures on the basis of the causes of disaster. Some disasters and their management and mitigating measures are described below:

i. Preparedness

ii. Rescue of the affected people

iii. Help, rehabilitation of and relief to the effected people

iv. Mobilization of help in a proper way

v. Development of public awareness

1. Management and mitigating measures for earthquake

An earthquake is the sudden shaking of the earth's surface. It occurs due to various reasons. It damages human constructed works like buildings, houses, roads, bridges, etc. and kills human beings and other animals. Earthquake may occur at any time. So we should adopt various measures to keep us safe during the earthquake.

Fig. 23.9 *Earthquake*

Preventive measures before earthquake

i. We should identify a safe place inside and outside the house.

ii. We should firmly fix cupboards, photo frames, television, mirror, etc. to the wall so that they do not fall and hurt us during the earthquake.

iii. We should repair the foundation of house, walls, ceilings, windows, windowpanes, electric wires, etc. on time.

iv. We should keep an emergency bag keeping dry food, radio, mobile phone, torch light, water bottle and first aid box.

Measures to be adopted during earthquake

i. If we are near the door of the house and if there is a safe open place we should move to the safe place outside the house carefully quickly.

ii. If we are sitting inside the house, we should stay in the safe place inside the house.

iii. If we are sitting/working outdoor, we should stay in the safe open place. But we should not stay just below electric cables and near the trees.

iv. If we are riding/driving vehicle, we should stop the vehicle and stay safely.

v. We should switch off electric supply and close the gas stove.

vi. We should not panic too much.

Measures to be adopted after earthquake

i. We should stay in a safe place and we should not enter the house immediately after an earthquake.

ii. We should rescue the victims carefully.

iii. We should give first aid to the injured persons and take them to the hospital immediately.

iv. If we get injured, we should seek help from others.

v. We should inform the rescue team on time.

vi. If we are inside the house, we should go to the safe open place after the earthquake.

vii. We should check the condition of the house such as pillars, walls, window panes, doors, etc. before entering.

viii. We should listen to the emergency news of the earthquake broadcast by radio/ TV and take caution accordingly.

2. Management and mitigating measures for flood and landslide

The overflow of water on both sides of a river, stream, etc. due to heavy rainfall, melting of ice, outburst of glacier lakes, blockade of river, etc. is called flood. Flood destroys life and property. Flood covers roads, fertile land, crops, human settlement, bridges, etc. Flood mainly occurs in the Terai region and causing damage to unmanaged cities of Nepal every year. Similarly, the slide of landmass, soil, rock, etc. down wards due to effect of gravity is called landslide. The mitigating measures and management of flood and landslide are given below.

Mitigating measures for flood and landslide

i. We should not panic.

ii. We should stay in a safe place.

iii. We should not try to cross the flooded river.

iv. We should help the affected people.

v. We should inform seniors or rescue team if we see a blocked river or stream.

vi. We should give first aid to victims and rush them to hospital for treatment.

vii. We should manage the dead bodies properly after flood and landslide.

Fig. 23.10

Flood

Landslide

Management of flood and landslide

i. Embankment should be done on the bank of rivers, streams, etc.

ii. Construction of houses and buildings on the slopes and banks of rivers should be avoided.

iii. We should plant trees having fibrous roots like bamboo, etc. on the bank of rivers and the places where soil erosion takes place.

iv. We should plant trees on bare land.

v. We should identify flood and landslide prone areas.

vi. Terrace farming should be adopted in slopes.

vii. Proper drainage of water should be done.

3. Management and mitigating measures of fire

Fire is a condition in which flames go out of control and destroy life and property. Every year fire destroys a lot of life and property in Nepal. Short-circuiting, misuse and mishandling of fire or sources of fire are the main causes of fire in Nepal. Fire mainly occurs in hot and dry summer days. If fire catches the forest, it is called forest fire or wild fire. Fire damages life, property, human, settlements, etc. It also kills people, wild animals, birds, plants, etc.

The management and mitigating measure of fire are given below:

i. We should keep the sources of fire like match box, lighter, etc. out of the reach of children.

Fig. 23.11

Fire on house

Forest fire

ii. We should not throw cigarette butts in the forest or other places.

iii. We should check and maintain the household wiring system periodically.

iv. We should not smoke and put fire in the forest.

v. We should try to douse fire if it catches the house or the forest.

vi. We should keep fire brigade in alert condition.

vii. We should help fire victims and give first aid to them.

viii. We should extinguish fire properly after cooking food.

4. Management and mitigating measures for epidemics

The rapid spread of communicable diseases among many people in a short period of time is called epidemics. It kills many people within a short time. The management and mitigating measures for epidemics are given below:

i. We should keep our surroundings clean.

ii. We should drink boiled and filtered water.

iii. We should conduct sanitation programmes.

iv. We should keep our water resources neat and clean.

v. We should pay attention to personal hygiene.

vi. We should kill the vectors/agents of diseases.

vii. We should take patients to hospitals for treatment.

viii. We should adopt precautions and preventive measures agains epidemics.

Methods of Environment Conservations

We should use natural resources wisely and economically while conducting development works in order to conserve the environment. Both environment and development are interrelated to each other. Sustainable development can be done only with the wise and economic use of natural resources without affecting natural environment. Natural environment is the common property of all human beings and other organisms. Therefore, human beings should play a great role to conserve natural environment. The natural resources should not be over exploited while conducting development works. We should adopt following measures to conserve environment.

1. Generating public awareness

Public awareness should be generated to conserve natural environment. The effort of the government or a few people is not sufficient to conserve natural environment for sustainable development. Public participation plays a significant role for economic development and environment conservation. We should give proper education to local people to generate awareness for environment conservation. We should conduct various programmes like public notice, workshop, training, etc. to generate public awareness.

2. Afforestation and conservation of forest

Forest plays a great role to maintain balance in natural environment. Similarly, forest help to reduce soil erosion and landslide. Therefore, we should plant trees on bare lands and conserve the existing forest to conserve the natural environment.

Fig. 23.12 Plantation of trees

3. Conservation of water resources

The conservation of rivers, ponds, streams, pools, snow, etc. is the conservation of water resources. We should protect water resources from pollution, flood and landslide. We should plant trees near the sources of water. We should conduct cleaning campaigns and should not throw waste materials into the sources of

Fig. 23.13 Cleaning around water resources

water. We should not bath and wash clothes in the sources of water. We should not defecate near the sources of water. Conservation of water resources helps to conserve natural environment.

4. Conservation of soil

Soil is one of the most important natural resources. We should conserve soil to preserve its natural quality and fertility. We should not throw waste materials in the soil. We should reduce the use of insecticides, pesticides and chemical fertilizers. We should control overgrazing. We should plant trees on bare land. We should encourage afforestation and deforestation to conserve the soil. Embankment should be done on the bank of rivers, streams, etc. We should plant trees like bamboo on the bank of rivers, streams, etc. Similarly, terrace farming should be done in the slopes to conserve the soil.

Fig. 23.14

Embankment on riverside

5. Pollution control and environmental sanitation

Environmental pollution is a burning issue at present. Industrialization, unmanaged urbanization, overuse of fossil fuels, lack of awareness, etc. are the major causes of environmental pollution. We should manage wastes properly. Biodegradable wastes should be used to produce compost manure. Non-biodegradable wastes should be recycled and reused properly. Hospital wastes and industrial wastes should be disposed properly. We should use biogas and solar energy for cooking. We should conduct sanitation programmes to keep our surroundings clean.

Fig. 23.15

Dirty environment

Clean environment

6. Conservation of cultural resources

Our country is rich in cultural resources. Temples, Gompas, Stupas, etc. are our cultural resources. We should conserve and promote our cultural resources. We should keep the surroundings of cultural resources neat and clean.

7. Public participation

Public participation plays a significant role to conserve natural environment. We should involve as many people as possible to conserve the environment.

National and International Agencies Involved in Environment Conservation and Promotion

1. National Trust for Nature Conservation (NTNC)

The National Trust for Nature Conservation was established in 1982 AD to work in the field of nature conservation and sustainable development. It is an autonomous non-governmental organization of Nepal which is supported by a network of international partners. It manages the Annapurna Conservation Area Project (ACAP) and the Manaslu Conservation Area Project (MCAP) together with other projects in and around national parks and wildlife reserves of Nepal.

Fig. 23.16 NTNC

The National Trust for Nature Conservation has successfully undertaken many projects on nature conservation, tourism, biodiversity, development management and sustainable rural development.

2. World Conservation Union (IUCN)

The World Conservation Union (IUCN) was established in 1984 AD in the name of the International Union for Conservation of Nature and the Natural Resources Nepal is a member of the IUCN since 1973 AD. The IUCN focuses on natural conservation, biodiversity and nature based solutions. The mission of the IUCN is to influence, encourage and assist societies throughout the world to conserve nature and natural resources. The IUCN helps Nepal to design curriculum and publish books,

Fig. 23.17 IUCN

construct educational materials, frame environmental policy to conserve forest and wildlife and to manage national parks and wildlife reserves. The IUCN focuses on the study of status of environment, policy making and sustainable development. It also publishes the IUCN red list of threatened animals. The IUCN spreads scientific knowledge regarding endangered species.

3. World Wide Fund for Nature (WWF)

The World Wide Fund for Nature was established in 1961 AD. It was formally called the World Wildlife Fund. It is the world's largest independent conservation organization working in more than 100 countries including Nepal. It is working on issues regarding the conservation, research and restoration of the environment. The main mission of the WWF is to stop degradation of the earth's natural environment and to build a future in which humans live in harmony with nature by conserving the world's biodiversity, ensuring the use of renewable resources is sustainable, promoting the reduction of pollution and wasteful consumption.

Fig. 23.18 WWF

In Nepal, the IUCN helps to conserve watersheds, endangered species of flora and fauna like red panda, tiger, one-horned rhino, etc.

4. United Nations Environment Programme (UNEP)

In June 1972, United Nations Organization organized a conference in Sweden regarding environment conservation. This conference propounded the concept that we should conserve environment for healthy living and for use by our future generations. This conference also decided to celebrate June 5 as the World Environment Day every year. At the end of 1972, the General Assembly of the UNO established the United Nations Environment Programme. The UNEP is an agency of the UN that co-ordinates the United Nations environment activities. The UNEP assists developing countries including Nepal in implementing, environmentally sound policies and practices. The governments of different countries, scientists, businessmen, ladies and youths are involved in various programmes organized by the UNEP.

Fig. 23.19 UNEP

5. International Centre for Integrated Mountain Development (ICIMOD)

The ICIMOD was established in 1983 AD. The central office of the ICIMOD is located in Khumaltar, Lalitpur of Nepal. It is the first regional intergovernmental learning and knowledge sharing centre. In the ICIMOD, there are eight member countries of the Hindukush Himalayan region. They are Nepal, China, India, Afghanistan, Bangladesh, Myanmar, Pakistan and Bhutan.

The ICIMOD is committed to a shared vision of prosperous and secured mountain communities committed to peace, equity and environmental sustainability. The mission of The ICIMOD is to develop and provide integrated and innovate solutions in cooperation with national, international and regional partners. It works to conserve the ecosystem, social and cultural diversity of the hilly region through knowledge sharing and regional cooperation.

Fig. 23.20 *ICIMOD logo*

Activity 1

- Observe the condition of the environment in your locality. Visit a place hit by soil erosion, flood or landslide. Prepare a short report on it.
- What role can you play to conserve the natural environment in your locality? Prepare a short report and submit it to your science teacher.

Key Concepts

1. Environment is the natural world around us. It consists of living beings and non-living things.
2. The damage or disturbance in any aspect of the environment due to human activities and natural disasters is called the environmental degradation.
3. Environment pollution can be defined as the contamination of the environment due to mixing of waste materials that make the environment impure.
4. The contamination of air with unwanted and harmful substances is called air pollution.
5. The contamination of water with unwanted and harmful substances is called water pollution.
6. The contamination of land due to mixing of waste materials is called land pollution.
7. Various gases like carbon dioxide, carbon monoxide, methane, ozone, nitrous oxide, sulphur dioxide and water vapour surround the earth. These gases are called greenhouse gases.

8. Greenhouse effect can be defined as the phenomenon of increasing the temperature of the earth due to greenhouse gases. The temperature of the earth is increasing gradually due to greenhouse effect. This process is called global warming.
9. Due to human activities, greenhouse effect is increasing day by day on the earth. It is responsible for the increase in temperature on the earth's surface and change in climate.
10. The change in the earth's global climate over time is called climate change. Increase in the amount of greenhouse gases in the atmosphere is the main causes of climate change.
11. Acid rain is the rain containing small amount of acids like sulphuric acid, nitric acid, carbonic acid, etc.
12. An event that occurs suddenly and affects life and property is called a disaster.
13. The natural events that occur suddenly and cause loss of life and property are called natural disasters.
14. The disasters that occur due to human activities are called human induced disasters.
15. The disasters that commonly occur in Nepal are flood, landslide, forest fire, storm, glacier lake outburst, epidemics, lightning, earthquake, etc.
16. Earthquake is the sudden shaking of the earth's surface.
17. Earthquake may occur at any time. So, we should adopt various measures to keep us safe during the earthquake.
18. If we are near the door of the house and if there is a safe open place we should go to the safe place outside the house carefully and quickly.
19. The overflow of water on both sides of a river, stream, etc. due to heavy rainfall, melting of ice, outburst of glacier lakes, blockade of river, etc. is called flood.
20. The slide of landmass, soil, rock, etc. down wards due to effect of gravity is called landslide.
21. Fire is the condition in which flames go out of control and destroy life and property. Every year fire destroys a lot of life and property in Nepal.
22. If the fire catches the forest, it is called forest fire or wild fire. Fire damages life, property, human, settlements, etc. It also kills people, wild animals, birds, plants, etc.
23. The rapid spread of communicable diseases among many people in a short period of time is called epidemics.
24. We should use natural resources wisely and economically while conducting development works in order to conserve the environment.

25. Natural environment is the common property of all human beings and other organisms. Therefore, human beings should play a great role to conserve natural environment.
26. Public participation plays a significant role for economic development and environment conservation.
27. We should plant trees on bare lands and conserve the existing forest to conserve the natural environment.
28. Environmental pollution is a burning issue at present. Industrialization, unmanaged urbanization, overuse of fossil fuels, lack of awareness, etc. are the major causes of environmental pollution.
29. Public participation plays a significant role to conserve natural environment. We should involve as many people as possible to conserve the environment.
30. The National Trust for Nature Conservation was established in 1982 AD to work in the field of nature conservation and sustainable development.
31. The mission of the IUCN is to influence, encourage and assist societies throughout the world to conserve nature and natural resources.
32. The main mission of the WWF is to stop degradation of the earth's natural environment and to build a future in which humans live in harmony with nature.
33. The ICIMOD is committed to a shared vision of prosperous and secured mountain communities committed to peace, equity and environmental sustainability.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Human beings exploit natural resources to fulfill their demands. ☐

b. The percentage of nitrogen gas in the atmosphere is 20.9%. ☐

c. Land pollution increases the productivity of crops. ☐

d. Road accidents and explosion of bombs are human induced disasters. ☐

e. The ICIMOD was established in 1983 AD. ☐

2. Fill in the blanks using appropriate words.

a. The contamination of water with wastes and unwanted materials is called ....

b. The ice of the Himalayan and the polar region melts due to ....

c. The events that occur suddenly and cause loss of life and property are called ....

d. The sudden shaking of the earth is called ....

e. The NTNC was established in ....

3. Answer the following questions.

a. What is meant by environmental degradation?

b. What is environmental pollution?

c. What is air pollution? Write any three causes and three effects of air pollution.

d. What is water pollution? Write any three causes and three effects of water pollution.

e. What is land pollution? Write its causes and effects.

f. What is sound pollution? Write any three causes and four effects of sound pollution.

g. What is greenhouse effect?

h. Name any three greenhouse gases.

i. Write any three causes that increase greenhouse gases in the atmosphere.

j. Write any three adverse effects of greenhouse gases.

k. What is meant by climate change? Write down any four effects of climate change.

l. What is acid rain? Write down causes, effects and preventive measures of acid rain.

m. What are disasters? Name the two types of disasters.

n. Write any five measures for mitigating disasters.

o. What is an earthquake? Write down its mitigating measures.

4. Write short notes on:

a. IUCN

b. NTNC

c. WWF

d. ICIMOD

5. What is meant by epidemics? Write down the management and mitigating measures of epidemics.

6. What is a forest fire? Write down the management and mitigating measures of fire.

7. Write any five measures for environment conservation. Describe any two of them in brief.

UNIT 24

Environment and Sustainable Development

Weighting Distribution (Approximate)	Teaching periods : 8	Marks (in %): 2

Before You Begin

Environment is the natural world around us where plants and animals live. Environment consists of the physical world us well as the biological world. The earth is the common habitat for all plants and animals. Living beings get air, water, food, habitat, etc. from the earth. Environment is made of the abiotic and the biotic components. The abiotic components of the environment include sunlight, air, water, soil, temperature, pressure, rainfall, etc. Similarly, the biotic components of an environment include different types of plants and animals.

Sustainable development refers to development that lasts long and does not degrade the environment. Sustainable development is the process of development that meets the need of present generation without compromising the ability of future generations to meet their own needs.

Learning Objectives

After completing the study of this unit, students will be able to:

i. introduce environment and sustainable development.

ii. define biodiversity and explain its types with examples.

iii. explain the principles of sustainable development.

iv. describe global efforts for sustainable development.

v. explain the importance of sustainable development.

Syllabus

- Biodiversity
- Types of biodiversity
  - Ecosystem diversity
  - Species diversity
  - Genetic diversity
- - Principles of sustainable development
- Global efforts of sustainable development
- Importance of sustainable development

Glossary: A dictionary of scientific/technical terms

sustainable	:	capable of being sustained, able to be used without being completely used up or destroyed
biodiversity	:	the existence of large number of plants and animals
species	:	a group of closely related organisms which can interbreed freely to produce fertile offspring
genetic	:	heritable, relating to or determined by the origin
ecosystem	:	the structural, functional and self-sustaining unit made of living beings and non-living things
mutual	:	shared between two or more people or groups

Environment and Sustainable Development

Biodiversity

Biodiversity is the existence of different types of plants and animals on the earth. A variety of living organisms, viz. plants and animals are found around us. They differ in habitat, structure, shape, size, colour, behaviour, life cycle, reproduction, etc. In simple words, biodiversity is the biological diversity. It refers to the genetic variation, ecosystem variation and species variation on the earth.

Types of Biodiversity

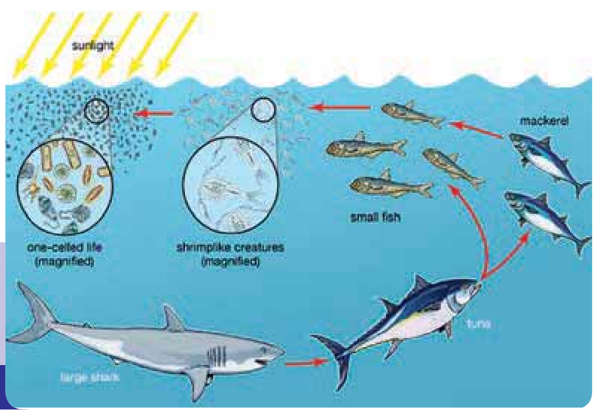
There are three types of biodiversity. They are as follows:

1. Ecosystem diversity
2. Species diversity
3. Genetic diversity

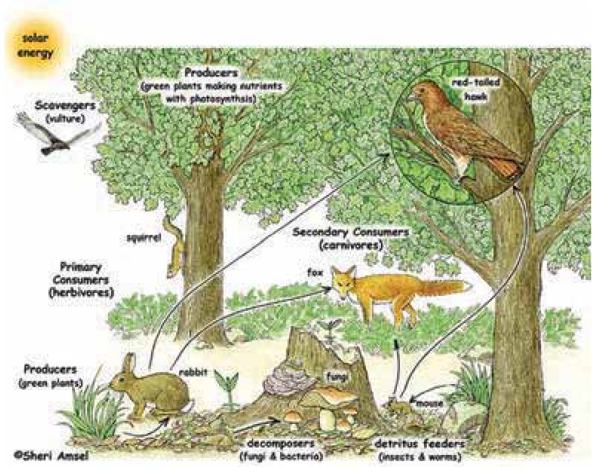
1. Ecosystem diversity

There is a close relationship between living beings, non-living things and physical environment. Due to this relationship, a fixed type of ecosystem is formed in a certain place. An ecosystem can be defined as the self-sustainable structural and functional unit of the biosphere. There are two main type of ecosystems, viz. aquatic ecosystem and terrestrial ecosystem. The ecosystem that operates in water is called aquatic ecosystem. The aquatic ecosystem includes fresh water ecosystem and marine water ecosystem. Fresh water ecosystem includes river, pond, lake, pool, etc. Similarly, the terrestrial ecosystem includes forest, grassland, cropfield, desert, etc. These ecosystems differ from each other in various aspects. There is a great difference in the aquatic and terrestrial ecosystems in Nepal due to variation in climate and geological structure. Therefore, different types of animals and plants are found in different parts of Nepal.

Fig. 24.1



Aquatic ecosystem



Forest ecosystem

2. Species diversity

A group of closely related organisms which can interbreed freely to produce fertile offspring is called species. Different types of living beings are found on the earth. One species of plant or animal is different from another species. Different types of plants are found around us. They are named as algae, fungi, moss, fern, trees, herbs, shrubs, climbers, etc. on the basis of differences among them. Similarly, animals are named as cow, buffalo, dog, cat, sheep, tiger, human, etc. on the basis of differences among them. The organisms that look similar in structure may have many differences. For example, goat and dog both are mammals but they also have many differences among them. Therefore, the variation among the organisms of different species is called species diversity.

Fig. 24.2

Species diversity

3. Genetic diversity

In every offspring, the genetic characteristics are transferred from parents to their offspring with the help of genes. The heredity units that transfer genetic characteristics from parents to their offspring are called genes. They are located in chromosomes. There is variation among the members of the same species. Similarly, there is variation among the offspring of the same parents. Such variation is called genetic diversity. So genetic diversity can be defined as the variation among the members of the same species. For example, the diversity among human beings such as Aryan, Mangol, Nigro, etc. In Nepal, genetic diversity can be seen among different castes such as Brahmin, Newar, Gurung, Magar, Sherpa, Rai, Limbu, Tharu, etc. Nepal is a rich country in genetic diversity.

Brahmin

Newar

Gurung

Magar

Fig. 24.3

Sherpa

Rai

Limbu

Tharu

Activity 1

Study the biodiversity (ecosystem diversity, species diversity and genetic diversity) in your locality. Write a short report on it and submit to your science teacher.

Differences between Ecosystem diversity and Species diversity

Ecosystem diversity	Species diversity
1. It is the variation on the self-sustaining systems in which there is interaction between biotic and abiotic components.	1. It is the variation among the organisms of different species.
2. It refers to the diversity of a place at the level of an ecosystem.	2. It refers to the variation of different kinds of species of our surroundings.

Differences between Species diversity and Genetic diversity

Species diversity	Genetic diversity
1. It is the variation among the organisms of different species.	1. It is the variation in hereditary units that transfer parental characteristics to their offspring.
2. It refers to the variation of different kinds of species of our surroundings.	2. It refers to the variation among the members of the same species.

Principles of Sustainable Development

Development is the process of growing or causing something to grow or become larger or more advanced. Human beings conduct various development works for their benefit. Human beings create an artificial environment by modifying the natural environment by conducting various development activities. These activities destroys the natural environment, which also affects plants and animals. Therefore, we should conserve the natural environment while conducting development activities. We should conduct development works by preserving natural resources for future use. Such type of development is called sustainable development. It is also called "development that lasts long". Sustainable development conserves and promotes human beings as well as the earth. Sustainable development refers to the use of natural resource at present without compromising the right to development of the future generations. The major principles of sustainable development are as follows:

1. Conservation of ecosystem

The main aim of sustainable development is to conserve and sustain the earth. To conserve and sustain the earth, we should conserve different types of ecosystem like aquatic ecosystem and terrestrial ecosystem.

2. Conservation of biodiversity

We should conserve different types of plants and animals for sustainable development. Human beings can conduct development activities by conserving natural resources and organisms. We should conduct various national and international programmes to conserve biodiversity.

3. Sustainable development of society

We should develop sustainable society for sustainable development. We should improve the lifestyle of human beings for sustainable development. Proper education, health services, employment, security, etc. are the components of a sustainable society. These facilities should be provided to the people for sustainable development of society.

4. Population control

Human beings exploit natural resources to meet the demand of increasing population. Population is growing day by day but the amount of natural resources cannot be increased as they have a limited stock in nature. Therefore, population growth should be controlled to meet the goal of sustainable development and maintain balance in the environment.

5. Development of human resources

Human beings play a significant role to utilize and conserve natural resources. Skilled manpower can promote and conserve natural environment for sustainable development. We should disseminate knowledge and skill to the people for sustainable development. Development of human resources is essential for sustainable development.

6. Increase in people's participation

The effort of a few persons is not sufficient for sustainable development. The participation of almost all the people is essential for sustainable development. The objectives of sustainable development can be achieved by increasing public participation.

7. Conservation of cultural resources

The social norms and values, cultural practices, religions, customs, etc. are called cultural resources. They are important aspects of the environment. Sustainable development focuses on conservation of cultural resources. It is our duty to conserve cultural resources by avoiding superstitions.

8. Included within carrying capacity of the earth

The development activities conducted by human beings on the earth should be within the carrying capacity of the earth. All things that human beings want cannot be obtained from the earth. The carrying capacity or bearing capacity of the earth is limited. Therefore, we should conduct development activities within the bounds of the carrying capacity of the earth.

Differences between Development and Sustainable Development

Development	Sustainable Development
1. It is a process by which members of society increase their personal and institutional capabilities.	1. It is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
2. Development meets the needs of the present generations only to meet their own need.	2. Sustainable development meets the needs of the present generation and future generation without compromising the ability to meet their own need.

Activity 2

Observe various development activities conducted by human beings in your locality for ten days and note them down in your copy. Find out which activities are based on principles of sustainable development and which are not. Prepare a short report and submit to your science teacher.

Global Efforts on Sustainable Development

Sustainable development refers to the use of natural resources at present without damaging their condition for future generations. In 1983, the General Assembly of the United Nations Organization formed an independent commission under the chairmanship of Norway's prime minister Mrs. Gro Harlem Brundland related to environment and development. In April 1987 the commission published its report "Our Common Future" including the concept of sustainable development. According to this commission, sustainable development is the development that meets the needs of the present generation without comprising the needs of future generations.

A conference was held in 1992 in Rio de Janeiro on "Environment and Development". It emphasized the importance of environmental conservation for sustainable development. Similarly, the World Food Organization has given priority to conservation and management for fulfilling the needs of future generations. Globally, following points are focused for sustainable development.

Fig. 24.4 *Sustainable Development Goals*

i. Conservation of nature and management of natural resources.
ii. Focus on environmental conservation
iii. Conservation of biodiversity
iv. Conservation of ecosystem
v. Pollution control
vi. Population control
vii. Poverty alleviation
viii. Promotion of investment in environmental sector
ix. Increase in public participation
x. Formation of community groups and non-governmental organizations
xi. Conservation for future generations

Importance of Sustainable Development

Sustainable development is essential for environmental conservation. Development activities should not affect the environment adversely. If development activities affect the environment, such type of development activities do not last for a long time. The importance of sustainable development can be described as follows:

1. Wise and economic use of natural resources

We should be careful while using natural resources. We should limit the use of minerals, drinking water, insecticides, chemical fertilizers, forest products, pesticides, etc. It helps to preserve natural resources for the future generations.

2. Development of basic sectors

Sustainable development emphasizes the development of basic sectors such as health facilities, education, agriculture, tourism, social welfare, etc. for development of human beings. While developing aforementioned sectors, we should conserve and promote the natural environment.

3. Perception of responsibility

Concept of sustainable development changes the knowledge, skill and perspective of human beings. It gives the knowledge of conservation and utility of natural resources. It develops the concept that all natural resources are common for all living beings and every body should conserve them for future use.

4. Development based on public participation

Sustainable development focuses on public participation. The effort of only a few people is not sufficient for sustainable development. Public participation is very important for conservation and promotion of environment. It increases the conservation spirit of local people.

5. Determination of limit of development

Human beings try to use unlimited natural resources to fulfill their needs. It exploits the non-renewable natural resources as they have a limited stock in nature. Therefore, development activities should be within the bearing capacity of the earth.

6. Long lasting thought

Human beings should not use natural resources in excess. The concept of sustainable development helps preserve present resources for the utility of future generations with their limited and wise use at present. It will not create difficulty in continuation of life in the future.

Project Work

Observe development activities that are being conducted in your locality. Observe those development activities and find out whether these activities are being conducted according to the concept of sustainable development or not. Prepare a short report on it.

Key Concepts

1. Environment is the natural world around us where plants and animals live. Environment consists of physical world us well as biological world.
2. Sustainable development refers to development that lasts long and does not degrade the environment.
3. Biodiversity is the existence of different types of plants and animals on the earth.

4. An ecosystem can be defined as the self-sustainable structural and functional unit of the biosphere.
5. The group of closely related organisms which can interbreed freely to produce fertile offspring is called species.
6. The variation among the organisms of different species is called species diversity.
7. The heredity units that transfer genetic characteristics from parents to their offspring are called genes.
8. Genetic diversity can be defined as the variation among the members of the same species.
9. Sustainable development conserves and promotes human beings as well as the earth. Sustainable development refers to the use of natural resource at present without affecting their conducting for future generations.
10. We should develop sustainable society for sustainable development. We should improve the lifestyle of human beings for sustainable development.
11. We should disseminate knowledge and skill to the people for sustainable development. Development of human resources is essential for sustainable development.
12. The carrying capacity or bearing capacity of the earth is limited. Therefore, we should conduct development activities within the carrying capacity of the earth.

Exercise

1. Put a tick (√) for the correct statement and a cross (×) for the incorrect one.

a. Environment consists of the abiotic and the biotic components. ☐

b. The difference between plants and animals is called ecosystem diversity. ☐

c. Sustainable development does not include conservation of cultural resources. ☐

d. We should use natural resources wisely and economically. ☐

e. Public participation is very important for sustainable development. ☐

2. **Fill in the blanks using appropriate words.**

   a. .... is a self-sustaining unit of the biosphere made of .... and non-living things.

   b. .... is the existence of different types of plants and animals on the earth.

   c. Existence of different types of human beings is the example of .... diversity.

   d. The objective of sustainable development can be achieved by increasing .... participation.

   e. Determination of limit of development is essential for .... development.

3. **Answer the following questions.**

   a. Define environment and sustainable development.

   b. What is biodiversity? Name three types of biodiversity.

   c. What is meant by ecosystem diversity? Give example.

   d. Define species diversity with an example.

   e. What is meant by genetic diversity?

4. **Write any two differences between development and sustainable development.**

5. **Write any two differences between ecosystem diversity and genetic diversity.**

6. **State the principles of sustainable development and describe any two of them.**

7. **Why should we control population growth for sustainable development? Explain in brief.**

8. **State any five global efforts on sustainable development.**

9. **Write short notes on:**

   a. Species diversity
   b. Wise and economic use of natural resources
   c. Population diversity
   d. Conservation of cultural resources

10. **Describe the importance of sustainable development in brief.**

11. **Long lasting thought is essential for sustainable development. Justify this statement.**

Specification Grid

Science and Environment
(Theory)

Grade: 8 | **F.M.: 75**

Time: 2 hours 15 minutes | **P.M.: 30**

Subject Areas	Units	No. of questions	No. of Sub questions	Full marks	(K) 30%	(U) 40%	(A) 20%	(HA) 10%	Remarks
Physics	Measurement, Force and Velocity Simple Machine, Pressure, Work, Energy and Power Heat, Light Sound, Magnetism, Electricity	5	10	25	7.5	10	5	2.5	
Chemistry	Matter Metal and Non-metal Acid, Base and Salt Some Useful Chemicals	3	6	15	4.5	6	3	1.5	
Biology	Living Beings Cell and Tissue Life Processes	3	6	15	4.5	6	3	1.5	
Geology and Astronomy	Structure of Earth Weather and Climate Earth and Space	1	2	5	1.5	2	0	1.5	
Environment Science	Environment and its Balance Environmental Degradation and its Conservation Environment and Sustainable Development	3	6	15	4.5	6	3	1.5	
Total		15	30	75	22.5	30	14	8.5	

Note:

- There are a total to 15 questions and each question has two sub-questions. The weighting of the main question is 5 marks and that of each sub-question may be 2 or 3 marks.
- All units should be included while making question paper.
- Question paper should include the questions to test the **Knowledge (K), Understanding (U), Application (A) and Higher abilities (HA) levels of students**.

Practical

Grade: 8 **F.M.: 25**

Time: 1 hour 30 minutes **P.M.: 10**

Subject Areas	Units	Drawing/ labelling/ explanation (5)	Practical work, etc. (5)	Construction of materials and experimentation (5)	Field visit/mini project work (6)	Viva voce (4)
Physics	Measurement, Force and Velocity					
	Simple Machine, Pressure, Work, Energy and Power					
	Heat, Light					
	Sound, Magnetism, Electricity					
Chemistry	Matter					
	Metal and Non-metal					
	Acid, Base and Salt					
	Some Useful Chemicals					
Biology	Living Beings					
	Cell and Tissue					
	Life Process					
Geology and Astronomy	Structure of Earth					
	Weather and Climate					
	Earth and Space					
Environment Science	Environment and its Balance					
	Environmental Degradation and its Conservation					
	Environment and Sustainable Development					

Note: The pass marks of theoretical exam will be 30 and that of practical exam is 10.

Model Question

Science and Environment

Grade: 8 **F.M.: 75**
Time: 2 hour 15 minutes **P.M.: 30**

Group A: Physics

1. a. What is mass? Write two differences between fundamental and derived unit. 1K + 2U
   b. What will be the final velocity of vehicle, if it started from rest and accelerates at $4m/s^2$ after 5 seconds? 2HA
2. a. Define: 1+1+1=3K
   ii. Mechanical advantage ii. Velocity iii. Efficiency
   b. Prove that, liquid pressure (P) = hdg.
3. a. Define work and power, write the relationship between them. 1K+1K+1U
   b. Write two difference between clinical and simple thermometer. 2U
4. a. What is refraction of light? Which type of mirror is used as side mirrors in vehicles and why? 1K+0.5K+1A
   b. What is unit of frequency? Write any two differences between echo and reverberation. 0.5K+2U
5. a. Draw the diagram to show the arrangement of the molecular magnets in magnetic substance. 2A
   b. Why do we use dry cell in torch light? Write any three reasons. 3A

Group B: Chemistry

6. a. Write the molecular formula of common salt. Write the chemical equation of the following word equation. 1K+2U
   Hydrogen + Oxygen $\rightarrow$ Water
   b. Draw the electronic configuration of Magnesium atom. 2A
7. a. What is chromatography? Which types of the mixtures are separated from it?1K+2U
   b. Write any one use of sulphur and copper each. 1+1=2U
8. a. What effect do acid, base and salt have on different indicator? Show in a table. 3A
   b. How can you detect hardness of water collected from different sources? 2U

Group C: Biology

9. a. Draw a labelled diagram of virus. 3A
   b. Why does modification of root occur? Write any two causes of it. 2U
10. a. Write the relationship between cells, tissues and organs in human body. 3U
    b. Write the name of tissues found in animals. 2K
11. a. What do you mean by vegetative propagation? Write the name of two plants that reproduce by this process. 1K+1U
    b. What is photosynthesis? How can you demonstrate that plants prepare their food on leaves? Write with an experiment. 1K+2HA

Group D: Geology and Astronomy

12. a. What is soil erosion? In which region of Nepal does rain fall more? Why? 1K+1.5U
    b. What is phases of the moon? Write any three reasons for the existence of living beings on earth. 1K+1.5U

Group E: Environment Science

13. a. What can human being get from nature? Write any three things with examples. 3U
    b. Write the differences between national park and wildlife reserve. 2K
14. a. Write any four reasons of water pollution. Give any one measure that mitigates water pollution in your region. 2U+1HA
    b. What is climate change? Write two effects of climate change. 1+1=2k+A
15. a. What is biodiversity? Write its types. 1.5+1.5=3K
    b. What can you do in your residential area for protection of environment? Write any four points. 2HA