

SCIENCE

STANDARD-VII

Untouchability is a sin
Untouchability is a Crime
Untouchability is inhuman



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Preface

A tremendous explosion of knowledge has occurred in physical and biological sciences during the last five decades. Consequently it has become necessary to introduce several new concepts even at the higher primary level without sacrificing the basic aspects.

In preparing this book as an integrated science book, clarity has been given preference over brevity. Hence most students should be able to learn the contents by themselves.

It is hoped that the text book will stimulate in students the spirit of inquiry, the power of critical observation and the ability, to understand facts and perceive broad scientific concepts.

This text book has been written by several authors. Therefore the styles of presentation of the text vary.

Several boxes containing additional information have been included to motivate students to take a lively interest in the subject. The matter within the boxes does not form the course content. However the teachers are instructed to frame their own questions from the contents of the text, including activities for the examinations.

While preparing for the examinations, students should not restrict themselves, only to the questions/problems given in the self evaluation. They must be prepared to answer the questions and problems from the entire text.

-Text book committee

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1. Measurement

In our daily life we make measurements of various physical quantities such as length, area, volume, mass, time, speed and force. These quantities have to be measured very accurately otherwise observations and conclusions are liable. Hence, the methods of obtaining accurate measurements are very important part of physics.

1.1 Indirect methods for the measurement of length

Length, width, thickness are the terms used to describe the lengths of a regular body in different planes. That means these basically measure length.

1.1.1 Measurement of thickness of a wire

Thickness is the length of a straight line passing through the cross section of a wire.

Wind the wire around a pencil as shown in the fig 1.1. No space is left between two successive turns. Count the number of turns of the wire on the pencil. Measure the length occupied by the turns with the help of a scale. Divide this length by the number of turns. It gives the thickness of the wire.

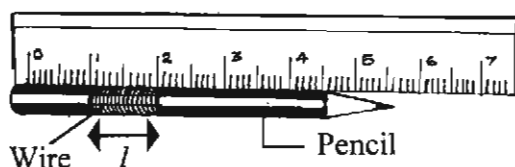


Fig. 1.1 Measurement of thickness of wire
Example: Find out the diameter of a 20 turn wire coiled in a wooden piece of cylinder.

Measure the length occupied by the wire with the help of a scale. Suppose the length is 2 cm.

$$\begin{aligned}\text{Thickness of wire} &= \frac{\text{length of 20 turns}}{\text{number of turns}} \\ &= \frac{2}{20} \text{ cm}\end{aligned}$$

Thickness of wire = 0.1 cm or 1 mm.

1.1.2 Measurement of diameter of a cylinder

Place the cylinder between the two rectangular wooden blocks. Do not press the wooden blocks too hard. Place a scale above the blocks as shown in fig.1.2. Note the length from the inner edges of wooden blocks. This gives the diameter of the cylinder.

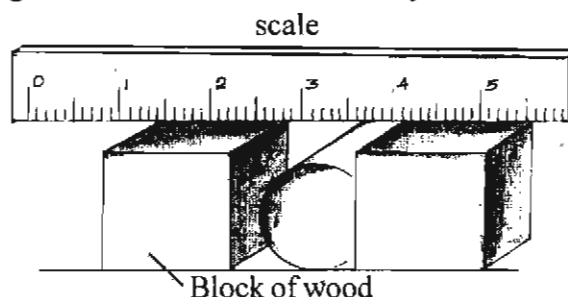


Fig. 1.2 Measurement of diameter of a cylinder

1.2 Determination of area of regular and irregular surfaces

1.2.1 Measurement of Area

The amount of surface occupied by an object or a place is called area.

In S.I. system the unit of area is metre square (m^2).

1.2.2 One metre square

The area of a square surface, whose side is equal to one metre is one metre square.

Fig 1.3 shows a square surface PQRS such that $PQ=QR=RS=SP= 1 \text{ m}$. The area of the surface enclosed by PQRS is 1 m^2 .

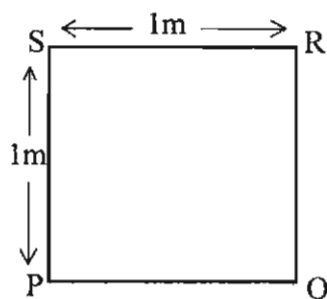


Fig. 1.3 One square metre

1.2.3 Measurement of area of a regular surface

Suppose you want to measure the area of the face of a book of length 10 cm and breadth 5 cm.

Place the face of the book on the centimetre graph paper as shown in the fig.1.4. With the help of a sharp pencil mark the outline of the book.

Each square on the graph paper has a side equal to 1 cm. Thus the area of each square on the graph paper is 1 cm^2 . Each square is again divided into 10 small divisions. So the area of the small squares on the graph paper is equal to 1 mm^2 .

$$\begin{aligned}
 \text{Area of the face of book} \\
 \text{PQRS} &= \text{Area of 50 squares} \\
 &= 50 \times \text{area of 1 square} \\
 &= 50 \times 1 \text{ cm}^2 \\
 &= 50 \text{ cm}^2 \quad (1)
 \end{aligned}$$

Notice that the length of the face of the book is 10 cm and its breadth is 5 cm. If we multiply length by breadth then,

$$\begin{aligned}
 \text{length} \times \text{breadth} &= 10 \text{ cm} \times 5 \text{ cm} \\
 &= 50 \text{ cm}^2 \quad (2)
 \end{aligned}$$

If we compare (1) and (2), then we can say that area of the face of the book

Table 1.1 Area of regular surfaces

Sl. No.	Shape	Figure	Area	Formulae
1	Square		<i>side x side</i>	l^2
2	Rectangle		<i>length x breadth</i>	lb
3	Parallelogram		<i>base x height</i>	bh
4	Triangle		$\frac{1}{2} \times \text{base} \times \text{height}$	$\frac{1}{2} bh$
5	Circle		$\pi \times \text{radius} \times \text{radius}$	πr^2

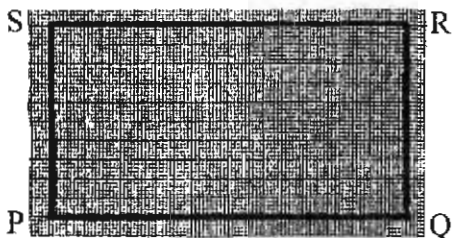


Fig. 1.4 Measurement of the area of a book

$PQRS = \text{length} \times \text{breadth}$.

Thus the area of a regular rectangular surface can be found by finding the product of its length and breadth.

Activity 1.1

To find the area of rectangular card by using a centimetre graph paper.

Example

If the length of the field is 50 m and its breadth is 40 m, find its area.

Here, length = 50 m

breadth = 40 m

$$\begin{aligned} \text{Area} &= \text{length} \times \text{breadth} \\ &= 50 \times 40 \\ &= 2000 \text{ m}^2 \end{aligned}$$

1.2.4 Measurement of area of an irregular flat surface

The area of irregular surfaces can also be found by using a graph paper.

Suppose we want to measure the area of a leaf.

Place the leaf flat on the centimetre graph paper. With the help of a sharp pencil mark the outline of the leaf.

Now count the number of complete squares enclosed by the face of leaf. In fig.1.5 the number of complete squares is 14.

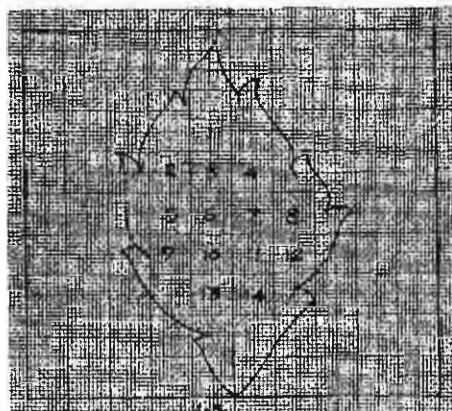


Fig. 1.5 Measurement of area of a leaf

Then count the total number of millimetre squares in the remaining marked area.

The area of the irregular figure, in square centimetres, is the number of complete squares (centimetre squares) added to the number of millimetre squares divided by 100.

Hence, the area of the irregular figure would be

Number of centimetre squares = 14

Number of millimetre squares

$$\text{divided by } 100 = \frac{1075}{100} = 10.75$$

Sum of the two squares

$$= 14 + 10.75 = 24.75 \text{ cm}^2$$

Activity 1.2

To find the area of irregular glass plate by using a (centimetre) graph paper.

Place the glass plate on the centrimetre graph paper. With the help of a sharp pencil mark the outline of the glass plate. Find the area as described in section 1.2.4

Objects like card board, cut-out, a piece of broken glass plate and leaf are the examples of irregular surfaces.

1.3 Measurement of volume

Objects occupy space according to their sizes.

The space occupied by a substance (solid, liquid or gas) is called its **volume**.

1.3.1 Unit of volume

The unit of volume in S. I. system is cubic metre (m^3).

One cubic metre ($1m^3$) is the volume occupied by a cube whose each side is equal to 1 m.

Imagine a vessel having each side i.e., length, breadth and height equal to 1 m. If we fill this vessel with water, then volume occupied by the water is

one cubic metre ($1 m^3$).

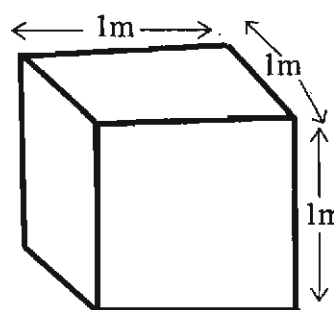


Fig. 1.6 One cubic metre

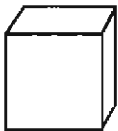


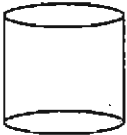

1.3.2 Measurement of volume of regular solids

Objects which have a regular, geometric shape are called '**regular objects**'. The formulae for calculating the volume of regular objects of different shapes are given in table: 1.2

Example

If the length of a box is 50 cm, breadth is 10 cm and its height is 20cm,

Table 1.2 Volume of regular surfaces

S. No.	Shape	Figure	Formulae for volume
1	Cube		$side \times side \times side = l^3$
2	Cuboid		$length \times breadth \times height = lbh$
3	Sphere		$\frac{4}{3} \times \frac{22}{7} \times radius \times radius \times radius = \frac{4}{3} \pi r^3$
4	Cylinder		$\frac{22}{7} \times radius \times radius \times height = \pi r^2 h$
5	Cone		$\frac{1}{3} \times \frac{22}{7} \times radius \times radius \times height = \frac{1}{3} \pi r^2 h$

find its volume.

$$\begin{aligned}\text{Here, length} &= 50 \text{ cm} \\ \text{breadth} &= 10 \text{ cm} \\ \text{height} &= 20 \text{ cm}\end{aligned}$$

$$\begin{aligned}\text{Then the volume of the box} \\ &= \text{length} \times \text{breadth} \times \text{height} \\ &= 50 \times 10 \times 20 \\ &= 10000 \text{ cm}^3 \\ &= 10000 \text{ cc}\end{aligned}$$

1.3.3 Measurement of volume of liquids

Liquids such as water, milk, petrol, diesel and cooking oils are measured in terms of their volume.

Liquids do not have a definite shape. Instead, they take the shape of the containers into which they are poured. Liquids have a fixed volume.

The volume of liquids is generally measured in litres (*l*), the sub-multiple of one litre is milli-litre (*ml*).

$$1 \text{ litre} = 1000 \text{ ml.}$$

One milli-litre is also equal to one cubic centimetre (1 cm^3 or 1 cc)

Example

1. Calculate the volume of a brick of length 10 cm, breadth 5 cm and height 4 cm.

$$\begin{aligned}\text{length of brick} &= 10 \text{ cm} \\ \text{breadth of brick} &= 5 \text{ cm} \\ \text{height of brick} &= 4 \text{ cm} \\ \text{volume of brick} \\ &= \text{length} \times \text{breadth} \times \text{height} \\ &= 10 \times 5 \times 4 \\ &= 200 \text{ cm}^3\end{aligned}$$

2. A rectangular tank has a length of 55 cm, breadth of 15 cm and height 10 cm. Calculate the volume of the tank. A cylindrical drum has a height of 7 cm and radius 5 cm. Calculate its volume. The tank is to be filled with water using the drum. How many times is the drum used to fill the tank?

$$\begin{aligned}\text{length of the tank} &= 55 \text{ cm} \\ \text{breadth of the tank} &= 15 \text{ cm} \\ \text{height of the tank} &= 10 \text{ cm}\end{aligned}$$

$$\begin{aligned}\text{Then the volume of the tank} &= \\ &\text{length} \times \text{breadth} \times \text{height} \\ &= 55 \times 15 \times 10 \\ &= 8250 \text{ cm}^3\end{aligned}$$

$$\begin{aligned}\text{radius of the drum} &= 5 \text{ cm} \\ \text{height of the drum} &= 7 \text{ cm}\end{aligned}$$

$$\begin{aligned}\text{Then the volume of the drum} \\ &= \frac{22}{7} \times 5 \times 5 \times 7 \\ &= 550 \text{ cm}^3\end{aligned}$$

The number of times it takes, to fill the tank by using this drum is found by the formula

The number of times

$$\begin{aligned}&= \frac{\text{volume of the tank}}{\text{volume of the drum}} \\ &= \frac{8250}{550} = 15 \text{ times}\end{aligned}$$

That means the volume of the tank is 15 times bigger than compared to the volume of drum.

1.4 Volume of irregularly shaped solids

An object which does not have a regular geometric shape is an irregular object. The volume of irregular objects are measured using the displacement method.

1.4.1 Measuring cylinder method

Take a measuring cylinder and fill it nearly half with water. Note the initial level of water (A). Tie a thread around a small stone. Lower the stone into the cylinder till it is completely immersed in the water. The stone should not touch the sides or the bottom of the cylinder and there should not be any air bubbles (fig1.7). The solid displaces water equal to its own volume. Note the final level of water (B).

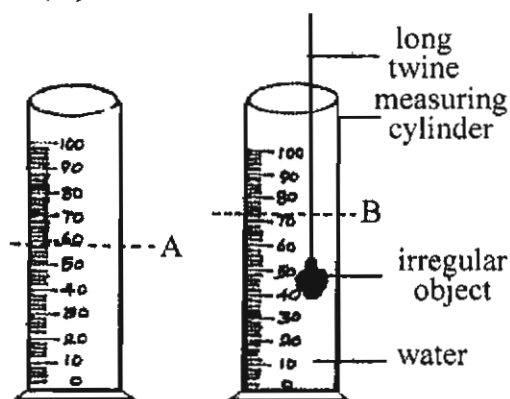


Fig. 1.7 Determination of volume of irregular object

The difference between the levels (B-A) is the volume of the given irregular solid. This method is known as the displacement method.

Find out the volume of different solid objects which sink in water using the same method.

Note that the above method can not be used for substances soluble in water. For such substances we take a liquid like kerosene oil in which the substances are not soluble. Then the same method can be used to find the volume.

1.4.2 Over-flow jar method

Fill the overflow jar with water till it reaches the level of the side tube or spout. Place a measuring jar below the spout. Tie a long thread to the object and lower it completely into the water (Fig.1.8). Water displaced by the solid is collected in the measuring jar. The volume of displaced water gives the volume of the irregular solid.

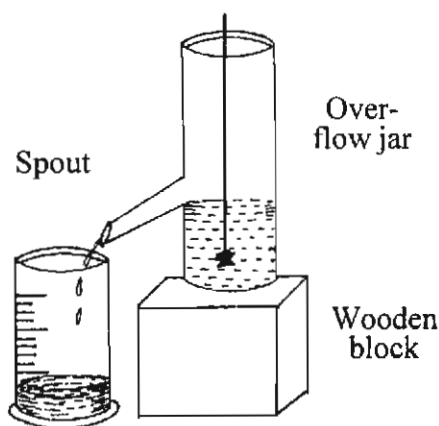


Fig. 1.8 Determination of volume of irregular objects

1.4.3 To find the volume of lead shots using measuring jar

Take a measuring jar. Fill it with water to any particular level. Note the volume of water in it. Gently drop 50 lead shots into the jar. There is an increase in the volume of water. The increase in volume of water in jar is equal to the volume of 50 lead shots. From this we can find out the volume of one lead shot.

volume of 50 lead shots =

final reading – initial reading

volume of 1 lead shot =

$$\frac{\text{final reading} - \text{initial reading}}{50} \text{ ml}$$

Repeat the experiment by changing the number of lead shots and find out the average volume of a lead shot.

1.4.4 To find the volume of irregular solid which floats in water

Take a measuring jar. Fill it nearly half with water. Tie the sinker (a piece of stone) to a thread and lower it in water contained in a measuring jar. Note the volume of water (A). Tie a cork to the sinker. Lower the combination in water (fig.1.9). Note the volume of water (B).

$$\text{Volume of the cork} = (B - A) \text{ cm}^3$$

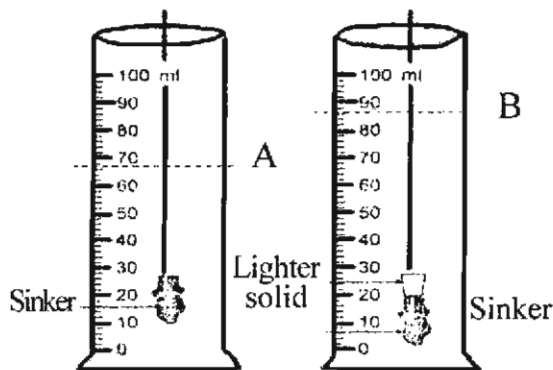


Fig. 1.9 Determination of volume of irregular solid

1.5 Density and its determination

1.5.1 Density

Take a wooden sphere in one hand and an iron sphere of same size in the other. Which one feels heavier? Iron sphere weighs more than wooden sphere.

By saying iron is heavier than wood, we mean that iron will weigh more than wood, if both of them are of the same volume. That means for the same volume of iron and wood, the matter

is more tightly (more densely) packed in iron than wood.

The mass per unit volume of substance is called density.

If the density of a substance is 'D' when its mass is 'M' and its volume is 'V' then

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{i.e. } D = \frac{M}{V}$$

In S.I system; unit of density is kg/m^3 (or) kg m^{-3}

Activity 1.3

Take an aluminium ball and a lead ball of same volume. Find out the masses of the balls. These two are not equal. Lead ball is heavier than aluminium. Why?

The density of aluminium is 2700 kgm^{-3} . It means 1 m^3 of aluminium weighs 2700 kg.

Similarly, the density of lead is 11300 kg m^{-3} . It means 1 m^3 of lead weighs 11300 kg.

1.5.2 Determination of Density

(i) To determine the density of a regular solid

Find the mass of a given regular solid by using a physical balance. Find out accurately the dimensions of the solid. Then calculate its volume by using formula.

If M be the mass of the solid, V the volume and D the density

Then the density of the solid

$$D = \frac{\text{mass}(M)}{\text{volume}(V)} \text{ kgm}^{-3}$$

(ii) To determine the density of an irregular solid

The density of irregular objects are measured using the displacement method.

Find out the mass of the irregular solid 'M' by using a physical balance. Fill nearly half of the measuring jar with water. Note the volume of water (A). Use a long thread and tie the solid. Lower the solid into the jar till it is completely immersed in water. Now the water level rises. Note the new level of water (B) (fig. 1.10).

$$\text{Volume of solid} = (B - A) \text{ cm}^3$$

Density of the solid

$$= \frac{\text{Mass of the solid}}{\text{Volume of the solid}}$$

$$D = \frac{M(\text{g})}{V(\text{cm}^3)} = \frac{M}{V} \text{ g cm}^{-3}$$

$$= \frac{M}{V} \times 1000 \text{ kg m}^{-3}$$

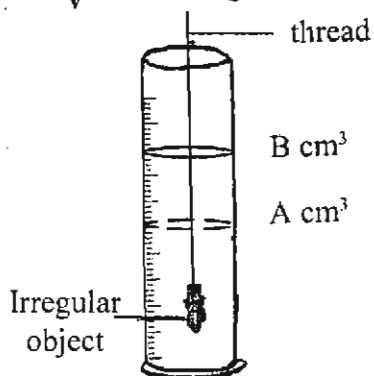


Fig. 1.10 Determination of the density of an irregular object

Example : For a block of iron of dimensions 5 cm x 5 cm x 4 cm if its mass is 750 gm, what is its density?

length of iron block = 5 cm

breadth of iron block = 5 cm

height of iron block = 4 cm

volume of iron block (V)

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

$$= 5 \times 5 \times 4$$

$$= 100 \text{ cm}^3$$

Given mass (M) of iron block

$$= 750 \text{ gm}$$

$$\text{Density } D = \frac{M}{V} = \frac{750}{100} = 7.5 \text{ g cm}^{-3}$$

$$= 7.5 \times 1000 \text{ kg m}^{-3}$$

Table 1.3

Density of some common substances

Sl.no	Substance	Density kg m ⁻³
1	Water	1000 (at 4° C)
2	Sea Water	1026
3	Milk	1030
4	Ice	920
5	Petrol	700
6	Kerosene oil	800
7	Mercury	13600
8	Cork	250
9	Iron	7900
10	Lead	11300
11	Aluminium	2700

1.6 Measurement of time

Time is needed to answer many questions like "When did it happen?".

Any phenomenon that repeats itself is a possible time standard.

In ancient days man produced some devices to measure the time by the observation of natural phenomenon. The duration of the solar day was used

as a unit of time. Time interval between two successive noons is called a solar day. The mean solar day is the average of all solar days in a year.

The time taken for one rotation of the earth by itself is a solar day. The earth revolves around the sun in one year.

$$\begin{aligned} 1 \text{ year} &= 365\frac{1}{4} \text{ solar day} \\ 1 \text{ solar day} &= 24 \text{ hour} \\ 1 \text{ hour} &= 60 \text{ minute} \\ 1 \text{ minute} &= 60 \text{ second} \\ 1 \text{ second} &= \frac{1}{24 \times 60 \times 60} \\ &= \frac{1}{86400} \text{ th part of a} \\ &\quad \text{mean solar day.} \end{aligned}$$

The S.I unit of time is second.

These natural phenomena, induced men to produce some time measuring devices like sun dial, water clock, sand clock and candle clock, etc.,

Then pendulum clock was made. The time taken by the pendulum to complete one oscillation is a constant. This is used to measure the time in pendulum clock.

A wall clock is made by winding a spring. When the spring unwinds itself, several wheels connected to it rotate. By this reason the pendulum oscillates. The oscillation of the pendulum only controls the seconds hand of the wall clock.

In modern days stop clocks and stop watches are used to measure very short time intervals accurately. In modern

watches the pendulum is replaced by balancing wheel. The mechanism is the same.

Now-a-days battery operated watches, electronic digital watches, quartz watches and atomic clocks are used to measure time. In digital clocks the time is displayed directly in digits. In quartz watches, the vibration of a quartz ring is used to measure the time. Atomic clock is the most accurate one. The time interval of an energy change in cesium atom is the basis for measurement of time in this clock.

Activity 1.4

Skipping is a good exercise to trim our body. Isn't it? Can you measure the time taken for one skipping

Take a stop watch. Start the watch when your friend starts skipping. You start counting from one, two.... fifty. Allow her for 50 skipplings. Stop the watch and find out the time. This is the time taken for 50 skipplings. Then divide this time by 50 to get the time taken for one skipping (fig 1.11)



Fig. 1.11

Activity 1.5

You all know that our heart beats nearly 72 times per minute. Using a stop watch find out the time interval between two pulses in your wrist (fig 1.12).

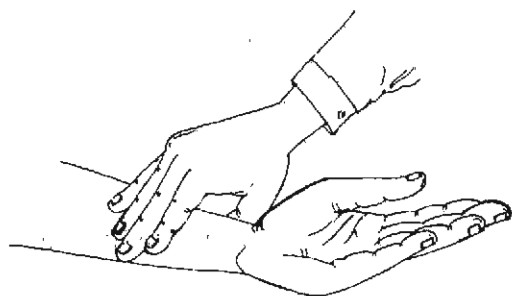


Fig. 1.12

1.7 Simple pendulum

The simple pendulum consists of a heavy bob or sphere suspended by an inelastic thread. The other end is held between the two halves of a split cork (fig.1.13). When the bob is pulled and then released, it oscillates.

The to-and-fro movement of the bob is called an **oscillation**. The time taken for completing one oscillation is called the **period of oscillation**. The distance between the centre of the bob to the point of suspension is the length of the pendulum. The maximum displacement of the bob from the mean position is called its **amplitude**.

Set up a simple pendulum and adjust the length to 50 cm. Make it oscillate. Start a stop clock when the bob comes to one extreme position. Allow it to make ten complete oscillations. Note the time. Now calculate the time taken for one oscillation.

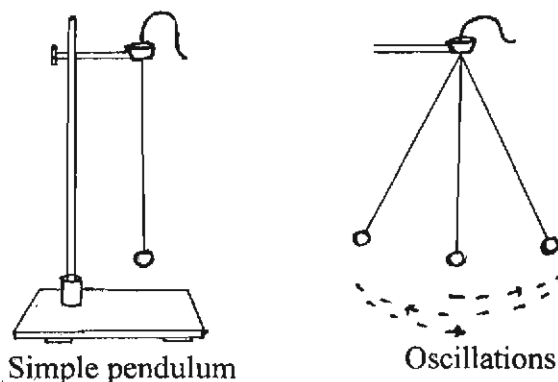


Fig. 1.13

Suppose, the time taken for 10 oscillations is 14 second. Then the time taken for 1 oscillation is $= \frac{14}{10} = 1.4$ second. That is period of oscillation $T = 1.4$ second

Perform the experiment again with different lengths that is 70, 80, 90 and 100 cm. Tabulate the readings in table (1.4) and find out the period of oscillations.

Table 1.4 Period of oscillation for different lengths of the pendulum

S. No.	Length (cm)	Time for 20 oscillations(s)	Period of oscillation(s)
1	70		
2	80		
3	90		
4	100		

It will be found that the period of oscillation increases with the increase in length of the **pendulum**

Activity 1.6

Find the period of oscillation of a simple pendulum

- with metal bob of different sizes and shapes

b. with bobs made of different materials such as iron, brass, aluminium etc.,

c. with different amplitudes.

You will find that the period of oscillation of a pendulum does not depend on the shape, mass or material

of the bob and the amplitude of oscillation.

The period of oscillation of a simple pendulum of length 100 cm will be two seconds. This is called **seconds pendulum**.

SELF EVALUATION

I. Choose the correct answer

- Example of the irregular object
(a) a piece of broken glass plate (b) table (c) book (d) black board
- Volume of a cylinder
(a) $\frac{4}{3} \pi r^3$ (b) lbh (c) $\pi r^2 h$ (d) $\frac{1}{3} \pi r^2 h$
- The maximum displacement of the bob from the mean position is called
(a) amplitude (b) period of oscillation
(c) length of the pendulum. (d) velocity
- The earth revolves around the sun in
(a) one month (b) one year (c) one solar day (d) one week
- The time taken for one oscillation is called
(a) second (b) mass (c) period of oscillation (d) minute

II. Fill in the blanks by using correct answers

- The amount of surface occupied by an object or a place is called ———
- The area of irregular bodies such as a broken glass plate can be found by using ———
- Volume of rectangular slab is the product of its length, ——— and height.
- Density of water is ——— at 4° C.
- Mass per ——— is called density.

III. Match the following

- | | | |
|-------------------------|---|----------------------------|
| 11. Mass | — | vibration of a quartz ring |
| 12. 1000 ml of a liquid | — | length x length x length |
| 13. Parallelogram | — | one litre. |
| 14. Quartz watch | — | base x height |
| 15. Cube | — | kilogram |

IV. Give short answers

16. What is meter square ?
17. Define one cubic metre.
18. What are called regular objects ?
19. What is density ? Give its unit.
20. Name the watches used in modern days.
21. What is the length of the simple pendulum?

V. Give detailed answers

22. How can you measure the area of a leaf by using a graph sheet?
23. Give the method to measure the diameter of a cylinder using blocks of wood?
24. With the help of a measuring jar how can you measure the volume of irregularly shaped solids?
25. Explain the method of measuring the volume of irregularly shaped solid by using overflow jar.
26. How is the volume of lead shots determined?
27. Describe the method of determining the volume of irregular solids which float in water?
28. How can you determine the density of an irregular solid?
29. With the help of a neat diagram explain the construction of a simple pendulum.

Problems

1. Calculate the area of the field which has the length of 20m and breadth 10m.
[200m²]
2. Calculate the volume of a book of length 20cm breadth 15cm and height 2 cm.
[600cm³]
3. A box has the dimensions of 8 cm x 8 cm x 10 cm. It's mass is 6.4 kg. What is its density ?
[10,000 kg m⁻³ (or) 10 g cm⁻³]
4. The Initial level of water in a measuring cylinder is 40.2 cm³. When a stone is immersed in it , the water level raises up to 48.7 cm³. Calculate the volume of the stone.
[8.5 cm³]
5. In a simple pendulum, the time taken for 20 oscillations is 38 seconds. Calculate the time taken for one oscillation. [1.9 second]

Think over it

1. Does air have density ?
2. When a metal ball is immersed in water; will its density change?
3. Why does helium balloon go up in air?
4. Can time be measured without any periodic motion?
5. When it is 6'o clock in the morning in your place, will it be same in all other places in the world?

2. Water

Molecular formula : H_2O

Molecular weight : 18

Structure : 

2.1 Importance of Water for Sustaining Life

Water is the most abundant and precious substance available on the earth. Like air, water is also essential for survival. Water plays a key role in carrying out important activities like drinking, cooking, cleaning, washing, bathing, cooling, generating power, and putting off fire. All living matter (unicellular or multicellular) like plants or animals contain 70% to 90% of water. Water is also essential for the germination of seeds and growth of plants. Plants use enormous amount of water during photosynthesis. Today, more than ever, water is both slave and master to people. We live in a world of water.

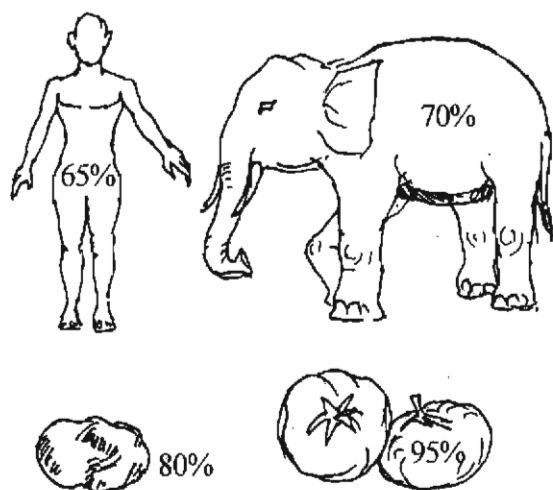


Fig. 2.1 Amount of water in living things

2.1.1 Sources of water

Water is present almost in all natural things like plants, animals, rocks and air. About $\frac{4}{5}$ of the earth's surface is made of water. Water is everywhere. Without water, there can be no life. On the surface of the earth it is present in the form of oceans, rivers and lakes. Water exists above the earth's surface in the form of water vapour, mists and clouds. Below the earth's surface, water is present in the form of underground stream, well water, spring water.

Interesting facts about water

How much of water is on the earth?

There is about 1.4 thousand million cubic kilometers of water.

How much of the earth's water is fresh?

Only about 3 percent of the earth's water is fresh.

How much of water do living things contain?

All living things consist mostly of water. The body of human being is about 65% of water. An elephant is about 70% water. A potato is about 80% water. A tomato is about 95% water (fig. 2.1).

How much water does a person use every day?

On average, a woman must take a minimum of 1.5 litres of pure water per

day, and a man needs a minimum of 2 litres of pure water. A person needs about 3.5 litres to 4 litres of liquid food. On average, each person in a developing country uses about 260 litres of water a day in the home.

Do you know?

Two-thirds of our body is water. Most of our blood is water. Every organism of the body like brain, heart, liver and muscles contain water. The skin is like a layer of tiny water filled balloons. If you press the skin, you will feel that it is bouncy.

2.2 Different states of water and their interchangeability

Water exists in three states in nature as

- a) solid in the form of ice.
- b) liquid in the form of water.
- c) gas in the form of steam.

(Fig. 2.2)

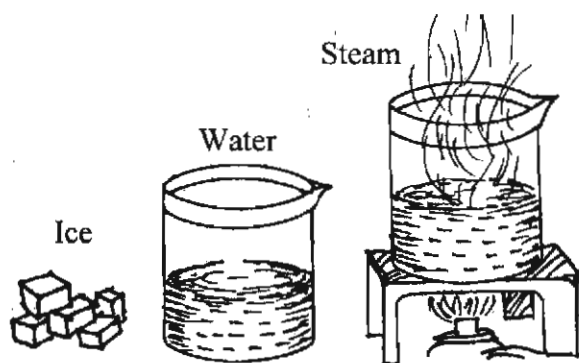
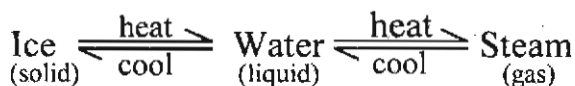


Fig. 2.2 Different states of water

Interchangeability

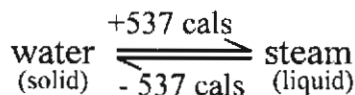
The three states of water can be interchanged by changing their temperature as shown below.



Water changes into solid state when its temperature becomes 0° C. Water changes into steam when its temperature raises to 100° C. However, if the temperature is between 0° C and 100° C water slowly changes into water vapour. As a simple rule, higher the temperature, more rapidly the water changes into water vapour and intermixes with air.

Latent heat of vapourisation

Water changes into steam by absorbing 537 calories of heat per gram of water at 100° C and the steam changes into water evolving 537 calories of heat per gram of steam.



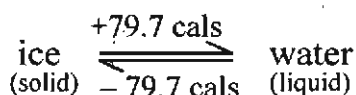
It is because, the supplied heat energy is used only to change the state of boiling water, but is not used to raise its temperature. This heat energy is stored in steam and is commonly called latent heat of vapourisation of steam. The steam has the highest latent heat of vapourisation and its value is 537 cal/g.

Do you know?

You might have seen your mother preparing idlis. Raw idlis are steamed in a special arrangement. When steam passes through idlis it supplies large amount of heat energy (537 cal/g) and hence helps in rapid cooking.

Latent heat of fusion

Water is converted into ice by the evolution of 79.7 calories of heat per gram of water. This heat energy is called latent heat of fusion of ice. Ice changes into water by the absorption of 79.7 calories of heat per gram of ice.



Ice has the highest latent heat of fusion and its value is 79.7 cal/g.

Activity 2.1

To study the melting of ice

Materials required

A glass or plastic funnel, few ice cubes, laboratory thermometer, a beaker and a stand.

Method

Fix the funnel with the help of a stand above a beaker. Add few ice cubes in the funnel. Insert the

thermometer into the ice and observe the temperature. You will notice water dripping into the beaker due to the melting of ice. Ice melts at 0°C and the temperature remains constant at 0°C (fig. 2.3). On the other hand if we allow water to cool it solidifies into ice at 0°C .

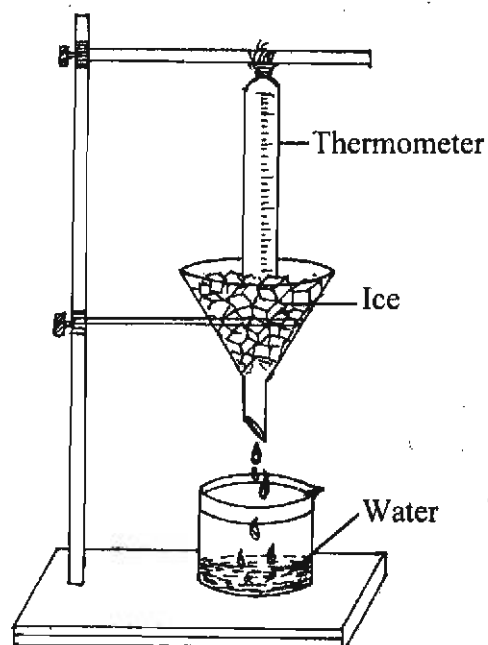


Fig. 2.3 Melting of ice

Table 2.1 Solubility and insolubility of some substances in water

Sl. No.	Solute	Solvent	Solubility	Product
1.	sugar	water	dissolves in water	sugar solution is formed.
2.	common salt	water	dissolves in water	sodium chloride solution is formed.
3.	charcoal	water	insoluble in water	charcoal floats on water.
4.	iron filings	water	insoluble	iron filings settle at the bottom.
5.	coconut oil	water	insoluble	oil forms a layer on water.

Do you know?

Cooling of soft drink bottles

Soft drink bottles are cooled by surrounding them with ice. It is because every 1 gram of ice on melting will extract out 80 cal of heat from the contents of the soft drink bottle.

Specific heat capacity of water

If we heat water at 0°C, its temperature starts raising. The amount of heat required to raise the temperature of 1g of water through 1°C is called specific heat capacity of water. The specific heat capacity of water is 1 cal/g°C that is 4.184J/g/K

2.2.1 Water as a solvent

Water is a universal solvent. Water is the most frequently used solvent since it dissolves many substances.

Water dissolves

- electrolytes* eg. acids, bases and salts.
- non-electrolytes* eg. sugar, alcohol.
- gases* eg. ammonia, hydrogen chloride.
- organic compounds* eg. sugar (sucrose)

Water dissolves almost every substance to a certain extent and is therefore called a universal solvent.

Table 2.1 and fig 2.4 clearly shows the solubility of some substances in water.

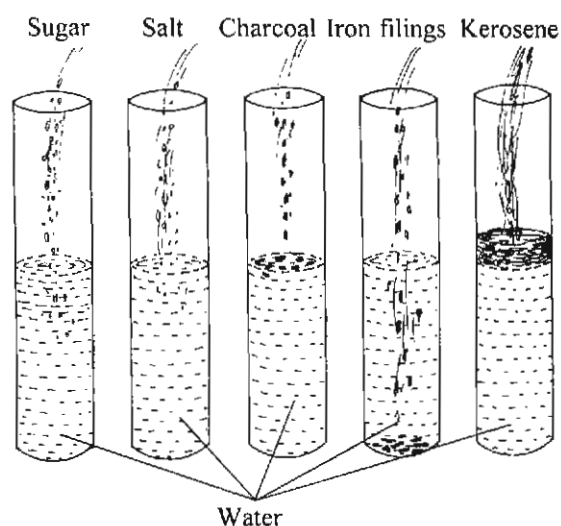


Fig. 2.4 Solubility and insolubility of some substances in water

Do you know?

solute + solvent → *solution*

solute — The dissolved substance
eg. sugar, sodium chloride

solvent — The substance which dissolves the solute eg. water

solution — A uniform mixture of the solute and solvent. eg. sodium chloride solution in water.

Activity 2.2

Aim: To show that water is a good solvent.

Materials required : Test tubes, water, salt, stirrer, and a watch glass.

Method: Fill about half of the test tube with water, add a teaspoonful of salt to it and stir. Salt will soon disappear. Add some more salt. It again dissolves to form a clear solution. After some time, it becomes difficult to dissolve more salt in the solution. Now heat

the solution. You will see that the remaining salt dissolves on heating. So the solubility increases on heating.

Thus we see that water is a good solvent. It dissolves various solids, liquids as well as gases. Solids like salts, sugar, and various other chemicals dissolve in water. Liquids like alcohol, vinegar, honey, acids etc dissolve in water. Gases like CO₂, ammonia, sulphurdioxide etc., dissolve in water.

Oxygen is also soluble in water and it is the dissolved oxygen that helps aquatic creatures to respire.

2.3 Water cycle in nature

It is estimated that about $\frac{4}{5}$ of the earth's surface is covered with water. The region covered with water is known as the hydrosphere. The science dealing with the water of the earth, their distribution on the surface and underground etc., is known as **Hydrology**.

It is estimated that the hydrosphere contains about 14,60,000 cubic km of water. Of this 97.3% is in the oceans and the seas. Only 2.7% of water is found in glaciers, fresh water lakes, rivers and underground water. Of this only 1% is potable.

Water cycle is the circulation of water from the earth's surface to the atmosphere and then back to earth. The water that we actually use comes back to us again and again. From seas,

rivers, ponds and lakes, water evaporates due to the heat of the sun and forms clouds. The clouds thus formed are carried in the atmosphere to long distances and on cooling come down as rain. This water cycle is continuous(fig. 2.5).

“The continuous circulation of water from the surface of the earth to the atmosphere and back to the earth, involving process of evaporation and

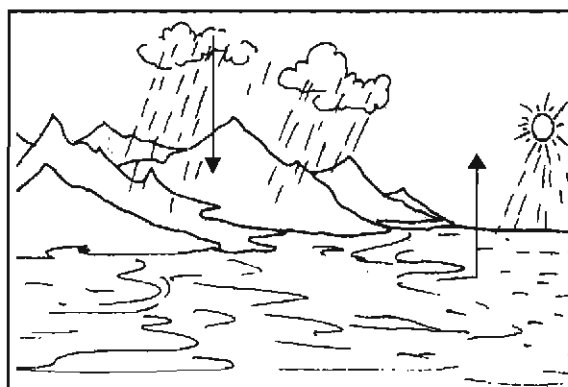
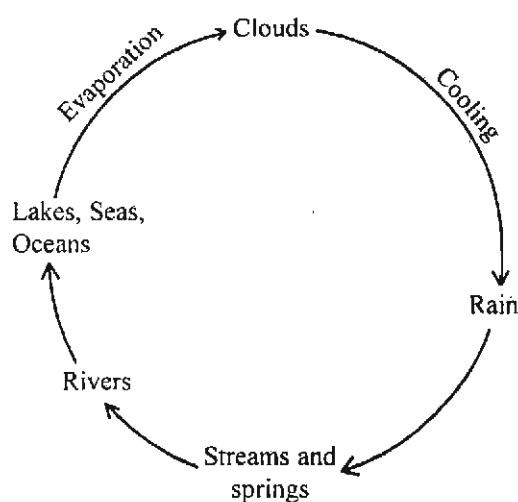


Fig. 2.5 Water cycle

condensation is called the water cycle or hydrologic cycle”.

2.4 Water pollution

Pollution is an undesirable change in the physical, chemical and

biological characteristics of land, air and water that may affect human life and other species.

Air pollution, water pollution, soil pollution, noise pollution and radiation pollution are the types of pollution.

Water pollution

The undesirable change in water that affects the health of human beings, animals and plants is called water pollution. It is the contamination of water by sewage, toxic chemicals, metals, oils and other substances.

Do you know?

According to World Health Organisation (WHO) about 5 million people die every year by drinking polluted water.

2.4.1 Causes of Water Pollution

Water pollution is mainly caused by the discharge of waste into natural water resources. Pollution of water is one of the crucial and ecological problems in India. It is estimated that 70% of all available water in India are polluted. Water pollution is caused by industrial waste, sewage, agricultural chemicals and wastes and defecation of living things.

i) Pollution caused by industrial wastes

There is discharge of many pollutants into waste water from industries. This waste water contains many poisonous chemicals. When it is

directly discharged into water systems, it kills the fish and water plants. If it is consumed by animals or plants it causes serious diseases. When hot water is discharged from industries into rivers or lakes, it causes thermal pollution.

ii) Pollution caused by sewage

Sewage consists of human wastes, rubbish and water used for laundering or bathing. These wastes spoil the ground water, rivers and lakes. The sewage water contains organic matters. They are used as food for the bacteria present in water. So the population of bacteria is increased and these bacteria consume more oxygen present in water. This causes the death of fishes and other organisms.

iii) Pollution caused by agricultural chemicals and wastes

Agricultural pesticides and fertilizers cause much pollution to water when discharged into rivers and lakes.

iv) Pollution caused by defecation of living beings

In rural area, people defecate in the open fields. Animals also defecate anywhere and everywhere. When rain falls, these wastes are washed into stream and rivers, hence water gets polluted. If such water is consumed by animals or human beings it causes diseases like dysentery, diarrhoea, jaundice, cholera, typhoid etc. The wastes of human beings and animals

contain eggs of worms like tap worm, hook worm, round worms etc.,. When this polluted water is consumed by animals, it causes serious diseases.

2.4.2 Prevention of water pollution

Controlling water pollution depends on the efforts of governments, scientists, business industry, agriculture and environmental organizations and individuals.

Water pollution is prevented in the following ways

i) The Pollution due to defecation can be solved as follows

In villages, the people should be encouraged to use latrines. In doing so, the excreta is converted into useful manure, further more it is not carried to rivers by rain water.

The cowdung may be converted into biogas in biogas plants (Gobar gas plants). This gas can be used for cooking and illumination purposes, where as the slurry left behind is a rich natural manure.

ii) Sewage treatment

The most efficient sewage treatment plants use three separate processes namely

- a) primary treatment
- b) secondary treatment
- c) tertiary treatment

The sewage water should be treated properly and all harmful substances should be removed from it before

discharging them into the rivers. Organic matters should be broken down by aerobic bacteria in the individual factories before being released into the sewage system. Similarly sewage treatment plants should be used in cities.

iii) Prevention of pollution due to industrial and agricultural operations

a) Disposal of industrial wastes should be prohibited. Washing and cleaning should be done away from the sources of water like rivers, lakes etc.,

b) Organic matters should be broken down by the aerobic bacteria in the individual factories before being released into the sewage system.

c) Radioactive wastes must be kept in the concrete containers before throwing into the sea.

d) Industrial wastes should be chemically treated to remove the pollutants.

e) The use of synthetic detergents must be minimized.

f) Minimum amount of fertilizers and pesticides must be used.

g) Large amount of manure must be used instead of fertilizers.

h) Natural pesticides such as neem oil must be used.

2.5 Composition of water

2.5(a) Discovery of Water

The elements present in water are hydrogen and oxygen in the ratio 1:8 by weight and 2:1 by volume. **Hendry**

Cavendish in 1781 showed that water can be prepared by igniting a mixture of two volumes of hydrogen and one volume of oxygen.

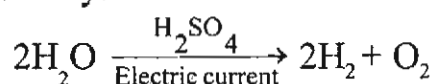
The French chemist **A.L. Lavoisier** in 1783 showed that water is a chemical compound of two elements of hydrogen and oxygen. Each molecule of water is made up of two atoms of hydrogen and one atom of oxygen. Water should thus be chemically called hydrogen monoxide (or) hydride of oxygen.

2.5(b) Experiment to find the volumetric composition of water

Electrolysis of water

Hoffmann's method

The volumetric composition of water can be determined with the help of Hoffmann's voltameter. When electric current is passed through acidified water, it is electrolysed into hydrogen and oxygen which are released at the cathode and anode respectively.



The apparatus consists of two graduated tubes connected by a horizontal tube. They are provided with air tight stoppers at the top. In between them is another vertical tube with a bulb, which is also attached to the horizontal tube. The bottom of the graduated tubes are closed with cork stoppers through which platinum electrodes are introduced (fig. 2.6).

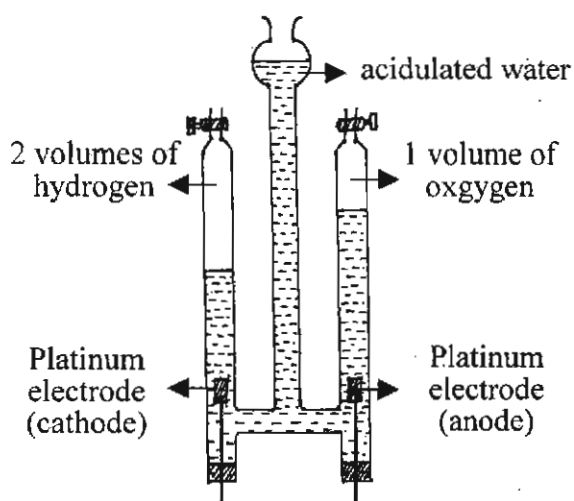


Fig. 2.6 Hoffmann's voltameter

Keeping the stoppers of the graduated tubes open, acidified water is poured through the bulb of the middle tube. When the tubes are filled with water, the stoppers are closed firmly. The platinum electrodes are connected to the terminals of battery and an electric current is passed.

Water is electrolysed into its constituent elements hydrogen and oxygen. Hydrogen is liberated at the negative electrode (cathode), where as oxygen is liberated at the positive electrode (anode). They push down the water level in their respective graduated tubes. The volume of the gases liberated can be measured from the differences in the water levels. It is notified that the decrease in the level of water in the negative electrode is twice that in the positive electrode. This shows that the volumetric ratio of hydrogen and oxygen is 2:1.

Do You know?

What is Electrolysis?

The process of decomposition of the molecules of a substance by the passage of electric current is called Electrolysis.

The substance whose molecules decompose with the passage of electric current is called electrolyte. eg. sodium chloride, copper sulphate, acidified water (water with dilute sulphuric acid), alkaline water (water with sodium hydroxide).

Volume ratio, weight ratio and percentage composition of elements in water.

volumetric composition (volume ratio) H:O	2:1
gravimetric composition (weight ratio) H:O	2:16=1:8
percentage composition	H = 11.11%
	O = 88.89%

2.5.1 Physical properties

- Pure water is a transparent, colourless, odourless, tasteless liquid. The unusual taste of water is due to the presence of dissolved air, carbon dioxide and certain salts.
- The freezing point of water at 1 atmospheric pressure is 0°C.
- The boiling point of water at 1 atmospheric pressure is 100°C.

(iv) Conductivity of water

- Thermal*: Water is a poor conductor of heat.
- Electrical*: Pure water is a poor conductor of electricity. Acidified or alkaline water is a good conductor of electricity.

Experiment to show the reversibility of water



Distillation method

The above reversibility of water can be demonstrated using distillation setup. Water is taken in the flask 'A' connected with a Liebig's condenser through which cold water is circulated. A receiver is connected with the Liebig's condenser (fig. 2.7). Heat the water in the Flask 'A'. Water distills into steam which is cooled and liquefied into water again by the Liebig's condenser. Water is collected in the receiver. Thus the reversibility of water can be proved.

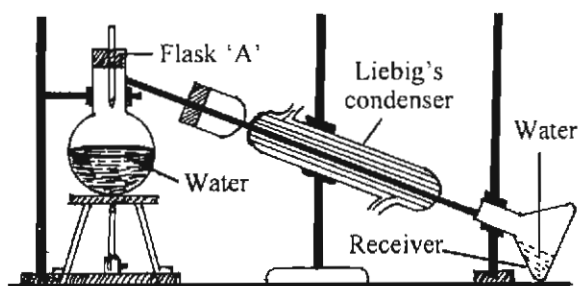


Fig. 2.7 Distillation of water

2.5.2 Density and volume of water and ice

If the mass of water remains the same the density of water varies inversely with volume. That is if the volume of

water increases, its density decreases. On cooling, below 4°C volume of water increases. Hence volume of ice at 0°C is greater than that of water at 4°C (Fig. 2.8). Density of ice at 0°C is therefore less than the density of water at 4°C . It has been found that the density of water is 1 g/cc at 4°C and the density of ice at 0°C is 0.91 g/cc .

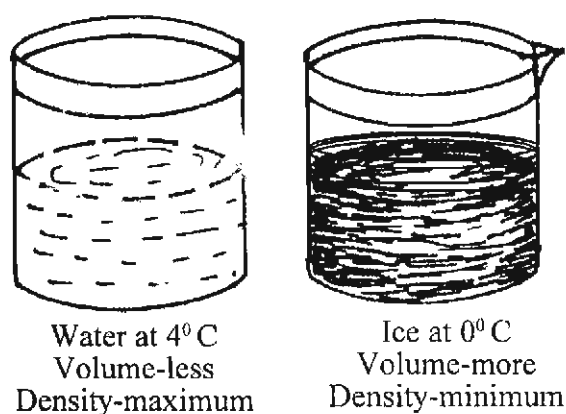


Fig. 2.8 Density and volume of water and ice

Reason for the floating of ice on water

There is more space in ice than in water. So volume of ice at 0°C is greater than that of water. Thus ice at 0°C has lower density than water at 4°C and hence ice floats on water (fig 2.9).

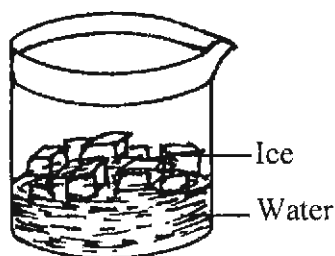


Fig. 2.9 Ice floats on water

2.6 Salinity of sea water

The largest source of natural water is the sea. It contains a large percentage

(3.5%) of dissolved salts with the chief constituent being sodium chloride (2.8%). Salts of potassium, calcium and magnesium are also present in sea water. Due to the presence of sodium chloride and other salts sea water is salty to taste and hence called Saline water. Its salinity is usually expressed as the amount of dissolved salts contained in 1000 parts of water, an average value being about 35 per 1000 (or) 3.5%.

Sea water contains an abundance of phytoplanktons such as algae, fishes, turtles, snakes, crabs and marine mammals. It provides food, dissolved oxygen and CO_2 in sufficient amounts to them. The temperature variations in sea water are moderate and salts and minerals present in it suit the organism.

Preparation of salts from sea water

In coastal areas, sea water is collected in small rectangular lagoons (or) square shaped lagoons. The water is then allowed to evaporate. When all the water has evaporated crystals of common salt are left behind. These crystals are sometimes further dried and purified, by the method of recrystallisation. Sometimes, the common salt is iodised to increase the amount of iodine present in it. This is done to prevent the incidence of goitre in human beings. The common salt thus obtained is packed in bags and transported for wholesale and retail markets.

The brine or Sea water consists of dissolved salts in large percentage. On evaporation, one kilogram of sea water with a salinity of 3.5% will give salts in the following proportions.

No	Salt	Weight
1.	Sodium chloride	27.213g
2.	Magnesium chloride	3.807g
3.	Magnesium sulphate	1.658g
4.	Calcium sulphate	1.260g
5.	Potassium sulphate	0.863g
6.	Calcium carbonate	0.123g
7.	Magnesium bromide	0.076g
	Total	35.000g

Activity 2.3

Prepare a saturated solution of common salt by dissolving more amount of salt in water. Take a few teaspoonful of this solution on a watch glass and put it over a water bath. Heat the water in the water bath and allow the solvent to evaporate. After some time, when the water has completely evaporated, white crystals of common salt are left behind on the watch glass. You can feel the Saline taste of this salt by putting a pinch of it on the tip of your tongue.

2.6.1 Conversion of sea water (saline water) into potable water

Reverse osmosis technique

Reverse osmosis is a process in which pure solvent passes from a

concentrated solution to a dilute solution when they are separated by a semi permeable membrane.

Reverse osmosis takes place only when the hydrostatic pressure applied on the concentrated solution is greater than the osmotic pressure. This method is used for desalination of sea water.

Removal of dissolved salts from the sea water is known as desalination.

In this method, sea water (hard water) is taken in the inner vessel and pure water (soft water) is taken in the outer vessel. Sea water and soft water are separated by a semi permeable membrane. A hydrostatic pressure greater than the osmotic pressure is applied on the sea water (hard water). Now pure water from the inner vessel passes into the outer vessel, leaving the dissolved salts. Thus de salination of sea water takes place (fig 2.10).

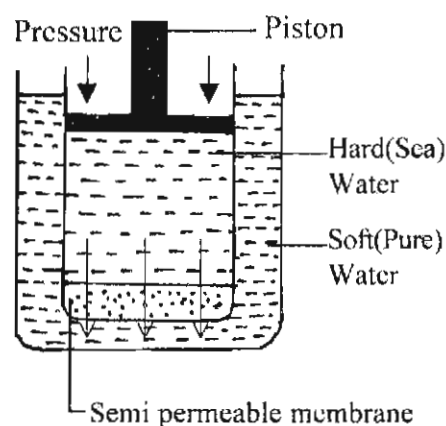


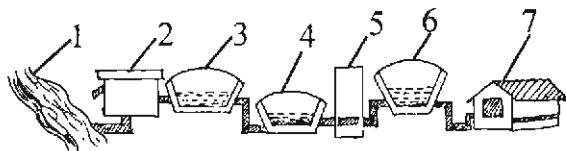
Fig. 2.10 Reverse Osmosis

2.6.2 Water treatment

Treatment of water obtained from different sources

The water available from its various sources may not always be fit for drinking and cooking purposes. It may contain germs and other undesirable impurities. So it has to be treated before it is made available to the public. Following steps are adopted in treating the water that we get through taps (fig 2.11).

- (i) sedimentation
- (ii) filtration
- (iii) addition of chemicals



- | | |
|-----------------------|----------------------|
| 1. River | 2. Pumping Station |
| 3. Sedimentation tank | 4. Sand and gravel |
| 5. Sand filter | 6. Chlorination tank |
| 7. To overhead tank | |

Fig 2.11 Purification of natural water for drinking

i) Sedimentation

In pumping station, water is first subjected to sedimentation wherein it is treated with alum and lime. These chemicals bring about the coagulation of the suspended particles, i.e., join together the smaller particles to form larger particles which then settle on standing.

ii) Filtration

The water after sedimentation is filtered by passing it through beds of sand. During this process solid impurities and some micro organisms are removed from water.

iii) Addition of Chemicals

Chlorine is now added to kill the micro organisms which still exist, and lime is added to prevent the rusting of water pipes. Bleaching powder is also added to tank water instead of chlorine.

2.7 Rain water harvesting

In nature 4/5 of the earth's crust is covered by water. Water is essential for all living things. Water plays an important role in the production of most of the substances by man.

Importance of rain water

Water is very important in our day to day life. Water is a basic necessity not only to man but also to plants and animals. Eventhough the earth contains large amount of water less than 1% of it is fresh water. This water is available in the form of lake water, river water and well water and underground water. These water resources are maintained by rain. To meet our water requirements we depend mainly on the above said water resources. The importance of rain water is not felt at this juncture. Rain water is not only cultivating food materials to the consumer but also serves as a basic food.

What is meant by rain water harvesting?

The rain water we get from the rain during the **rainy** season is wasted. Hence rain water must be collected and saved. Saving the rain water in the earth

and using it is called rain water harvesting.

Advantages of rain water harvesting

Rain water harvesting helps to raise the ground water level so that the water level in the wells and borewells is increased. For example, if we save the average rain in one year (857 mm) it helps us to get 500 litre of water everyday from one unit ground area. This is enough for a family consisting of 5 persons.

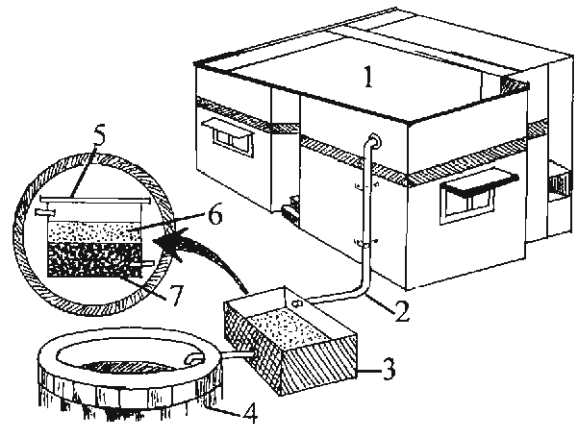
Methods of rain water harvesting

Rain water harvesting can be done by three methods.

- 1) Collection of rain water from terraced buildings.
- 2) Collection of rain water from the houses thatched by tiles and coconut leaves.
- 3) Collection of rain water from the open space around the buildings.

1) Rain Water saved from terraced buildings

As it is shown in figure 2.12 the rain water collected from the open terraced building can be brought into filter bed of size 2'x2'x3' through storm water pipe. The filter bed is filled first with brick bats and above that sand is added. From the filter bed the purified water can be discharged into either open wells or deep bore wells through pipes.



- | | |
|------------------|---------------------|
| 1. Open terrace | 2. Storm water pipe |
| 3. Filter bed | 4. Well |
| 5. Concrete slab | 6. Sand |
| 7. Brick bats | |

Fig 2.12 Rain water harvesting

2) Collection of rain water from thatched houses

The rain water from the thatched houses can be collected by rain water gutter. The water thus collected is passed into a filter tank through drain pipe. The filtered water is then passed into a water tank. Water collected in the tank can also be used for domestic purpose. The overflowing water is passed into open bore wells or deep bore wells through pipes.

3) Collection of rain water from open space around the building

Rain water that collects in the open space around the buildings mostly mixes with sewage water and gets wasted. Hence this rain water can also be collected and saved beneath the ground in wells or bore wells.

SELF EVALUATION

I. Choose the correct answer

- Volume of water increases when it is cooled below
(a) 100°C (b) 4°C (c) 40°C (d) 273°C
- Latent heat of vapourisation of water is
(a) $+537\text{ cal}$ (b) -537 cal (c) $+79.7\text{ cal}$ (d) -79.7 cal
- The percentage of salts present in sea water is
(a) 2.8% (b) 3% (c) 3.5% (d) 3.9%
- The gravimetric percentage composition of hydrogen and oxygen in water is
(a) 2:1 (b) 1:2 (c) 8:1 (d) 11.11 : 88.89
- The region covered by water is known as
(a) hydrosphere (b) ionosphere (c) atmosphere (d) none of these
- Sea water is converted into potable water by
(a) electrolysis (b) filtration
(c) reverse osmosis (d) primary treatment

II. Fill in the blanks

- The human body contains _____ percentage of water.
- _____ showed that water can be prepared by igniting the mixture of two volumes of hydrogen and one volume of oxygen.
- _____ % of water is present in tomato.
- Water is chemically called as _____.
- _____ is the volumetric composition of water.
- The gravimetric composition of water is _____.
- The three forms of water are _____, _____ and _____.
- When 1g of water is converted into ice at 0°C amount of heat evolved is _____ calories.
- _____ is an example of non-electrolyte.
- _____ is an example of water pollutant.
- _____ is a disease caused by water pollution.
- Electrolysis of acidulated water gives _____ and _____.

19. _____ is the device used for the determination of volumetric composition of water.

III. Match the following

- | | | |
|-----------------------------------|---|---------------------------------|
| 20. 0°C at 1 atmospheric Pressure | - | specific heat capacity of water |
| 21. 100°C at 1 atm | - | non conductor of electricity |
| 22. 1 cal /g/K | - | sea water into potable water |
| 23. pure water | - | 0.91 g / cc |
| 24. reverse osmosis | - | boiling point of water |
| 25. density of ice at 0°C | - | freezing point of water |

IV. Give short answer

26. What are the sources of water ?
27. What are the three physical states of water ?
28. What is latent heat of vapourisation ?
29. Show that water is a universal solvent.
30. Give an example for each of the following
(i) solute (ii) solvent (iii) solution
31. Define hydrology.
32. What is meant by water cycle ?
33. What is water pollution ?
34. Why does ice float on water ?
35. What is rain water harvesting ?
36. What is latent heat of fusion ?

V. Give detailed answer

37. Explain the treatment of water from different sources with neat sketch.
38. Explain reverse osmosis process with neat diagram.
39. How is hydrologic cycle effected? Explain with a neat sketch.
40. Explain the various methods of rain water harvesting.
41. Explain Hoffmann's method to show the volumetric composition of water.

3. Structure of Matter

We know that things around us can be classified into groups on the basis of their common properties. However, there are two properties which are common to all kinds of materials, irrespective of their being visible to the eye or not.

- 1) All material bodies occupy some space.
- 2) All material bodies have some mass.

Anything which occupies space and has mass is called matter

Examples of matter

The buildings, water and air etc..

All matter is made up of substances, which in turn, are made of tiny particles. The closeness to each other of these particles in any matter makes

it a solid or liquid or gas. The properties of any matter arise due to the nature of the particles present in it. The word matter is used for all the substances and materials from which the universe is composed.

3.1 Three physical states of matter

Solid

The matter that occupies a definite space and has a definite shape is called a solid (fig. 3.1).

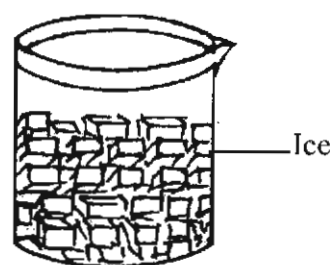
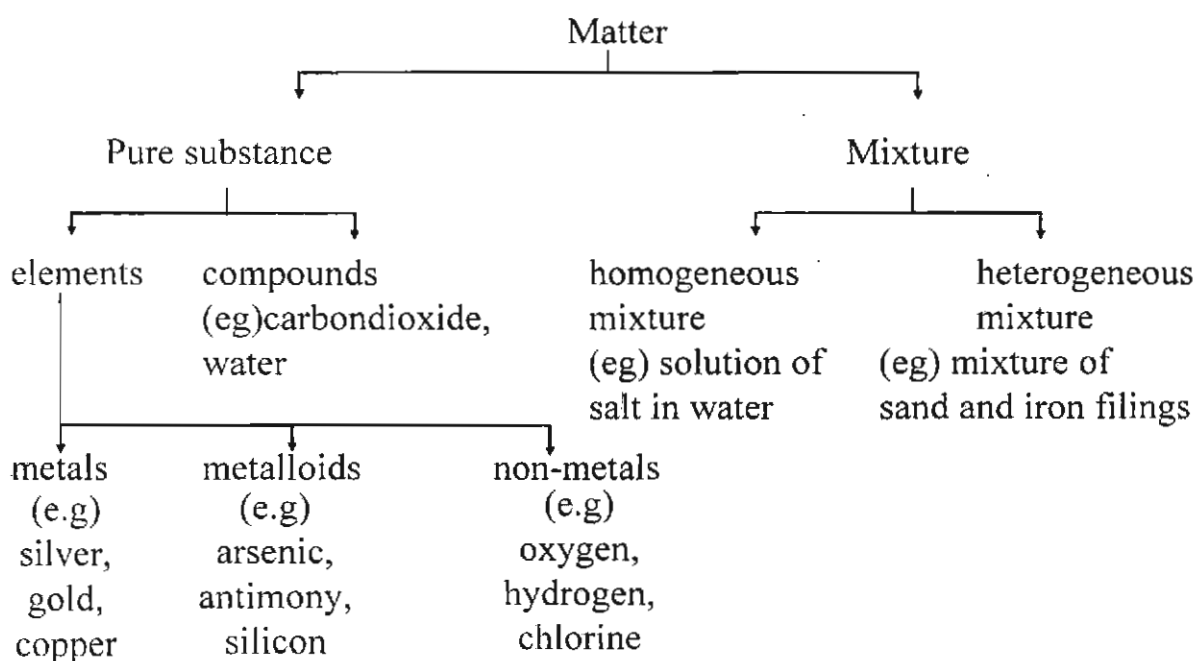


Fig. 3.1 Solid

Classification of matter into different types



Liquid

The matter that occupies a definite space but has no definite shape is called a liquid (fig. 3.2).

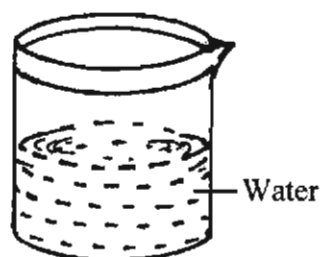


Fig. 3.2 Liquid

Gas

The matter that neither occupies a definite space nor has a definite shape is called a gas (fig. 3.3).

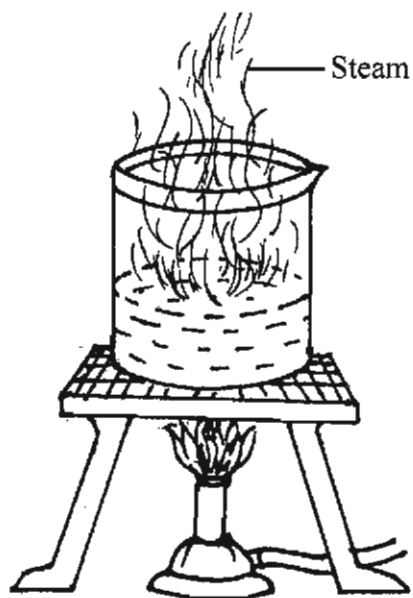


Fig. 3.3 Gas

Properties of solids, liquids and gases (Table 3.1)

Sl.No	Solids	Liquids	Gases
1	are hard.	are not hard.	are not hard.
2	have a definite shape and volume.	have definite volume but no definite shape.	have neither definite shape nor definite volume.
3	cannot flow	can flow from higher level to lower level.	can flow in all directions.
4	inter molecular space is minimum.	inter molecular space is moderate.	inter molecular space is maximum.
5	cannot be compressed appreciably.	cannot be easily compressed.	can be easily compressed.
6	inter molecular forces are maximum.	inter molecular forces are less than that in solid.	inter molecular forces are negligible.

Activity 3.1

Classify the things as solid, liquid or gas.

coin, orange juice, book,
oxygen, petrol, stone,
water, water vapour, hydrogen,
table, pen, kerosene.

3.1.1 Miscibility and immiscibility of liquids

Miscibility of liquids

Water and alcohol are thoroughly miscible liquids. That is alcohol is soluble in water.

Immiscibility of liquids

Oil and water are immiscible liquids. That is oil is insoluble in water.

When oil is mixed with water, two layers are formed. Oil forms upper layer while water forms lower layer.

Experiment to show the miscibility of water with alcohol

Take 20 ml of water in a beaker and pour 10 ml of ethyl alcohol into water and stir well with a glass rod.

See what happens?

The two liquids completely mix with each other and forms a homogeneous mixture (fig. 3.4).

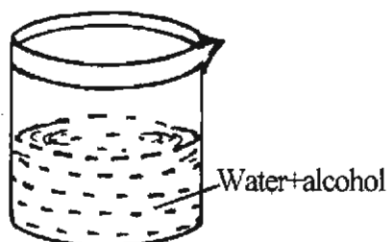


Fig. 3.4 Miscibility of water with alcohol

Experiment to show the immiscibility of water with oil

Take 20 ml of water in a beaker and pour 10 ml of coconut oil into it and stir well with a glass rod.

See what happens?

Water does not mix with oil. Oil forms the upper layer and water forms the lower layer (fig. 3.5).

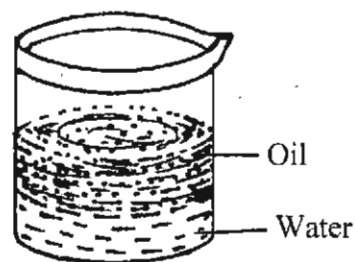


Fig. 3.5 Immiscibility of water with oil.

3.2 Interchangeability of different states of matter

3.2.1 Solid - liquid

Melting

The conversion of a solid into a liquid on heating is called melting.

eg. Ice(solid) changes into water (liquid) on heating.

The temperature at which a solid melts into a liquid is called the melting point of the solid. Melting point of ice is 0°C .

Activity 3.2

Aim : To demonstrate melting.

Materials required: Beaker, ice cubes, Bunsen burner.

Method:

Place some ice cubes in the beaker.

Heat it on a burner. What happens?
The ice melts into water (fig. 3.6).

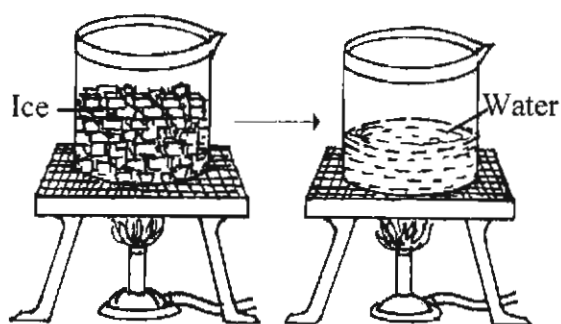


Fig. 3.6 Melting

3.2.2 Liquid - gas

Evaporation

The conversion of a liquid into vapour (gas) by heating is known as evaporation.

When evaporation takes place rapidly at a particular temperature, it is known as boiling. The temperature at which a liquid starts boiling is known as the boiling point of the liquid. Boiling point of water is 100°C .

Activity 3.3

Aim: To demonstrate evaporation.

Materials required

Beaker, water, bunsen burner.

Method

Heat the water in a beaker for sometime. You will see vapour over the water. On further heating, water starts boiling vigorously and hot steam is given off. As water changes into water vapour, the level of water in the beaker falls down (fig. 3.7).

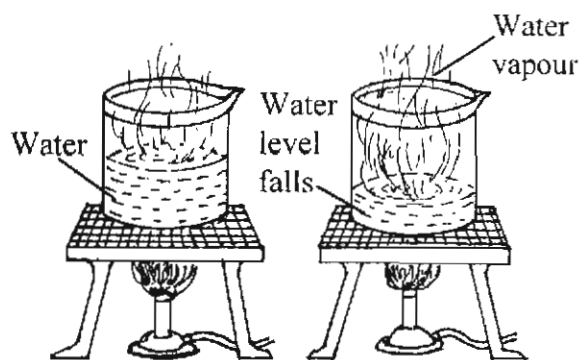


Fig. 3.7 Evaporation

3.2.3 Solid -gas

Sublimation

The process by which a solid directly changes into gaseous state on heating, without changing into liquid state and the gas so formed on cooling directly changes into solid state is called sublimation.

eg. Solids like camphor, iodine and ammonium chloride undergo sublimation.

Activity 3.4

Aim : To demonstrate sublimation

Materials required : Tripod stand, bunsen burner, china dish, glass funnel, cotton and ammonium chloride.

Method : Take a small amount of ammonium chloride in a china dish. Cover the dish by an inverted funnel. Plug the opening in the stem of the funnel with cotton. This prevents the exit of ammonium chloride vapours. Place the china dish on the stand. Heat well. Ammonium chloride vapour raise above and deposit on the cooler side of the funnel (fig 3.8).

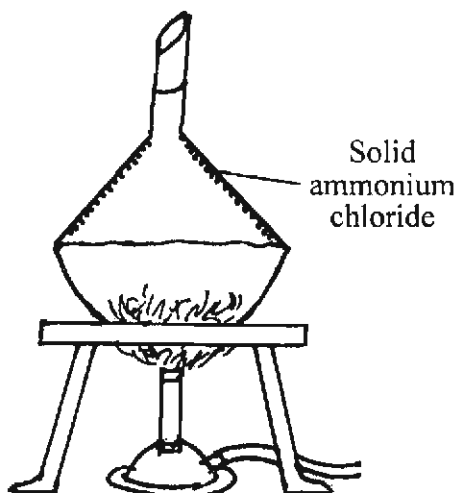


Fig. 3.8 Sublimation

3.2.4 Gas - liquid

Condensation

The conversion of a vapour (gas) into liquid by cooling is known as condensation.

Activity 3.5

Aim : To demonstrate condensation.

Materials required: Beaker, lid, water, bunsen burner.

Method

Put a lid over the mouth of the beaker in which the water is boiling. Remove the lid after a minute. What do you observe? You will see droplets of water on the inner side of the lid (Fig. 3.9). Where did they come from?

The vapour or steam given off during boiling has changed back into water on coming into contact with the cooler lid, that is, the water vapour on cooling changes back into water. This process is known as condensation.

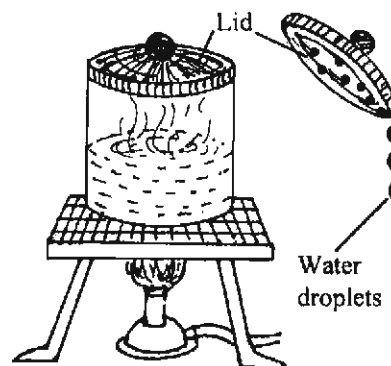
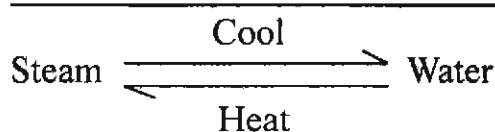


Fig. 3.9 Condensation



3.2.5 Liquid - solid

Freezing

The conversion of a liquid into a solid by cooling is known as freezing.

Activity 3.6

Aim : To demonstrate freezing.

Materials required : ice tray, water.

Method:

Put some water in an ice tray and put the tray inside the freezer. Take out the tray after a couple of hours. What do you see? The water has changed into ice (Fig 3.10).

This process of changing a liquid into solid is known as freezing (or) solidification.

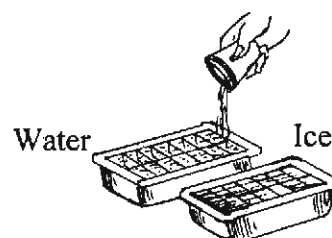


Fig. 3.10 Freezing

3.3 Element

Any pure substance which cannot be broken into two or more pure substances by any physical or chemical means is called an element.

An element is composed of only one kind of atoms or molecules. Elements are the building blocks of all materials.

Chemists have discovered 112 elements so far. Amongst these, 82 elements are normal elements. Remaining 30 elements are called radioactive elements. By radioactive elements we mean such elements which give out harmful radiations.

Atom

The smallest unit of an element which may or may not have an independent existence, but always takes part in a chemical reaction is called an atom. eg. Hydrogen atom, sulphur atom, copper atom, sodium atom.

Atom can be split into tiny sub atomic particles namely protons, neutrons, and electrons.

Molecule

The smallest unit of a pure substance, which always exists independently and can retain physical and chemical properties of that substance is called a molecule.

Two or more atoms combine in whole number ratio to give molecules.

Diatomic molecule

eg. 1) Hydrogen molecule (H_2) consists of two atoms of hydrogen .

2) Oxygen molecule (O_2) consists of two atoms of oxygen .

3) Chlorine molecule (Cl_2) contains two atoms of chlorine.

4) Nitrogen molecule (N_2) contains two atoms of nitrogen.

Hydrogen, oxygen, nitrogen and halogens like flourine, chlorine, bromine and iodine are **diatomic elements**.

3.3.1 Name and symbols of elements (First ten elements) Table 3.2

S.No	Elements	Symbol
1	Hydrogen	H
2	Helium	He
3	Lithium	Li
4	Beryllium	Be
5	Boron	B
6	Carbon	C
7	Nitrogen	N
8	Oxygen	O
9	Fluorine	F
10	Neon	Ne

More examples of common elements

Table 3.3

S.No	Elements	Symbol
1	Chlorine	Cl
2	Cobalt	Co
3	Nickel	Ni
4	Barium	Ba
5	Platinum	Pt
6	Zinc	Zn

3.3.2 Names of elements derived from Latin, Greek & German

Table 3.4

S.No	Elements	Latin Name	Symbol
1	Potassium	Kalium	K
2	Sodium	Natrium	Na
3	Iron	Ferrum	Fe
4	Tin	Stannum	Sn
5	Lead	Plumbum	Pb
6	Copper	Cuprum	Cu
7	Mercury	Hydrargyrum	Hg
8	Silver	Argentum	Ag
9	Gold	Aurum	Au
10	Tungsten	Wolfrum (German)	W
11	Antimony	Stibium	Sb

Triatomic molecule

Ozone molecule (O_3) consists of three atoms of oxygen.

Polyatomic molecule

Sulphur molecule (S_8) contain eight sulphur atoms.

Do you know ?

Mono atomic elements

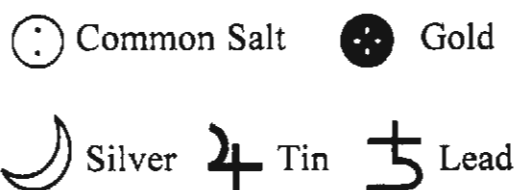
Most of the elements have atoms as their independently existing fundamental unit. In these elements atoms do not join to form molecules. Such elements are called mono atomic elements.

eg. copper, silver, helium etc.,

3.3.3 Alchemy - Explanation

In olden days alchemists believed that some metals like iron can be converted into gold. The art of transmutation of a metal into gold is called alchemy.

Examples of alchemist's Symbols



3.3.4 Dalton's atomic theory

John Dalton (1766-1844) the British chemist developed a theory that all elements are composed of tiny, indivisible particles called atoms and

that each element is made up of identical atoms. (But later, scientists proved that atoms are divisible).

1) All matter is made up of very tiny particles which cannot be broken down further. He called these tiny particles -atoms (Tomio in Greek means to divide or break). Atom, therefore, means non-divisible (A-tomio).

2) An element is a substance that has the same kind of atoms in it, that is, all atoms of an element are identical.

3) Atoms of elements combine in many ways to create the variety and complexity.

Dalton's symbols of some elements

Ⓢ Silver Ⓛ Lead Ⓤ Gold
 ● Carbon ○ Oxygen.

3.4 Compound

Only a few elements like oxygen, nitrogen, hydrogen etc.. occur freely

in nature. Most of the substances are formed by the combination of two or more elements. Such substances are called compounds.

Definition

A compound is a pure substance formed by the combination of two or more elements in a fixed ratio by mass. The basic independently existing units of a compound are molecules.

eg.

1. Carbondioxide

Carbon and oxygen combines to give carbondioxide.

2. Water

Hydrogen combines with oxygen to give water.

3. Haemoglobin

It is a compound of iron which is present in red blood corpuscles of blood.

Table 3.5 Name and formula of some compounds that we use in our daily life

Common name	Chemical name	Formula
Sand	Silicon dioxide	SiO ₂
Water	Hydrogen oxide	H ₂ O
Washing soda	Sodium carbonate	Na ₂ CO ₃
Baking soda	Soduim bicarbonate	NaHCO ₃
Soap	Sodium palmitate	C ₁₅ H ₃₁ COONa
Sugar	Sucrose	C ₁₂ H ₂₂ O ₁₁
Bleaching powder	Calcium oxychloride	(CaOCl ₂)
Common salt	Sodium chloride	NaCl
P.V.C. Plastic	Poly vinyl chloride	(-CH ₂ -CH-) _n Cl

4. Chlorophyll

It is a compound of magnesium which is present in green leaves and vegetables.

5. Calcium phosphate

It is a compound of calcium which is present in bones and teeth.

3.4.1 Water is a compound

The following facts will prove that water is a compound.

1. Hydrogen and oxygen in water exist in the ratio of 1:8 by weight. It means water has a homogeneous composition.

2. The constituents of water cannot be separated by physical means such as filtration, boiling, etc.,

3. When 1 part of hydrogen by weight is burnt with 8 parts by weight of oxygen to form water, large amount of heat energy is liberated.

4. The properties of water are entirely different from the properties of its constituents. For example, hydrogen is a gas which burns, whereas oxygen is a gas which helps in burning. However, water is a liquid which extinguishes fire.

3.4.2 Compounds in daily use

Bleaching Powder

1. It is used as
 - a) an oxidising agent
 - b) a bleaching agent
 - c) a disinfectant, and
 - d) a germicide.

2. It is used in the preparation of chloroform iodoform etc.

3. It is used in the sterilisation of drinking water.

Plastics

Plastics are used

1. for making electrical goods.
2. for making furniture, household articles and toys (fig.3.11)
3. for making special types of paints.
4. for making table tops, wind screens etc.
5. for making adhesives.
6. for making electrical appliances such as plugs, switches, holder, radio and TV cabinets.

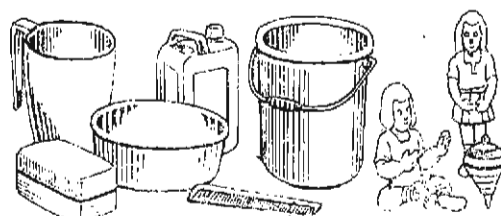


Fig. 3.11 Toys and household articles

Sodium bicarbonate(Baking soda)

1. It is used in fire extinguishers.
2. It is used in medicine to remove the acidity in stomach. Being alkaline, sodium-bicarbonate neutralises excess acid and relieves indigestion.
3. It is used in the preparation of baking powder. Baking powder contains sodium bicarbonate and tartaric acid. When baking powder is added to water (or when baking powder is heated) sodium bicarbonate and acid present in it react to produce carbondioxide

gas. During the preparation of cakes, breads etc., this carbon dioxide gas causes them to raise and become light.

Sodium carbonate

1. It is used in laundry as washing soda. In other words, sodium carbonate is used as a “cleaning agent” for domestic purposes. In fact, it is a component of many dry soap powders.

2. It is used for softening hard water.

3. It is used in the manufacture of many useful sodium compounds like caustic soda, borax, glass and soap, etc.

4. It is used in the manufacture of paper.

5. It is a valuable laboratory reagent.

6. It is used as a standard base in acid base titrations, to standardise acid solutions.

Sodium chloride

1. It is an essential constituent of our daily diet. So, it is used in the preparation of food items.

2. It is used as a starting material for the manufacture of many useful sodium compounds like caustic soda, washing soda and baking soda.

3. It is used to prepare hydrochloric acid which is used as an important chemical in chemical industries.

4. It is used to manufacture chlorine gas which is used as a bleaching agent.

5. It is used in the manufacture of soap (during the salting out stage).

6. It is mixed with ice and used as a freezing mixture for producing very low temperature.

7. It is used as a preservative for meat and fish.

Cotton

1. It is very useful in making cloths.

2. Soft cotton is used for medicinal purposes and in making pillows and cushions.

Dyes

1. Dyes are used to change the colour of hair, fabric, wood etc.

2. Dyes are also used in colouring the threads.

Sugar

1. It is used in preparing sweets, tonics, syrups, juices.

2. It is used in the preparation of alcoholic beverages.

3. It is used in toffees and confectionaries.

4. It is used to prepare glucose and fructose.

3.5 Mixtures

Definition

A mixture contains two or more pure substances mixed together in any ratio.

Kinds of Mixtures

1. *Homogeneous mixture*

A mixture in which its constituents are mixed uniformly is called homogeneous mixture.

eg. air, salt solutions.

2. *Heterogeneous mixture*

A mixture in which its constituents are not distributed uniformly is called heterogeneous mixture.

eg. a mixture of wood, dust iron and common salt.

Method of separation of components from a heterogeneous mixture

Take a mixture of wood dust, dust iron and common salt in a beaker. Insert a magnet into the mixture. Iron particles stick to the magnet. Take away the magnet to remove the dust iron. The remaining mixture contains wood dust and common salt. Add water to this mixture and stir. Common salt dissolves in water to form a solution. Filter the solution to remove the wood dust. Heat the remaining solution. Water evaporates leaving behind the common salt.

Air is a mixture

The following facts prove that air is a mixture.

1. The composition of air is not constant. It varies from place to place.
2. The different components of air retain their identity.
3. There is no specific formula for air.
4. The different components of air can be separated easily.
5. There is no energy change when the components of air are mixed.

Mixture of fertilizers

Mixture of fertilizers like N.P.K.

fertilizers are used in agriculture.

N.P.K. fertilizers contain ammonium nitrate, ammonium sulphate, ammonium phosphate and potassium chloride.

Activity 3.7

preparation of a heterogeneous mixture

Take a small amount of powdered charcoal and a small amount of powdered sand in a beaker and mix them thoroughly.

- ❖ *Can you see the particles of sand and charcoal?*
- ❖ *Are particles evenly distributed in the mixture?*

You will notice that black particles of charcoal can be easily distinguished from the particles of sand.

You will further notice that these particles are not evenly distributed. At some places charcoal particles are more than sand particles.

Such a mixture is called heterogeneous mixture.

Activity 3.8

Preparation of a homogeneous mixture

Take a glass half filled with water.

Add a spoonful of common salt in water and stir well.

- ❖ *Are particles of salt and water visible?*
- ❖ *Are these particles evenly distributed in the mixture?*

You will notice that salt particles cannot be distinguished from water particles.

You will further notice that the taste of solution is uniform throughout the solution. This suggests that particles of water and salt are evenly distributed.

Such a mixture is called homogeneous mixture.

Examples of mixtures

1. Sea water is a mixture of water and a large number of salts of metals.
2. Rock salt is a mixture of common salt and fine sand.
3. A cup of tea contains water, sugar, milk and extracts of tea leaves.
4. Smoke is a mixture of carbon particles and air.

3.5.1 Differences between mixtures and compounds (Table 3.6)

Mixtures	Compounds
<p>1. Nature</p> <p>When two or more elements or compounds or both are mixed together, such that they do not combine chemically, a mixture is formed.</p>	<p>When two or more elements unite chemically in a fixed proportion, a compound is formed.</p>
<p>2. Structure</p> <p>Mixture may be homogeneous or heterogeneous.</p>	<p>Compounds are always homogeneous.</p>
<p>3. Composition</p> <p>In case of mixtures their constituents can be present in any desired ratio.</p>	<p>In case of compounds, the constituents are present in fixed ratio by weight.</p>
<p>4. Properties</p> <p>The constituents of a mixture retain their individual chemical and physical properties.</p>	<p>The properties of the compounds are entirely different from the properties of constituents.</p>
<p>5. Separation of constituents</p> <p>The constituents of a mixture can be separated by physical means.</p>	<p>The constituents of a compound cannot be separated by physical means.</p>
<p>6. Energy changes</p> <p>During the formation of a mixture no energy change takes place.</p>	<p>During the formation of a compound energy changes take place.</p>

5. Cooking gas is a mixture of gases such as butane and pentane.

6. Air is a mixture of oxygen, nitrogen, carbon dioxide and water vapour.

7. Milk is a mixture of fats, carbohydrates, proteins, vitamins and mineral salts.

In this way, there is an endless list of mixtures.

SELF EVALUATION

I. Choose the correct answer

- The substance used for the softening of hard water is
 - copper sulphate
 - sodium hydroxide
 - sodium chloride
 - sodium carbonate
- The symbol of potassium is
 - P
 - Pt
 - Po
 - K

II. Fill in the blanks

- Matter exist in _____, _____ and _____ states.
- Haemoglobin is a _____.
- A compound is formed by the combination of at least _____ elements.

III. Match the following

- | | | |
|--------------|---|----------|
| 6. Metal | - | silicon |
| 7. Metalloid | - | book |
| 8. Non-metal | - | oxygen |
| 9. Solid | - | chlorine |
| 10. Gas | - | copper |

IV. Give short answer

- What is matter?
- Define element.
- Define compound.
- Define mixture.
- Give an example of compound, mixture and element.
- Write the name and symbol of two elements.

17. Name the three states of matter. Give an example for each.
18. Write the symbols for each of the following elements
 1. Chlorine -
 2. Iron -
 3. Silver -
 4. Gold -
19. Define molecule.
20. How many elements are known to scientists?
21. Name two diatomic elements.

V. Answer in detail

22. Define the following terms.
 - i) compound
 - ii) mixture
23. By giving reasons explain that water is a compound.
24. Explain the method of separation of the components of a heterogeneous mixture.
25. Define the following terms.
 - i) sublimation
 - ii) evaporation.
26. Give three differences between solids, liquids and gases.
27. Classify the following as elements, compounds and mixtures.
Water, blood, milk, kerosene, common salt, ice-cream, iodine, smoke, fog, honey, iron, marble, sand.
28. Write the differences between mixtures and compounds.
29. Write the uses of sodium carbonate.
30. How will you prepare a homogeneous mixture?
31. By giving reasons explain that air is a mixture.
32. Mention the uses of sodium chloride.
33. Give five examples of mixture.
34. What is a mixture? Explain the two types of mixtures with suitable examples.

4. Acids Bases and Salts

Acids, bases and salts are the three distinct classes into which almost all organic and inorganic compounds are divided. Each of these classes have a definite characteristic set of properties.

4.1 Acids

The word acid is derived from the Latin word "acidus" which means sour. Acids are compounds found naturally in plants or derived from minerals which have sour taste. Acids are directly or indirectly encountered in our daily life and in our diet.

Definition

An acid is a substance which gives hydrogen ions when dissolved in water (or) acid is a substance which contains **replaceable hydrogen ions(H^+)**

However all compounds containing hydrogen are not acids. For instance ammonia (NH_3), methane (CH_4), glucose ($C_6H_{12}O_6$) are not acids.

Acids derived from animals and plants are called organic acids.

eg. citric acid, formic acid

Acids derived from minerals are called inorganic acids.

eg. hydrochloric acid, sulphuric acid

4.1.1 Acids used in our day to day life and their sources (Fig. 4.1)

Table 4.1

No.	Name of the acid	Sources
1.	Citric acid	Citrus fruits like lemons, and oranges
2.	Lactic acid	Sour milk
3.	Formic acid	Stings of bees and ants
4.	Butyric acid	Rancid butter
5.	Tartaric acid	Tamarind, grapes and apples
6.	Acetic acid	Vinegar
7.	Malic acid	Apples
8.	Uric acid	Urine
9.	Oxalic acid	Tomato
10.	Stearic acid	Fats
11.	Cholic acid	Bile acids

4.1.2 Some common acids (mineral acids or inorganic acids) used in laboratories.

Table 4.2

No.	Chemical Name	Common Name	Formula
1.	Hydrochloric acid	Muriatic acid	HCl
2.	Sulphuric acid	Oil of vitriol or king of chemicals	H_2SO_4
3.	Nitric acid	Aqua fortis	HNO_3

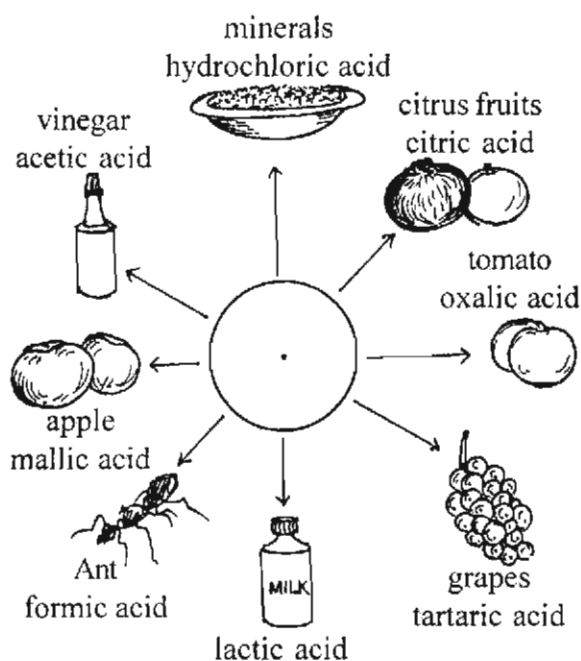


Fig. 4.1 Acids and their sources

Activity 4.1

Observe how copper vessels are washed in your house. Why is tamarind used for washing them?

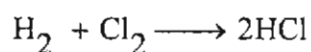
Prepare a list of some organic acids mentioning how they are used in the preparation of food stuffs.

Preparation of some acids

1. By direct combination of elements

Hydrogen gas reacts with chlorine gas to give hydrogen chloride gas. Hydrogen chloride gas is dissolved in water to get hydrochloric acid.

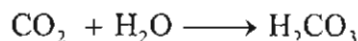
hydrogen + chlorine \rightarrow hydrogen chloride



2. By dissolving an acidic oxide in water

Carbon dioxide gas is dissolved in water to get carbonic acid. Soda water we drink contains carbonic acid.

carbon dioxide + water \rightarrow carbonic acid



Properties

4.1.3 Physical Properties

1. **Colour:** Mineral acids are colourless liquids. Sometimes sulphuric acid becomes light brown and hydrochloric acid becomes yellow due to impurities. Some organic acids are white coloured solids. eg. benzoic acid.

2. **Solubility:** Mostly all the acids are soluble in water except some organic acids.

3. **Nature:** Mineral acids are highly corrosive in nature. They burn the skin and eat away metals.

4. **Taste:** Acids are sour in taste. (Never taste or touch the concentrated acids. Taste a drop of very dilute solution of hydrochloric acid)

5. Indicator test

- i) Acids turn **Blue** litmus paper into **Red** colour (ABR) (fig. 4.2).

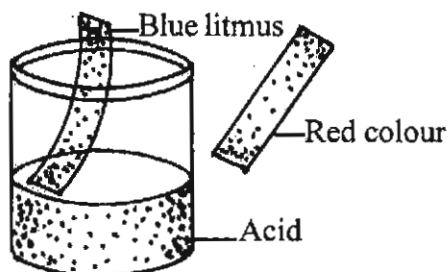


Fig. 4.2 Litmus test for acid

- ii) Acids give no colour with phenolphthalein
iii) Acids give pink colour with methyl orange (fig. 4.3).

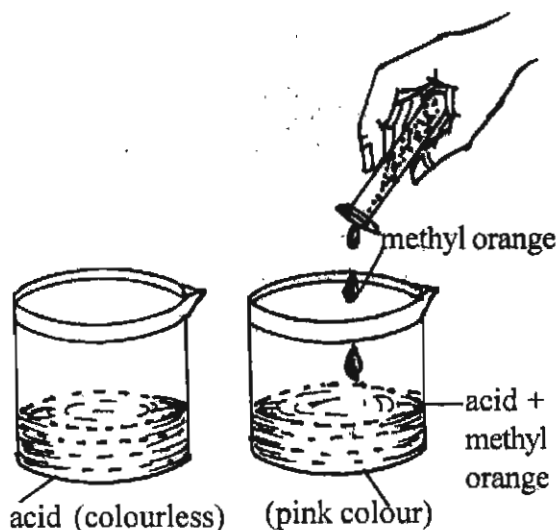


Fig. 4.3 Methyl orange test for acid

Indicator

Indicators are chemical compounds which show the acidic or basic nature of a solution by a characteristic colour change. eg. phenolphthalein, methyl orange.

Activity 4.2

Take dilute hydrochloric acid in a test tube.

Dip a piece of blue litmus paper and a red litmus paper separately in the acid. Find the colour change of the litmus paper in each case.

4.1.4 Chemical Properties

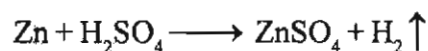
1) Reaction with metals

Acids give hydrogen gas when treated with active metals like zinc, magnesium etc.,

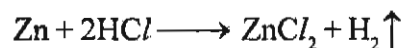
metal + acid \longrightarrow salt + hydrogen gas.

eg.

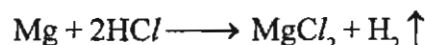
1. zinc + sulphuric acid \longrightarrow
zinc sulphate + hydrogen



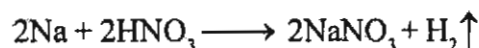
2. zinc + hydrochloric acid \longrightarrow
zinc chloride + hydrogen



3. magnesium + hydrochloric acid
 \longrightarrow magnesium chloride + hydrogen



4. sodium + nitric acid \longrightarrow
sodium nitrate + hydrogen



Activity 4.3

Take dilute hydrochloric acid in a test tube.

Add a piece of zinc into the acid. See what happens?

Hydrogen gas is liberated in the form of bubbles.

Identify the gas by showing a glowing splinter into the test tube. You can hear the pop sound. It is a test for hydrogen.

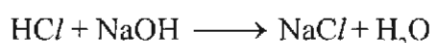
2) Action with alkalies (bases)

Acids react with bases (alkalies) to form salt and water. This reaction is called neutralisation.

eg.

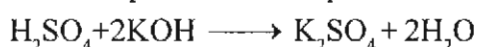
1. hydrochloric acid + sodium hydroxide

→ sodium chloride + water



2. sulphuric acid + potassium hydroxide

→ potassium sulphate + water



3. Action with carbonates

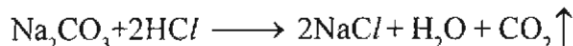
Acids react with carbonates to liberate carbondioxide gas.

eg.

sodium carbonate + hydrochloric acid

→ sodium chloride + Carbondioxide

+ water



Similarly acids react with bicarbonates.

Activity 4.4

Take a little sodium carbonate in a test tube and add dilute hydrochloric acid. What do you observe?

Bring a glowing splinter near the mouth of the test tube. The glowing splinter puts out. It shows that the gas released is carbondioxide.

Pass the liberated gas into lime water. The lime water turns into milky (fig. 4.4). It shows that the gas released is carbondioxide.

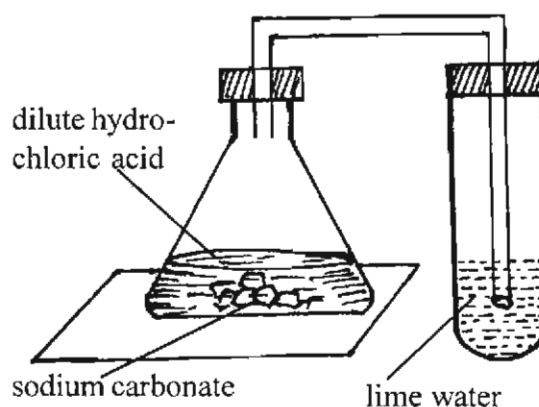


Fig. 4.4 Action of acid with carbonate

4.2 Bases

Definition

Bases are oxides or hydroxides of metals which gives hydroxyl ions (OH^-) when treated with water.

eg. Sodium hydroxide(NaOH), Potassium hydroxide(KOH), Calcium hydroxide [$\text{Ca}(\text{OH})_2$], Calcium oxide (CaO) and Sodium oxide(Na_2O).

Note: Ammonium hydroxide (NH_4OH) is a base but it is not a hydroxide of a metal.

Bases which are soluble in water are called “**alkalies.**”

eg. NaOH and KOH

The word Alkali was derived from the Arabic word “alquili” which means plant ashes. Ashes of plants are composed of mainly sodium and potassium carbonates.

All alkalies are bases, but all bases are not alkalies.

4.2.1 Some common bases used in daily life.

Table 4.3

No.	Name	Other name	Formula	Solubility in water
1.	Sodium hydroxide	Caustic soda	NaOH	soluble
2.	Potassium hydroxide	Caustic potash	KOH	soluble
3.	Calcium hydroxide	Slaked lime	Ca(OH) ₂	slightly soluble
4.	Calcium oxide	Quick lime	CaO	insoluble
5.	Iron(III) hydroxide	Ferric hydroxide	Fe(OH) ₃	insoluble
6.	Magnesium hydroxide	Milk of magnesia	Mg(OH) ₂	insoluble

4.2.2 Physical properties

1. **Colour:** Bases are colourless (except hydroxide of iron and copper) and odourless.

2. **Taste:** Bases are 'bitter' in taste.

3. **Nature:** Bases are soapy or greasy to touch. They are highly corrosive in nature. They burn the skin.

4. **Indicator test:**

i) Bases turn Red litmus paper into Blue colour (BRB) (fig. 4.5).

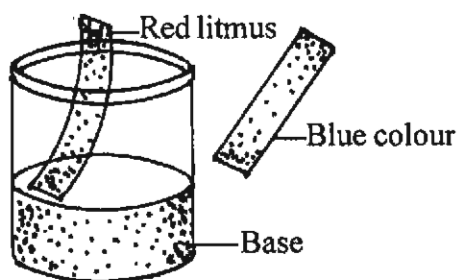


Fig. 4.5 Litmus test for base

ii) Bases give yellow colour with methylorange

iii) Bases give pink colour with phenolphthalein (fig. 4.6).

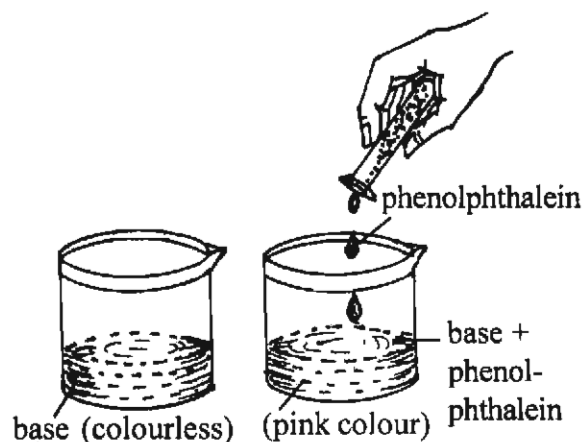


Fig. 4.6 phenolphthalein test for base

5. They are good conductors of electricity.

6. Most of the bases are insoluble in water except the hydroxides of sodium, potassium, calcium and barium.

Activity 4.5

Take a little of solid sodium hydroxide, potassium hydroxide, and calcium oxide in separate test tubes. Add water and find out which one dissolves.

4.2.3 Chemical Properties

1. Action with acids

Bases react with acids to form salt and water. This reaction is known as Neutralisation reaction.



eg.

potassium hydroxide + hydrochloric acid \rightarrow potassium chloride + water

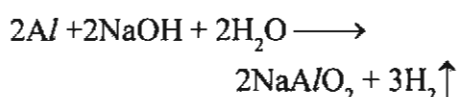


2. Action with metals

Metals like aluminium, zinc and tin reacts with alkalies and liberate hydrogen.

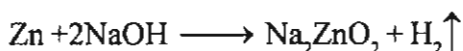
eg.

1. aluminium + sodium hydroxide + water \longrightarrow sodium meta aluminate + hydrogen



2. zinc + sodium hydroxide

\longrightarrow sodium zincate + hydrogen



4.2.4 Caustic Nature of alkalis

The solutions of alkalies like sodium hydroxide, potassium hydroxide are soapy to touch and are very corrosive. Skin irritation and burns are the typical results when the body contacts on alkalies.

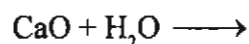
Sodium hydroxide is a powerful alkali and breaks down the proteins of the skin and flesh to a pasty mass. They corrode and destroy the cloths. It is due to caustic nature of alkalies sodium hydroxide is called caustic soda and potassium hydroxide is called as caustic potash.

4.2.5 Preparation of slaked lime from quick lime

When calcium oxide (quick lime) is added to water, it readily absorbs water and forms slaked lime (calcium hydroxide) with the liberation of heat energy.

quicklime + water \longrightarrow

slaked lime + heat energy



$\text{Ca}(\text{OH})_2 + \text{heat energy}$

The slaked lime is not soluble in water. It settles down and water comes up. The water over the slaked lime is a solution of quick lime. It is called lime water.

Uses of slaked lime

1. The slaked lime is used to prepare bleaching powder.

2. Slaked lime is used as a good disinfectant.

3. It is also used in white washing.

4. It is used in the preparation of many calcium salts.

5. It is used to prepare bordeaux mixture.

4.2.6 Differences between acids and bases (Table 4.4)

No.	Properties	Acids	Bases
1.	Definition	give hydrogen ions (H^+) when dissolved in water.	give hydroxyl ions (OH^-) when dissolved in water.
2.	Taste	Sour taste	bitter taste
3.	Action towards litmus	turn blue litmus into red	turn red litmus into blue
4.	Action with metals	evolve hydrogen gas	Generally bases do not react with metals but they react with metals like zinc and aluminium to liberate H_2
5.	Action with ammonium salts	do not react	evolve ammonia gas
6.	Action towards indicators	do not produce any colour with phenolphthalein but gives red colour with methyl orange.	give pink colour with phenolphthalein and yellow colour with methyl orange
7.	Absorption of CO_2	do not absorb CO_2 gas	bases like NaOH and KOH absorb CO_2 gas

Table 4.5 Salts used in daily life

No.	Common name	Chemical Name	formula
1.	Common salt or table salt or brine salt	Sodium chloride	$NaCl$
2.	Washing soda	Hydrated sodium carbonate	$Na_2CO_3 \cdot 10H_2O$
3.	Baking soda	Sodium bicarbonate	$NaHCO_3$
4.	Soda ash	anhydrous sodium carbonate	Na_2CO_3
5.	Sal ammoniac	Ammonium chloride	NH_4Cl
6.	Bleaching powder	Calcium oxy chloride	$CaOCl_2$
7.	Limestone or Chalkpiece or marble	Calcium carbonate	$CaCO_3$
8.	Nitre	Potassium nitrate	KNO_3
9.	Chile-salt petre	Sodium nitrate	$NaNO_3$
10.	Hypo	Sodium thiosulphate	$Na_2S_2O_3$
11.	Smelling salt	Ammonium carbonate	$(NH_4)_2CO_3$
12.	Epsom salt	Hydrated magnesium sulphate	$MgSO_4 \cdot 7H_2O$
13.	Plaster of paris	Hydrated calcium sulphate	$CaSO_4 \cdot \frac{1}{2} H_2O$
14.	White vitriol	Hydrated zinc sulphate	$ZnSO_4 \cdot 7H_2O$
15.	Blue vitriol	Hydrated copper sulphate	$CuSO_4 \cdot 5H_2O$
16.	Green vitriol	Hydrated ferrous sulphate	$FeSO_4 \cdot 7H_2O$

4.3 Salts

Salts are the ionic compounds generally formed by the neutralisation of an acid with a base.

The word salt is a general term. All chlorides, nitrates, phosphates, sulphates, carbonates etc., of metals and ammonium are salts.

4.3.1 Classification of Salts

Salts are classified as follows

1. Normal salts (simple salts)

eg. Sodium chloride, potassium chloride, sodium sulphate

2. Acidic salts

eg. sodium bisulphate, potassium bisulphate, sodium bicarbonate

3. Basic salts

eg. basic magnesium chloride, basic lead chloride

4. Double salts

eg. potash alum, Mohr's salt

5. Mixed salt

eg. Sodium potassium carbonate, bleaching powder

6. Complex salts

eg. potassium ferro cyanide, sodium zinc cyanide

4.3.2 Salt formation

Salts are generally formed by the neutralisation reactions.



eg. hydrochloric acid + sodium hydroxide \rightarrow sodium chloride + water



Neutralisation

The reaction between an acid and a base invariably results in the formation of salts and water and is called neutralisation.

Activity 4.6

Take about 5 ml of sodium hydroxide in a test tube. Add one or two drops of the phenolphthalein indicator. The solution will become pink coloured. Now add dilute hydrochloric acid slowly in drops. See what happens? The colour will disappear. This shows that **the base is completely neutralised by the acid.**

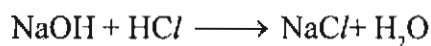
Preparation of simple salts

Simple salts are formed by the complete neutralisation of an acid by a base.

Simple salt is one which does not contain any ionisable or replaceable hydrogen atoms in its molecule.

1. Sodium chloride is prepared by the neutralisation of Sodium hydroxide with hydrochloric acid.

sodium hydroxide + hydrochloric acid \rightarrow sodium chloride + water



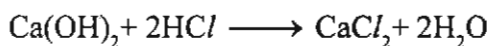
2. Potassium chloride is prepared by the neutralisation of potassium hydroxide with hydrochloric acid.

potassium hydroxide + hydrochloric acid \rightarrow potassium chloride + water



3. Calcium chloride is prepared by the neutralisation of calcium hydroxide with hydrochloric acid.

calcium hydroxide + hydrochloric acid → calcium chloride + water



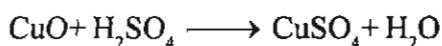
4. Zinc sulphate is prepared by the neutralisation of zinc oxide with sulphuric acid.

zinc oxide + sulphuric acid → zinc sulphate + water



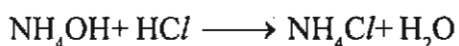
5. When copper oxide is treated with sulphuric acid, copper sulphate is formed.

copper oxide + sulphuric acid → copper sulphate + water



6. Ammonium chloride is prepared by treating ammonium hydroxide with hydrochloric acid.

ammonium hydroxide + hydrochloric acid → ammonium chloride + water



General properties of salts

1. **Colour:** Salts of sodium, potassium etc., are colourless. eg. NaCl , KCl etc., and salts of copper, iron, chromium etc., are coloured. eg. copper sulphate is blue coloured. Potassium dichromate is red orange coloured. Ferrous sulphate is green.

2. **Solubility:** Salts are usually soluble in water, however salts like carbonates, oxides and sulphates of some metals are insoluble in water.

eg. calcium carbonate.

3. **Melting and boiling points:** Most of the salts are solids with high melting point and boiling point.

4. **Conductivity:** Salt solutions in water are good conductors of electricity. Hence they are called electrolytes.

Do You know?

1. **Hydrated salts:** The salts which contain certain fixed number of water molecules, attached loosely to each molecule of the salt are called hydrated salts. eg. (i). hydrated ferrous sulphate $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$. (ii). hydrated copper sulphate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$

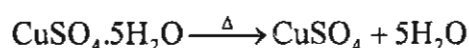
2. **Water of crystallisation:** The fixed number of water molecules which are in loose combination with one molecule of a salt is called water of crystallisation. eg. In epsom salt ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$) the water of crystallisation is 7.

Action of heat on Copper sulphate crystals

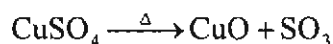
The hydrated copper sulphate is called blue vitriol or copper sulphate pentahydrate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$). It is a blue coloured crystalline solid.

On heating it loses water and becomes a colourless anhydrous salt. On further heating a black residue is obtained.

crystalline copper sulphate (blue) $\xrightarrow{\Delta}$ anhydrous copper sulphate (colour less) + water



anhydrous copper sulphate $\xrightarrow{\Delta}$
cupric oxide (black) + sulphur tri oxide



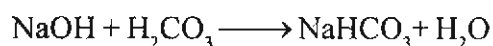
4.3.3 Partial Neutralisation

In a reaction between an acid and a base if some of the replaceable hydrogen ions in the acid or some of the replaceable hydroxyl ions in the base are left unreplaced, the reaction is called partial neutralisation. In this reaction acidic or basic salts are formed.

Acidic Salts

Acidic salts are prepared by the partial neutralisation of an acid by a base. These salts contain atleast one replaceable hydrogen atom.

eg. sodium hydroxide+carbonic acid
→ sodium bicarbonate (acidic salt) +
water

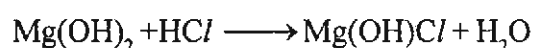


NaH_2PO_4 (Sodium hydrogen phosphate),
 NaHSO_4 (Sodium bisulphate) etc., are
other examples of acidic salts.

Basic Salts

Basic salts are prepared by the partial neutralisation of a base by an acid. These salts contain atleast one replaceable hydroxyl group.

magnesium hydroxide + hydrochloric
acid → basic magnesium chloride
(basic salt) + water



$\text{Pb}(\text{OH})\text{Cl}$ (basic lead chloride),
 $\text{Ca}(\text{OH})\text{Cl}$ (basic calcium chloride) are
other examples of basic salts.

Table 4.6 Differences between acidic salts and basic salts.

No	Acidic salts	Basic salts
1.	Acidic salts contain replaceable hydrogen atoms.	Basic salts contain replaceable hydroxyl groups.
2.	Acidic salts ionise in water to give hydronium ion (H_3O^+)	Basic salts ionise in water to give hydroxyl ion (OH^-)
3.	Acidic salts react with carbonates to give carbondioxide.	No such reaction is possible
4.	Acidic salt solutions turn blue litmus to red.	Basic salt solutions turn red litmus to blue.
5.	Acidic salts react with a base to form a normal salt.	Basic salts react with an acid to form a normal salt.
6.	Acidic salt solutions give no colour with phenolphthalein.	Basic salt solutions give pink colour with phenolphthalein.

4.3.4 Uses of salts

Salts are used in the fields like
a) domestic b) agriculture c) medicine
d) photography and e) industries

a) Domestic uses

- 1) Sodium chloride is used in food preparation and used as a preservative in making pickles, preserving fish, meats, vegetables, etc.
- 2) Baking soda is used as a self raising flour to raise the breads and cakes.
- 3) Washing soda is used to wash cloths.
- 4) Bleaching powder is used in bleaching cloths and cleaning water.
- 5) Calcium carbonate is used to prepare chalk piece.
- 6) Potash alum helps in rapid settling of suspended impurities in water. It is used for the purification of water.
- 7) Sodium benzoate is used as a food preservative.
- 8) Silver nitrate is used in hair dyes.

b) Agricultural uses

- 1) Bordeaux mixture (mixture of copper sulphate + lime) is used as an insecticide.
- 2) Ammonium chloride, ammonium sulphate and superphosphate of lime are used as fertilizers.
- 3) NPK (Nitrogen-Phosphorus-Potassium) fertilizers contain ammonium nitrate, ammonium sulphate, ammonium phosphate and potassium

chloride. These salts provide a source of nitrogen, phosphorus and potassium to the soil.

4) Salts like copper sulphate is used as a fungicide.

5) Nitre (Potassium Nitrate) is also used as a fertilizer.

c) Medicinal uses

- 1) Plaster of paris is used as surgical bandage to set fractured bones.
- 2) Epsom salt is used as a laxative by patients suffering from constipation.
- 3) Smelling salt provides relief from common cold.
- 4) Baking soda is also used for preparing antacid tablets for controlling acidity of stomach.

d) Photography

Silver nitrate, silver bromide and sodium thiosulphate (hypo) salts are used in photography.

e) Industrial uses

- 1) Potassium nitrate is used in fire works.
- 2) Sodium nitrate is used in gunpowder and fireworks.
- 3) Potash alum is used for tanning of leather, sizing paper and as a mordant.
- 4) Potassium chlorate is used in match industry
- 5) Copper sulphate is used in dyeing and printing industry. It is also used in electro plating of copper metal.

SELF EVALUATION

I. Choose the correct answer

- Which of the following is used in match industry.
(a) Sodium chloride (b) Sodium bicarbonate
(c) Sodium carbonate (d) Potassium chlorate
- Which of the following colours is given by phenolphthalein in a basic salt solution.
(a) yellow (b) pink (c) orange red (d) colourless
- Which of the following is an alkali
(a) NaOH (b) HCl (c) NaCl (d) NaHSO₄
- The gas evolved by the action of heat on copper sulphate is
(a) Carbon monoxide (b) Sulphur trioxide
(c) Sulphur dioxide (d) Carbon dioxide
- Which of the following is an indicator.
(a) Phenolphthalein (b) Sodium hydroxide
(c) Hydrochloric acid (d) Sugar solution

II. Fill in the blanks

- _____ is an example of citrus fruits.
- The word acid was derived from the latin word _____
- _____ is a mineral acid.
- Acids are _____ in taste.
- _____ turns blue litmus into red colour.
- _____ gas is evolved when metals react with acids.
- Bases which are soluble in water are called _____
- Sodium hydroxide is _____ to touch.
- The gas evolved when sodium hydroxide reacts with ammonium chloride is _____
- _____ is the formula of bleaching powder.
- Sodium chloride is a _____ salt.

17. _____ is an example for acidic salt.
18. The formula of hydrated copper sulphate is _____
19. _____ is called bordeaux mixture.
20. Silver bromide is used in _____

III. Match the following

- | | | |
|------------------------|---|----------------------|
| 21. Acid+Base | – | calcium oxide |
| 22. Base | – | baking soda |
| 23. Quick lime | – | calcium oxychloride |
| 24. Sodium bicarbonate | – | sodium carbonate |
| 25. Bleaching powder | – | red litmus into blue |
| 26. Washing soda | – | lactic acid |
| 27. Milk | – | salt + water |

IV. Give short answer

28. What are acids ? Give two examples.
29. What are indicators ? Give two examples.
30. Write the reaction of zinc with hydrochloric acid.
31. What are bases ? Give two examples.
32. Write short notes on the caustic nature of alkalis ?
33. What is neutralisation ? Give an example.
34. What is the action of zinc oxide with sulphuric acid ?
35. How is an acidic salt prepared?
36. What is partial neutralisation?

V. Give detailed answer

37. Explain the action of heat on copper sulphate ?
38. What are the differences between acids and bases ?
39. How is slaked lime prepared from quick lime? Mention its uses.
40. How are the following salts prepared?
a) Potassium sulphate b) Calcium sulphate
41. Write the domestic uses of salts.
42. Write the differences between acidic salts and basic salts.
43. How are salts classified ? Give an example for each.

5. Heat

Heat is a form of energy, which can be felt by our sense of touch.

Take an ice cube and hold it in your hand for a minute. What do you feel? It is very cold.

Now take some warm water and dip your finger in it. What do you feel? It is warm.

Gently rub your palms and touch the cheek with the palms. What do you feel? Do you feel hot? Why is it so?

While rubbing the hands the heat energy is produced. Here movements of hands produce heat energy due to friction. That is mechanical energy is converted into the heat energy.

Early man used this principle to produce fire by rubbing two flint stones against each other. Modern day devices like match sticks and electric lighters make use of friction to ignite the chemicals and fuels.

Heat is measured in terms of calorie or joule.

5.1 Sources of heat energy

The sun is the natural source of heat energy. Other sources of heat energy are based on conversion of chemical, electrical, nuclear and mechanical energies.

Materials which produce heat when burnt are called "fuels". Some common

Table 5.1 Common sources of heat energy

Sl.no	Name of the Source	Form of heat producing
1.	candle, spirit lamp, coal, cooking gas and fire wood.	chemical reactions produce heat energy.
2.	iron-box, water heater, electric stove, oven and geyser etc.,	electric power is converted into heat energy.
3.	sun, star, atomic power, atom bomb etc.,	nuclear reactions produce heat energy.

Table 5.2 Uses of fossil fuels

Sl.no	Name of the fossil fuel	Uses
1	Coal	Used as a fuel for engines and machineries
2	Petrol, diesel	Used as a fuel for all types of automobiles, aeroplanes, trains, ships etc.
3	Cooking gas	Used as fuel for domestic purposes.

fuels are: fire wood, bio-gas and dried cowdung etc. Some fossil fuels are coal, petrol, diesel and cooking gas.

Temperature

The concept of temperature comes from our sense of an object. When you touch an object you say it is relatively 'hot' or 'cold'. The aim to quantify and measure the difference in warmth of bodies led to the idea of temperature. We assign a number to an object as an indication of its warmth. For example, we assign 0°C to the ice and 100°C to the boiling water. A device used to measure the warmth of a body (its temperature) is called a thermometer.

The degree of hotness or coldness of a body is called **temperature**.

Temperature is measured in degree celsius or S.I. unit of temperature is kelvin.

5.2 Heat and temperature

Heat and temperature are different concepts, but related to one another.

Heat is the total energy of molecular motion of a substance. But temperature is a measure of the average energy of molecular motion in the substance.

When you heat a substance the thermal energy of the molecules increase thereby increasing the temperature of the substance.

Heat is the internal energy of a substance. By adding or removing heat, the temperature of a substance can be increased or decreased.

When you increase the amount of substance the number of molecules increases which needs more heat energy to raise the temperature.

Higher temperature of an object means that the molecules in it are moving with higher translational kinetic energy.

Activity 5.1

Take 50 ml of water in a vessel and introduce a thermometer into it. Note the initial temperature of water. Heat

Table 5.3 Difference between Heat and Temperature

S. No	Heat	Temperature
1.	It denotes the amount of heat energy contained in a body	It denotes the degree of hotness or coldness of a body.
2.	It depends upon the speed of the particles.	It depends upon the average speed of the molecules.
3.	It depends on the number of particles, size and type of particles	It does not depends on size or type of particles of the object
4.	It is measured in joule	It is measured in degree celsius or kelvin.

it with a bunsen burner, and record the time taken for water to boil. Note the temperature of boiling water. Repeat the same experiment with 100ml of water.

Observe that when the amount of water is doubled, the time taken and hence the amount of heat energy required for boiling is doubled.

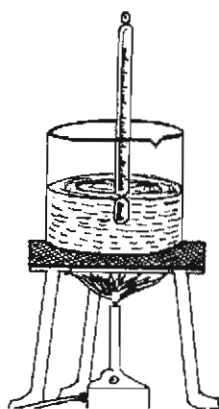


Fig. 5.1 Boiling of water

Do you know?

Summer and Winter

During the summer season the earth receives the radiation of heat energy from the sun at perpendicular direction. But in the winter season the earth receives the radiation of heat energy from the sun at an angle according to the tilting of the axis of rotation of the earth. So summer is hot and winter is cool.

Activity 5.2

Observe and record the maximum/minimum temperature of your village/town during summer and winter.

5.3 Effects of heat

Heat energy produces a number of effects in materials as well as in living bodies. In materials heat causes change in dimension, change in state and change in temperature.

5.3.1 Thermal expansion of solids

The expansion of an object due to heat is called thermal expansion. All substances (solid, liquid and gas) expand on being heated, though the amount of expansion is not the same in all materials. You have also learnt that gases expand more than liquids or solids.

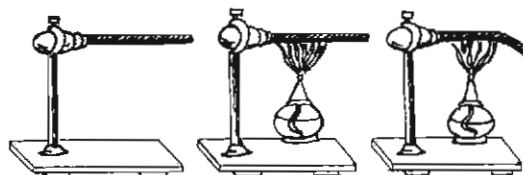


Fig. 5.2 Expansion of solid due to heating

When equal lengths of different metal rods of iron, copper, brass and aluminium are heated to the same level, they expand to different lengths.

5.3.2 Bi-metal Strip

The bi-metal strip consists of a strip of brass welded to a strip of iron of the same dimensions (fig. 5.3). Heat it over a flame uniformly all along its length. It will bend with the steel bar on the inner side. This is so because brass expands to a greater extent than steel. This experiment proves that different metals have different rates of expansion when subjected to the same amount of heat. This increase in the length of a solid when heated is known as its linear expansion.

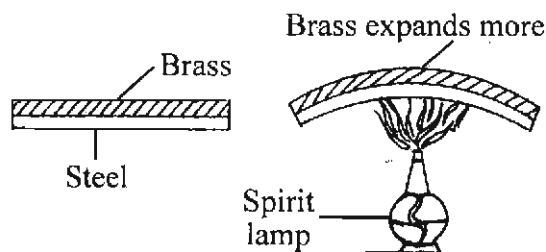


Fig. 5.3 Bi-metal strip

Bi-metal strips are used to control temperature in iron box, electric stove, refrigerator and geyser. The switches employing bi-metal strips are called thermostat.

Laying of rail tracks

The property of thermal expansion of solids is used in laying of rail tracks. Rails are made from steel which expand on heating and contract on cooling.

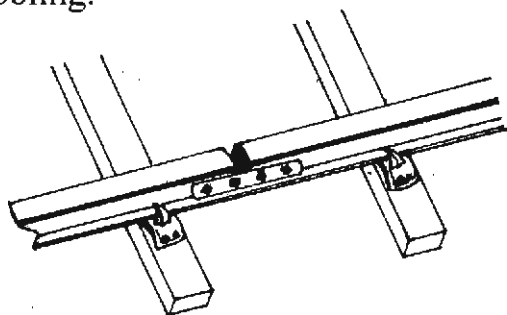


Fig. 5.4 Rail tracks

If the rails are fixed tightly, leaving no space for expansion or contraction, they will bend outward in summer and cause accidents.

To avoid this danger, small gaps are left in between the rails (fig. 5.4). The rails are then joined by fish plates. The fish plates also have holes which provide space for expansion. Thus in summer these gaps get smaller and in winter bigger, but the rail by itself remains straight.

Mounting of bridges

The girders are made from steel which expand on heating and contract on cooling. If the girders supporting the bridge are fixed in the walls of the pillars the bridge can fall due to expansion of steel.

Instead, the girders are mounted on the rollers, leaving a small space in between for the expansion or contraction (fig. 5.5). Thus the bridge is saved from possible collapse.

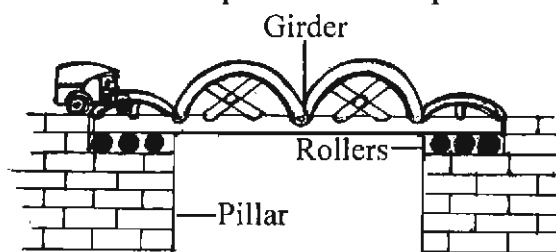


Fig. 5.5

Activity 5.3

Visit a railway station and observe the joints of the rails.

Thermal expansion of liquids

We know that a liquid expands on heating. Liquids have no definite shape, but have definite volume. Thus, the only expansion in liquids is volume expansion or cubical expansion. When you are heating the liquid, the container (solid) of the liquid expand first. Due to this expansion liquid level goes down from initial level to intermediate level. On continuous heating the expansion of liquid takes place. So the liquid level goes up. If we consider the expansion of liquid is from initial level to final level, it is

observed expansion or apparent expansion. If we consider the expansion of liquid is from intermediate level to final level, it is real expansion or absolute expansion.

5.3.3 comparison of thermal expansion of liquids

Do all liquids undergo the same amount of expansion on heating? We can see from the following experiment that the apparent expansions of different liquids are different.

Take four identical round bottomed flasks fitted with one holed rubber corks having narrow tubes. Fill one flask with water, another with kerosene, next one with alcohol and the fourth one with coconut oil to the brim so that liquid is seen in the glass tubing.

Fix strips of graph sheet on the glass tubes and mark the initial levels of liquids (fig. 5.6).

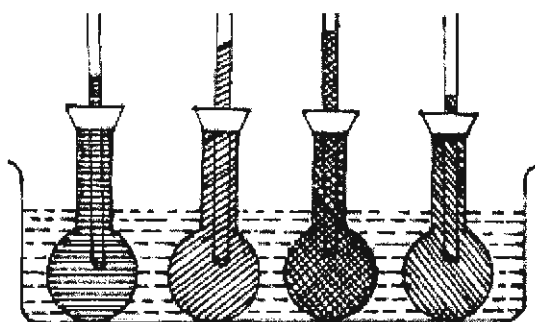


Fig. 5.6 Comparison of thermal expansion of liquids

Place the flasks inside a hot water bath for a few minutes and mark the final levels of liquids in the tubes. As the liquid gets heated it expands and the level in the tubes starts rising.

Arrange the liquids in the order of their expansion. This experiment shows that different liquids expand to a different extent when heated to the same temperature.

5.3.4 Anomalous expansion of water

In cold regions, the water in the ponds and lakes freezes during winter. How do the aquatic animals survive in the frozen ponds?

Generally the liquids show a decrease in volume when the temperature is decreased. Water alone shows an increase in volume in the region 4°C to 0°C . Hence the volume of a given mass of water is the least at 4°C that is the density of water is maximum at 4°C . This peculiar behaviour of water is known as the anomalous expansion of water.

The anomalous expansion of water can be demonstrated by the Hope's apparatus.

The Hope's apparatus consists of a tall cylindrical vessel. A trough containing a mixture of common salt and ice in the ratio of 1:3 is attached to the middle of the cylinder. This mixture is called a freezing mixture and can produce very low temperature upto -23°C . It is used for cooling the water.

Above and below the trough are two side outlets through which two centigrade thermometers are introduced as shown in fig. (5.7)

The cylinder is filled with water. The water near the trough is cooled and its

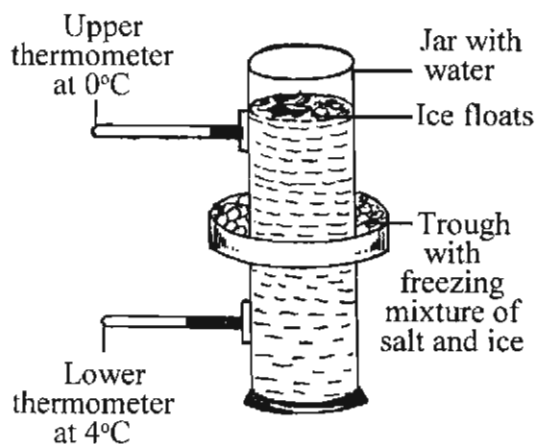


Fig. 5.7 Hope's apparatus

density increases. It sinks to the bottom of the vessel and water from the bottom moves up. A convectional current is set up till the temperature falls to 4°C.

On further cooling, the water near the trough becomes lighter and moves up causing another convectional current. The freezing mixture in the trough produces a cooling effect. The water above rapidly cools down. When the thermometer at higher level comes down gradually up to 0°C, the water freezes to form ice. The ice floats on the surface of water. But the temperature of water remains at 4°C at lower level.

On account of the anomalous expansion of water, the aquatic animals in the frozen ponds survive in severe winter.

In winter season the water at the surface of the pond gets cooled and moves to the bottom and the water at the bottom moves up to the surface. This convectional current takes place till the temperature of water at

the bottom becomes 4°C. As the temperature of water at the top level lowers further ice is formed at the top. The ice floats above the water (fig. 5.8).

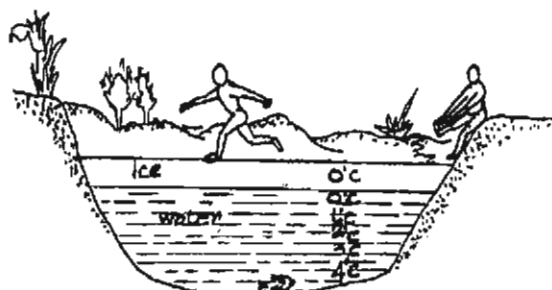


Fig. 5.8 Frozen pond

5.4 Effect of heat on living organisms

Only at some fixed body temperature the living beings function properly. In case of human body the temperature should be maintained at 98.6° F (37°C) for their effective functioning. If the surrounding temperature increases it becomes hot. It slows down the body functions. Similarly, in too cold conditions also the body functions vary. Some times the sudden increase in temperature, leads to change of behaviour in human beings.

The steep change in temperature suddenly leads to death of animals in water. This is due to decrease in dissolved oxygen content in water with increase in temperature.

It is not only true for animals but applicable for all kinds of living organisms including plants. In too hot climate the plants will not survive. Similarly they die in too cold climate conditions.

For this reason, we boil the milk as well as water to kill harmful bacteria. Similarly when we store the food items, vegetables in the fridge, due to the cold conditions the germs cannot multiply.

5.4.1 The effect of temperature in other planets

The planets will receive the amount of heat energy according to their distance from the sun. The earth's distance from the sun gives very suitable temperature for the survival of living organisms.

Now we are in search of existence of plant and animal life on other planets, similar one to that of on earth.

Mercury is a planet closest to the sun having the maximum temperature of about 370°C and the minimum temperature of -240°C . Venus has the maximum temperature of about 480°C . In case of moon the highest receiving temperature is 110°C and the temperature drops during nights upto -150°C . In planets with the distance from the sun greater than the earth like Mars, Saturn, Jupiter, Uranus, Neptune and Pluto the maximum temperature goes on decreasing. Due to these extreme climate conditions there is only a remote chance for the existence of living organisms on other planets. But in Mars planet the recent researches shows some small hope on possibility of living organisms.

5.4.2 Animals and plants in polar region

In polar regions some plants and animals are living even in extreme temperature conditions. They adopt themselves to the climatic conditions of the environment. Lichens is a plant which exists in polar regions. Polar bear, reindeer, polar pig are the animals living in the polar region.

5.5 Change of state

Substances exist in three states; solid, liquid and gas. In nature, water exists in all the three states - ice (solid), water (liquid) and steam or water vapour (gas). The state of a substance can be changed by heating or cooling.

For example, when ice is heated, it changes into liquid state; if more heat energy is supplied, then the water changes into steam.

When the steam is cooled it changes to liquid state. Similarly if water is cooled further, it loses heat energy and changes to solid state.

Activity 5.4

Take a beaker and put some ice cubes in it. Note its temperature by using a thermometer. Now start heating it, The ice first melts into water and then the water begins to boil and changes into steam. Note the temperature at both the stages.

Allow the water vapour to come into contact with a cold surface like a metal plate. The steam or water vapour forms droplets of water again. On further cooling they freeze to form ice.

The change of a solid into a liquid is called **melting or fusion**. The temperature at which a solid melts is known as its **melting point**.

The reverse process or change of liquid into its solid state is called **freezing**.

The change of a liquid into its vapour is called **evaporation**. The temperature at which this change takes place is called its **boiling point**.

The reverse process or change of vapour into a liquid is called **condensation**.

When you give the heat energy to the substances like iodine and camphor they do not melt to form a liquid but change directly into the vapour state. The process of a solid changing directly into its vapour without becoming a liquid is called **sublimation**. The reverse process i.e the direct change of vapour into a solid is also called **condensation**.

If we apply perfume on our skin, we feel a sensation of coolness. This is because the perfume has taken the heat from our skin to vapourise. All such liquids which evaporate very quickly

Table 5.4 Differences between Boiling and Evaporation

S. No	Boiling	Evaporation
1	Boiling is a rapid visible process	Evaporation is a slow invisible process
2	Boiling takes place at a fixed temperature called boiling point	Evaporation takes place at all temperatures
3	Boiling does not produce cooling	Evaporation produces a cooling effect
4	Boiling takes Place throughout the liquid	Evaporation takes place on the surface of liquids
5	During this process, there is no change in temperature	During this process, there is a variation in temperature.

Table 5.5 Freezing and Boiling points of some common liquids

Liquid	Freezing Point (°C)	Boiling Point (°C)
Water	0	100
Mercury	-39	357
Alcohol	-117	79

and at very low heat are called volatile liquids. Some examples are spirit, ether, alcohol, diesel, petrol and kerosene oil.

When we give heat energy to the liquid like water, it first boils and then becomes a vapour. Thus the change of a liquid into its vapour state can take place in two ways namely evaporation and boiling.

5.6 Thermometer

The property of thermal expansion of liquids is used in the construction of thermometers. It consists of a glass bulb, containing mercury, which is connected to a glass tube with a small capillary bore.

The glass bulb containing mercury is placed at the temperature of melting ice, the level of mercury is marked as 0°C . This temperature of melting of ice is called the lower fixed point. It is placed at the temperature of steam and the level of mercury is marked as 100°C . The temperature of boiling water is called upper fixed point of the thermometer.

The space between the two fixed points is divided into 100 equal parts. This temperature scale was devised by Celsius and the temperature is denoted in degree celsius ($^{\circ}\text{C}$)

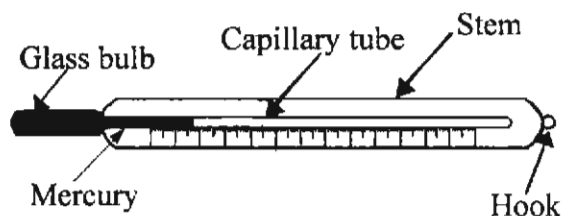


Fig. 5.9 Thermometer

5.6.1 Reasons for using mercury as a thermometric liquid

1. Mercury is opaque and a shining substance. It can be easily seen through glass.
2. Mercury has a uniform rate of thermal expansion.
3. Mercury is a good conductor of heat.
4. Mercury does not wet to the glass.
5. Mercury has a high boiling point (357°C) and a low melting point (-39°C), so that both high and low temperatures can be measure it.
6. Mercury quickly assumes the temperature of the object in contact with it by taking the least amount of heat.

5.6.2 Clinical thermometer

To measure the small variation in the temperature of the human body clinical thermometers are used. It measures temperature in a very short range of 10°C from 35°C to 44°C . So it accurately measures even small changes in body temperatures.

Clinical thermometer is similar in construction to a mercury thermometer. It has a short, fine capillary tube with a constriction and a slight bend near the mercury bulb. The radius of the constriction is very small.

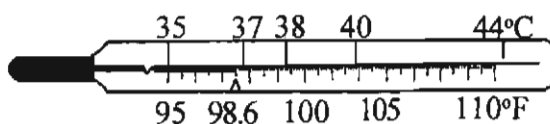


Fig. 5.10 Clinical thermometer

When the thermometer is placed in the patient's mouth the mercury in the bulb gets heated and expands, it crosses the bend and goes up to a particular position. The temperature will be noted. When the thermometer is taken out of the mouth of the patient, the constriction prevents the mercury from flowing back into the bulb. Then the thermometer is given a shake or a jerk, the mercury above the constriction comes down to the bulb.

5.7 Measurement of heat energy

Measurement of heat energy was a very difficult process in early days. The addition of heat energy raises the temperature. Hence the rise of temperature of water was used by the scientists to define heat energy.

The amount of heat energy required to raise the temperature of one gram of water through 1°C is called one **calorie**.

However, the unit of heat energy calorie was found to be very small. Thus a bigger unit kilo calorie is in use.

The amount of heat energy required to raise the temperature of one kilogram (1000g) of water through 1°C is called kilocalorie.

1 kilo calorie = 1000 calorie

This means that when 1 kilo calorie of heat is supplied to 1 kilogram of water, its temperature will raise by 1°C. The modern and generally accepted unit of heat energy is joule.

1 calorie = 4.2 joule

1 kilo calorie = 4200 joule.

Calorific value of fuels

Calorific value of a fuel is the total quantity of heat produced when a unit mass (or volume) of the fuel is burnt completely.

Unit of calorific value of solids and liquids is kJ kg⁻¹ and that of gases is kJm⁻³.

The calorific values of some common fuels are given in table 5.8.

5.8 Heat capacity

The heat capacity of a substance is the amount of heat energy needed to raise its temperature by 1°C

If a substance absorbs heat, its temperature raises and when it is cooled, it gives out heat.

5.8.1 Specific heat capacity

The specific heat capacity of a substance is the amount of heat required to raise the temperature of 1 kg of a substance by 1°C.

The unit of specific heat capacity is joules per kilogram per kelvin or J/kg/ K.

The quantity of heat = Mass x Specific heat x Change in temperature

$$Q = m s \theta$$

The quantity of heat absorbed or given out by a body depends on (i) the mass of the substance (ii) the temperature of the substance and (iii) the nature of the substance.

Table 5.8 Fuels and calorific values

Sl.no	Fuels	calorific values kJm^{-3}
1	Producer gas	4500
2	Water gas	13100
3	Coal gas	18650
4	Liquefied petroleum gas (L.P.G)	49400

Example

Calculate the amount of heat to be given to 1 kg of water to raise its temperature from 30°C to 50°C (specific heat capacity of water is 4200 J/kg/K)

$$\text{mass } m = 1 \text{ kg}$$

$$\text{specific heat capacity } s = 4200 \text{ J/kg/K}$$

$$\text{raise in temperature } \theta = (50-30) = 20\text{K}$$

$$Q = m s \theta$$

$$= 1 \times 4200 \times 20$$

$$Q = 84000 \text{ joule}$$

Specific heat capacity is a very important physical constant. The value of specific heat capacity for a given substance is a constant quantity. However, the specific heat capacity for different substances is different.

Experiment

Take two beakers A and B. Fill A with kerosene oil and B with an equal amount of water. Heat them for 10 minutes. You will find that beaker A will record a higher temperature than B (Fig 5.11). This is because the specific heat capacity of kerosene oil is less than that of the water.

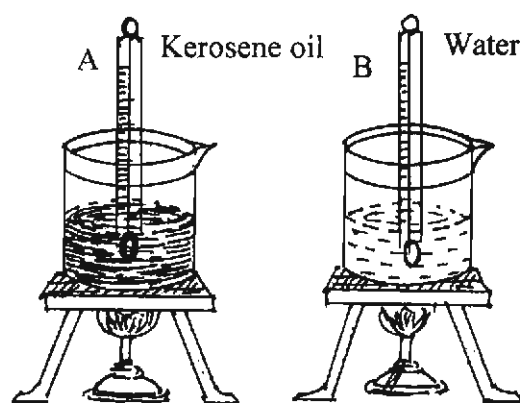


Fig. 5.11

This experiment shows that the quantity of heat absorbed depends on the nature of the substance.

5.8.2 Use of water as a coolant

It has been found that water has high specific heat capacity of $4200 \text{ Jkg}^{-1}\text{K}^{-1}$.

Water is used as a coolant in car radiators as it has high specific heat capacity. Thus it can absorb large amount of excess heat energy produced by automobile engines, but it itself does not rise to a very high temperature.

Similarly water is also used as coolant in large factories, steel mills, thermal power stations, etc.,

5.9 Transfer of Heat

If a bucket of hot water is left in an open space, it loses heat slowly and cools. How it loses its heat?

Pour equal amount of hot and cold water into a vessel. Touch the water. What you feel? Is it cold or hot? What has happened? The hot water lost its heat and the cold water gained the heat.

Heat is transferred from a body at a higher temperature to a body at a lower temperature. This flow of heat continues till their temperatures are equal. How does heat transfer take place?

Transfer of heat occurs through conduction, convection and radiation.

The heat is transferred along the body from one particle (molecule) to another without the movement of the particles themselves. This method of heat transfer is called **conduction**.

5.9.1 Conduction of heat in solids

Take a metal rod. On the rod fix four drawing pins with the help of wax. Place the metal rod on the table as shown in fig (5.12). Hold the metal rod in position with the help of wooden block.

Heat the tip of the metal rod by using lighted candle. As the rod gets heated, the board pins begin to fall down one by one.

In this activity, the heat energy is transferred from one molecule to the next, throughout the rod. Though the molecules do not move, yet the heat

is transferred because they are in close contact with each other. This method of heat transfer is called **conduction**.

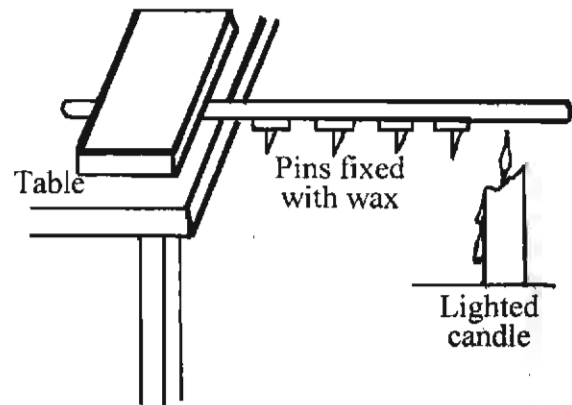


Fig: 5.12 Conduction of heat in metal rod

Activity 5.5

Take a knitting needle. Hold the needle in your hand. Heat one end of the needle by using lighted match stick. What do you feel? First it is warm, then it is hot and finally very hot.

From this experiment you learn that the heat energy has been transmitted through the needle without the actual movement of molecules of the needle.

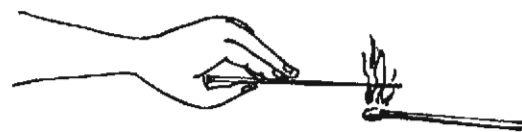


Fig. 5.13

5.9.2 Convection

The heat is transferred from hotter portions to colder portions by the actual movement of particles of a substance is called **convection**.

You might have noticed that during summer days the table fans and pedestal fans keep the room much

cooler than ceiling fans. Due to the heat the air becomes lighter and rises up. The table fans and pedestal fans are placed at the lower level and are able to circulate the cooler layers of air. Cool air enters through the window which are placed comparatively lower than ceiling.

A ceiling fan however circulates only the hotter layers of air which are present near the ceiling. Ventilators are placed near the ceiling so that the warm air goes out of the room whereas windows bring cool fresh air.

5.9.2.1 Convection of heat in liquids

Take a round bottomed flask and place it over a stand. Put a handful of crystals of potassium permanganate in it. Fill about two thirds of the flask with water. Heat it with a Bunsen burner (fig 5.14).

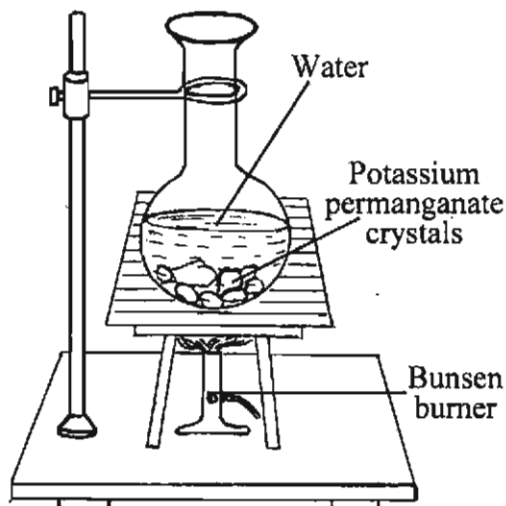


Fig. 5.14 Convection of heat in liquid

Water expands on heating and so becomes lighter and rises up. The colder and heavier water comes down to take its place. This is shown by the

movement of the thin lines of purple coloured water emerging from the crystals at the bottom of the flask. They rise upwards, reach the top and spread out. Many such streams can be seen. It proves that the convection of heat takes place in water.

5.9.2.2 Convection of heat in gases

Take a glass trough. Fill about one third with water. Place a lighted candle in the trough. Cover the candle with a glass tube. The candle flame is put out due to lack of fresh air. Take the T shaped card board and place it in the mouth of the tube. It divides the glass tube into two halves (fig. 5.15).

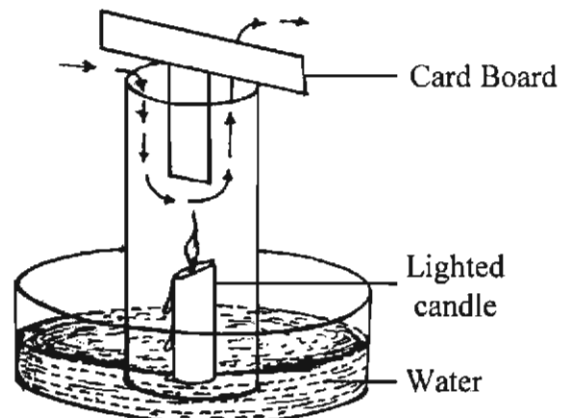


Fig. 5.15 Convection of heat in gases

Light the candle. The candle continues to burn because this cardboard regulates the supply of fresh air into the glass tube.

A convection current is set up and the hot air escapes through the other side. To prove this hold a lighted agarpathi stick near the mouth of the glass tube. You can see the smoke enter in through one side and escape through the other side of the card board.

Activity 5.6

Take a needle. Fix a circular foil at the end of the needle. Place a lighted candle below this arrangement. Note what happens?

The circular foil rotates. The air above the lighted candle expands and then becomes lighter and goes up so that the circular foil rotates.

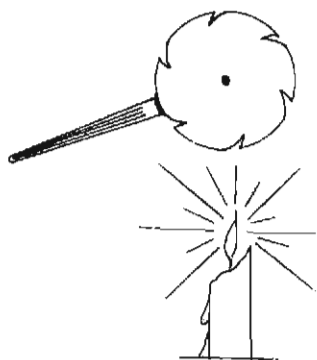


Fig. 5.16

5.9.3 Radiation

When you sit in front of the fire or an electric heater, you will feel the warmth. How does the heat travel from the heater to your body?

The heat cannot reach us by conduction because air is a very poor conductor of heat energy.

The heat cannot reach us through convection because hot air is lighter and moves upwards and not towards the sides. Hence heat transfer occurs through radiation in which the medium is not heated.

Radiation requires no medium. We receive heat from the sun by radiation. Most of the space between the sun and the earth is vacuum.

The heat transferred from one body to another body directly without heating the space in between two bodies is called **radiation**.

Since the surface temperature of the moon is lesser than that of sun, the light reflected from the moon is much cooler than the sun light.

Absorption of radiant heat by a body

When radiant heat falls on a body a part of it is absorbed by it. There is an increase in its temperature due to this absorption. If the surface of a body is painted black it absorbs more heat than when it is painted white.

Activity 5.7

Take two identical stainless steel tumblers. Blacken the entire surface of one tumbler. Record the temperature of water in them for every two minutes by using thermometer. Which one of these two tumblers loses heat quickly?

Black tumbler loses heat quickly. This is so because the black tumbler radiates more heat than the white one.

Applications of Radiation

1. White or light coloured clothes absorb less heat and keep our body cool that is suitable for summer. And black or dark coloured clothes absorb more heat and keep our body warm, so that it is suitable for winter.
2. The base of cooking utensils are painted black to absorb more heat.
3. Tankers which carry highly inflammable substances like petrol

are painted white to reflect the sun's radiation.

Activity 5.8

Take two cans of the same size. Paint one in dull black and the other one in shining white. Introduce a thermometer in each can. Fill both the cans about two-thirds full of water. Leave them in the sun for about two hours. What will be the observations?

You will find that the thermometer in the black can will show a higher temperature than the white can. This is so because the can painted in black absorbs more heat than the white can.

5.10 Conductors and insulators

Solids which allow heat to pass through them are called good conductors of heat.

eg. Metals such as iron, copper, aluminium, silver, and mercury.

Because of this property the cooking vessels and boilers are made of metals.

Materials which do not allow heat to pass through them are called poor conductors of heat or insulators.

eg. Wood, glass, rubber, leather, plastic, mica, stone, marble and thermocole.

The cooking vessels made of metals get heated up quickly. But their handles are made of poor conductors such as plastic or wood. All liquids and gases are poor conductors of heat.

The steel chair appears cooler to touch than a wooden chair because

steel is a good conductor of heat energy at the same time wood is a poor conductor.

5.10.1 Uses of good conductors

Some important uses of good conductors are listed below.

1. Cooking vessels are made of metals, so that the vessels get heated quickly and transfer the heat to the food being cooked.
2. Copper-bottom cooking vessels are used to save time and fuel because copper is a good conductor of heat.
3. Mercury is used in thermometers as it is a good conductor of heat.
4. The tubes used in automobile radiators are made up of copper which absorbs heat speedily from the hot water coming from the engine.

5.10.2 Uses of insulators (or) bad conductors

1. The handles of cooking vessels and the handles of heating iron are made of poor conductors or insulators like ebonite or wood.
2. Woollen clothes keep us warm during winters by retaining the heat of our body. Woollen clothes have fine pores which when filled with air is used to prevent the loss of heat.
3. Hot packs, hot water storage tanks are lined with wool, cork, fibre-glass or asbestos wool to prevent the heat from escaping.
4. In cold countries the water pipes are covered with cotton to prevent the freezing of water.

5. An ice-box has double walls and the space between them is filled with materials like wool, cork or thermocole which are insulators.

6. Mud houses with thatched roofs keep cool in summer and warm in winter as compared to concrete houses. It is because the thatched roof contains large amount of trapped air. Similarly, mud is a bad conductor of heat.

7. In cold countries animals are generally covered with thick fur. The fur contains a large amount of air and acts as an insulator.

5.11 Thermos flask

It is used to keep the hot liquid hot and the cold liquid cold for a long time. Heat loss due to conduction, convection and radiation are prevented. It was first constructed by sir James Dewar, so that it is also called Dewar flask or vacuum flask.

It is a double-walled glass vessel. The inner surface of the outer wall and outer surface of the inner wall are silvered. The space between the two walls is almost vacuum. The glass vessel is protected by enclosing it in a plastic or metal outer cover. The mouth of the vessel is closed by a cork or a plastic stopper.

When a hot or cold liquid is poured into the flask its temperature is maintained for a long time as very little heat is lost. The double walled glass is a poor conductor of heat. The vacuum between the glass walls prevent transfer of heat by convection. The silvered

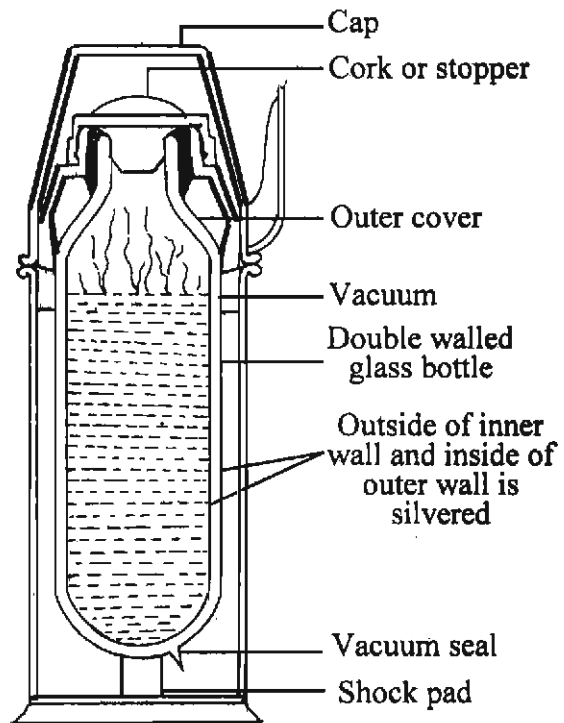


Fig. 5.17 Thermos flask

inner and outer walls of the bottle prevent transfer of heat by radiation. So a thermos flask maintains the same temperature for several hours.

Do you know?

Normally sea breeze is formed in day time and land breeze is formed during night time.

During the day time water gets heated up slowly due to enormous specific heat, whereas the land gets heated up quickly due to smaller specific heat. Due to the difference in the temperature sea breeze rushes to the earth to cool it down. During night time the land cools down rapidly and as explained above the land breeze rushes to the sea.

SELF EVALUATION

I. Choose the correct answer

- Unit of heat energy is
(a) kilogram (b) metre (c) joule (d) degree
- Boiling point of water is
(a) 0°C (b) 100°C (c) 357°C (d) -39°C
- The electric device with a thermostat is
(a) electric bulb (b) fan (c) radio (d) iron- box
- The good conductor of heat energy is
(a) glass (b) iron (c) mica (d) rubber
- The amount of heat energy 1 calorie is equal to _____
(a) 42 joule (b) 0.42 joule (c) 4.2 joule (d) 4200 joule

II. Fill in the blanks by using correct answers

- The density of water is maximum at _____.
- The temperature of a liquid is measured using a _____.
- Unit of specific heat capacity is _____.
- One calorie is equal to _____ joule.
- _____ is the plant that exists in the polar region.

III. Match the following

- | | | |
|-------------------------------------|---|-------------------------------------|
| 11. Specific heat capacity of water | - | -23°C |
| 12. Thermos flask | - | insulators |
| 13. Temperature of freezing mixture | - | mercury |
| 14. Handles of cooking vessels | - | $4200\text{ Jkg}^{-1}\text{K}^{-1}$ |
| 15. Thermometric liquid | - | double walls |

IV. Answer in one or two sentences

- What is called fuel?
- Name the metals commonly used in a bimetallic strip.
- Define joule.
- Name the animals living in the polar region.
- What is evaporation?
- What is condensation?
- Define calorie.
- Define specific heat capacity.
- What is meant by conduction of heat ?
- What is meant by convection of heat ?
- What is meant by heat radiation?
- What are insulators?

V. Answer in detail

28. Distinguish between heat and temperature.
29. Explain the peculiar behaviour of water in nature.
30. Give the differences between boiling and evaporation
31. List out the applications of radiation.
32. Describe the Hope's experiment with a neat diagram.
33. Describe the effect of heat on living organisms.
34. Give the reasons for using mercury as a thermometric liquid.
35. Explain the working of a thermometer with neat sketch.
36. Explain the working of a clinical thermometer.
37. Describe the experiment which shows that the absorbed heat is related to the nature of substance.
38. Give the uses of good conductors.
39. List out the uses of bad conductors.
40. Explain the working of a thermos flask.

Problems

1. Calculate the amount of heat energy required to raise the temperature of 100g of copper from 30°C to 40°C. Given specific heat capacity of copper is $385 \text{ J kg}^{-1}\text{K}^{-1}$ [385 joules]
2. How much heat energy is released when 10 kg of aluminium of specific heat capacity $913 \text{ J kg}^{-1}\text{K}^{-1}$ is cooled from 75°C to 25°C ? [456500 joules]

Think over it

1. Why is it easy to loosen a tight metal lid over a glass jar by holding it under a steam of hot water?
2. Will a metal metre scale show different length if it is taken from Coimbatore to Ooty ?
3. When the boiling water is heated continuously, will its temperature change?
4. Name a thermometer which does not make use of thermal expansion of substance.
5. A circular copper plate of uniform thickness has a circular hole in its centre. The plate expands when it is heated. Does the hole in the centre expand or contract?
6. How does the change of climate (temperature) affect the accuracy of a pendulum clock.
7. Is it possible to raise the temperature of a cup of water by stirring it?
8. Will a one cm long copper wire and 10 cm long copper wire expand by the same length for the same rise of temperature?

6. Light

Light is a form of energy. A body that produces light is said to be **self-luminous**. The main source of light for us is the sun. Bodies such as the sun, the stars, filament lamps etc., are said to be **luminous bodies**. Bodies which do not give out their own light are called **non-luminous bodies**. Though the planets and the moon are visible, they are non-luminous bodies. They just reflect the sunlight.

In this chapter, we shall study about the rectilinear propagation of light and reflection of light.

6.1 Rectilinear propagation of light

Hold an opaque obstacle in front of a point source of light and observe the shadow cast on a screen. The shadow is caused because light travels in a straight line. This is called *the rectilinear propagation of light* (fig. 6.1).

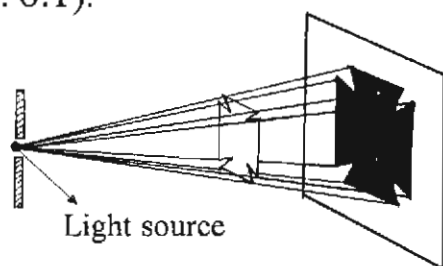


Fig. 6.1 Rectilinear propagation of light

6.1.1 Experiment to show that light travels in a straight line

A, B and C are three screens, in each of which a small hole is made. The screens are arranged so that the three holes are in a straight line. A candle flame is arranged behind the hole

in C. An observer looking through the hole in A can see the light of the candle flame (fig.6.2).

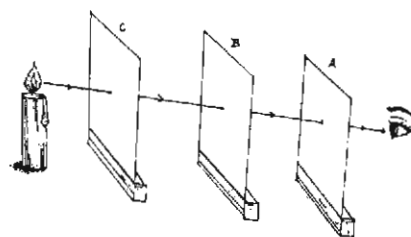


Fig. 6.2 Light travels in a straight line

But, if any one of the screen is slightly displaced, the light is at once cut off. This experiment clearly shows that light travels only along straight lines.

6.1.2 Velocity of light

Velocity of light is the distance travelled by the light in one second. The velocity of the light in air or vacuum is 3×10^8 m/s or 3,00,000 km/s

6.1.3 Pin hole camera

Make a pin hole in the middle of one side of a hard board box. Cut off a square on the opposite side and paste a tracing paper over it. Point the pin hole to a distant object and observe the image on the tracing paper (fig.6.3).

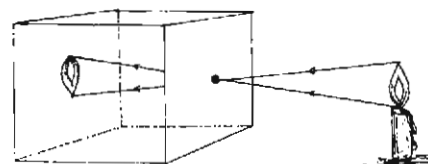


Fig.6.3 Pin hole camera

You can see an inverted image of the object on it. Why is the image inverted?

This is because the light travels in a straight line.

Activity 6.1

When the distance between the pin hole and the tracing paper is increased or decreased, observe the nature of images formed in the pin hole camera. If the distance increases, the size of the image increases and if the distance decreases, the size of the image also decreases.

When the size of the pin hole is enlarged, the clarity of the image decreases and hence the image becomes blurred.

Problem 6.1

The sun is 150 million kilometer away from the earth. Calculate the time taken for sun light to reach the earth.

The velocity of light is the distance travelled by the light in 1 second.

The velocity of light $C = 3 \times 10^8$ m/s.

To travel 3×10^8 m, time taken by the light = 1 second.

To travel $150 \times 10^6 \times 10^3$ m, time taken = $\frac{150 \times 10^6 \times 10^3 \times 1}{3 \times 10^8}$ s

Therefore, time taken by the sun light to reach the earth = 500 s.

6.2 Formation of shadows

If an opaque object AB is placed between a bulb and the wall, the light falling between the points A and B cannot pass through the object. The portion of the wall directly behind AB

does not receive any light, while the rest of the wall around it receives light.

Thus a shadow A_1B_1 of the object is formed on the wall (fig. 6.4). The shadow has the *same shape* as the object.

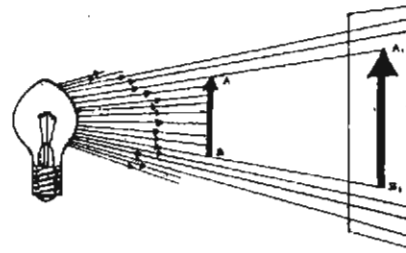


Fig. 6.4 Shadow formation

6.2.1 Formation of shadows – Umbra and Penumbra

When an opaque object is placed in the path of light from a point source a dark shadow with sharp edges is formed on the screen (fig. 6.5). This shadow is called *umbra*.

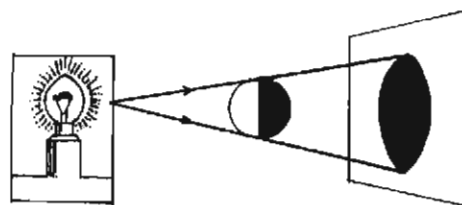


Fig. 6.5 Shadow due to a point source

When the opaque object is placed in the path of light from an extended source of light, the dark centre of the shadow called umbra is still observed. No light from the lamp reaches the umbra region (fig. 6.6).

The light shadow which surrounds the umbra receives light from the extreme points of the extended source. This ring of shadow is not completely dark and is called *penumbra*. The

brightness of the penumbra is not uniform. It is very dark near the umbra and very bright at the outer edges where more light can reach it.

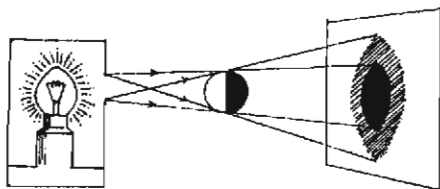


Fig.6.6 Shadow due to extended source

Activity 6.2

Place a piece of card with a small hole in it in front of the lamp and observe the nature of the image formed on a screen. You can see the shadow of the card with a bright circular disc in it on the screen.

Do you know how the bright disc is formed?

The answer for this one is that light passes through the hole and does not pass through the card.

Activity 6.3

Place a pencil in the path of light beam of a light source and observe the shadow on a screen. Now place a book in the light beam instead of the pencil and again observe the shadow. What do you infer on the nature of these images?

In both the cases, the shadows have the **same shape** as the object.

Activity 6.4

When a pencil is kept very nearer to the ground in sunshine, a well defined shadow is formed. When it is kept at a larger distance from the ground, the

shadow is not clear. Why is it so?

If the distance increases from the ground, the umbra becomes very small and disappears later. The penumbra gets larger and at the same time more lighted up. Finally, penumbra becomes so faint that it is hardly visible. In such a situation no shadow is formed.

6.3 Eclipses

Solar and lunar eclipses are formed because light travels in straight lines. When the sun, the earth and the moon are in a straight line eclipses occur. Usually the lunar eclipse occurs more frequently than the solar eclipse.

Solar eclipse

Solar eclipse is formed on a new moon day. When the moon (M) comes between the sun (S) and the earth (E), the shadow of the moon falls on the earth. Those who are in the shadow region A on the earth are unable to see the sun (fig. 6.7). This is called **solar eclipse**. In the regions B and C, some part of the sun can be seen. These regions have a **partial solar eclipse**.

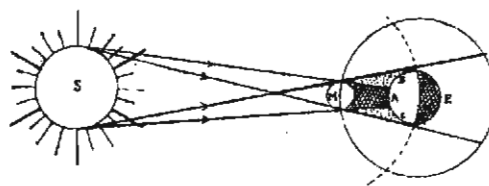


Fig.6.7 Solar eclipse

Lunar eclipse

Lunar eclipse is formed on a full moon day. When the earth (E) is in between the sun (S) and the moon (M), the moon disappears in the shadow of the earth. This is called **lunar eclipse**.

In the figure (6.8), a. represents **total lunar eclipse** and b. represents **partial lunar eclipse**.

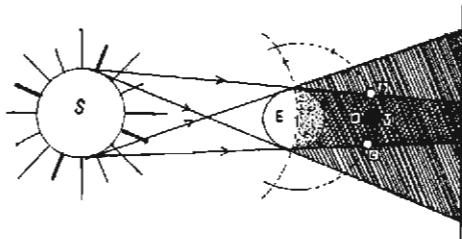


Fig.6.8 Lunar eclipse

Activity 6.5

Set up a model using a torch for the sun, table tennis ball for the moon and foot ball for the earth, to show how the solar and lunar eclipses are formed.

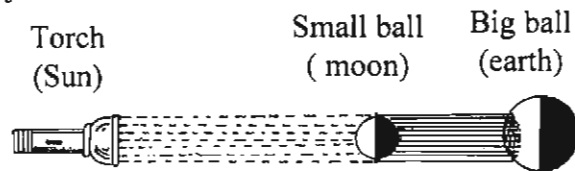


Fig.6.9 Model for solar eclipse

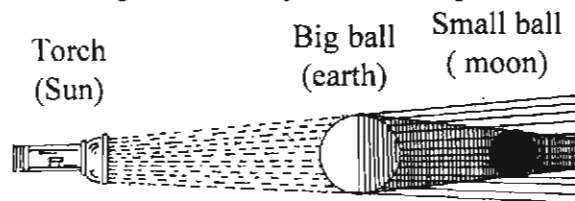


Fig. 6.10 Model for lunar eclipse

6.4 Reflection of light

When a beam of light falls on a plane mirror, it is sent back into the medium from which it came. This is called **reflection of light**.

6.4.1 Regular reflection .

When parallel rays of light fall on a smooth or highly polished surface, the reflected rays are parallel to each other. This is called **regular reflection**.

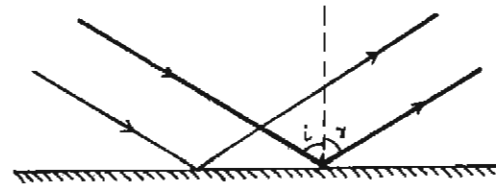


Fig.6.11 Regular reflection

6.4.2 Irregular reflection

When parallel rays of light fall on a rough surface, the reflected rays are not parallel to each other. This is called **irregular reflection**.

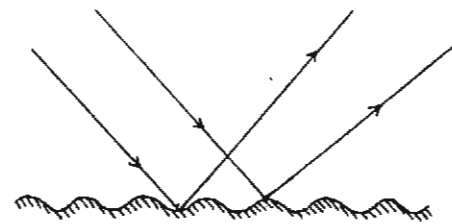


Fig.6.12 Irregular reflection

6.4.3 Reflection from a plane mirror

Let MOM' represent a plane mirror. Let AO be the ray of light that is incident on the mirror at O . This is called the incident ray. OB is the reflected ray. Let ON be the normal to the mirror at the point of incidence O .

The angle between the incident ray and the normal is called the angle of incidence (i) and the angle between the reflected ray and the normal is called the angle of reflection (r).

In the figure 6.13, $\angle AON = i$ and $\angle NOB = r$.

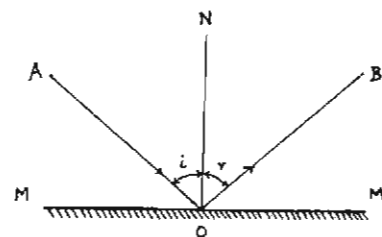


Fig.6.13 Reflection at a plane mirror

6.4.4 Laws of reflection

Law 1: The incident ray, the reflected ray and the normal lie in the same plane.

Law 2: The angle of incidence is equal to the angle of reflection.

Problem 6.2 When a light beam suffers reflection at a plane surface, **what is the angle of reflection, if the angle of the incidence is 30° ?**

According to the second law of reflection

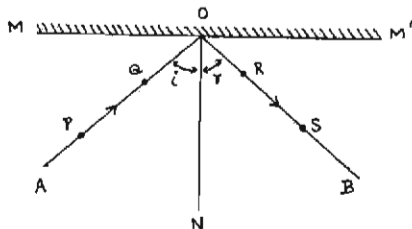
$$\text{angle of incidence} = \text{angle of reflection.}$$

Therefore, the angle of reflection = 30°

Activity 6.6

Take a drawing board and place a white paper on it. Place a plane mirror approximately 12 cm in length and 3 cm in breadth on the paper. Place two pins at P and Q on AO. AO represents the incident ray.

Take another pin R. Place R on the other side of the normal ON such that the images of P and Q and the pin R all lie on the same line. Similarly place another pin S such that the images of P and Q and the pins R and S are on the same line (fig. 6.14).



i = angle of incidence
 r = angle of reflection

Fig.6.14 Laws of reflection

Remove the pins and the mirror, draw the line BO to O through R and S. OB denotes the reflected ray. Measure the angles $\angle AON$ and $\angle NOB$.

From these observations, you will find that

1. The incident ray, the reflected ray and the normal lie in the same plane.
2. The angle of incidence $\angle AON$ and the angle of reflection $\angle NOB$ are equal.

6.4.5 Properties of images formed by plane mirrors

Stand before a plane mirror and observe the following properties.

1. The image formed by plane mirrors cannot be caught on a screen. Such images are called **virtual images**.
2. If you raise your right hand, your image in the plane mirror appears to raise its left hand. This is known as **lateral inversion** (fig.6.15a).



Fig.6.15a Lateral inversion

If an object O_1O_2 is placed in front of the mirror, each point will produce its own image at the same distance behind the mirror on the line I_1I_2 . Hence the image is laterally inverted (fig. 6.15b).

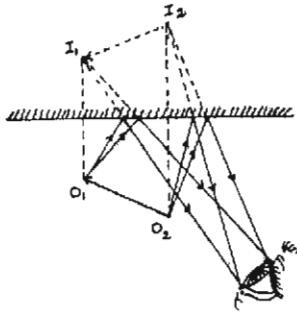


Fig. 6.15b Lateral inversion

3. Is your image in the plane mirror erect or inverted? It is **erect**.
4. Is there any difference in size between you and your image? There is no difference in **size**.
5. In a plane mirror, the image distance from the mirror is **equal** to the object distance (fig. 6.16).

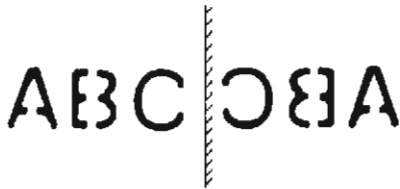


Fig. 6.16 The image distance is equal to the object distance

6.5 Uses of plane mirrors

1. The plane mirror is used as a looking glass.
2. They are used to produce multiple images in homes and shops for decorative purposes.
3. It is used in optical instruments such as periscope and kaleidoscope.
4. It is used to read and correct types composed for printing.

6.5.1 Periscope

Periscope consists of two plane mirrors in a tube. The mirrors are fixed in such a way that they face each other

at an angle of 45° to the line joining them. A light ray coming from the object after reflection by the mirror A, falls on the mirror B. Then the ray is again reflected by the mirror B in the direction shown. Thus an object in front of A can be seen from below (fig. 6.17).

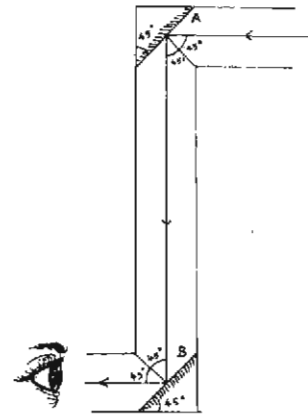


Fig. 6.17 Periscope

Periscopes are used in submarines to see objects above the sea surface.

6.6 Spherical Mirrors

Spherical mirrors are portions of spherical surfaces.

Spherical mirrors are of two types.

1. concave mirror and
2. convex mirror.

1. Concave mirror

If the outside of a spherical mirror is silvered, then it is called a concave mirror.

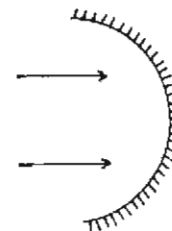


Fig. 6.18 Concave mirror

2. Convex mirror

If the inside of a spherical mirror is silvered, then it is called a convex mirror.

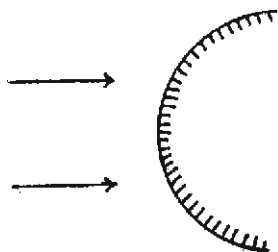


Fig. 6.19 Convex mirror

Activity 6.7

Take a bright stainless steel teaspoon. Look through its front to see your image and then look through its back. Do you notice any difference in the images?

A teaspoon when looked through its front acts as a concave mirror and when looked through the back acts as a convex mirror.

6.6.1 Definitions of the terms used in spherical mirrors

Pole (P)

This is the geometric centre of the spherical surface of the mirror.

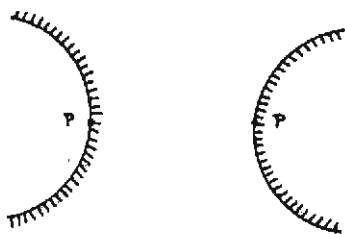


Fig.6.20 P-pole

Centre of curvature (C)

This is the centre of the sphere of which the spherical mirror is a part.

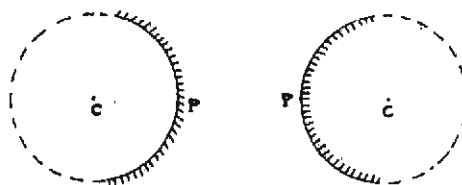


Fig. 6.21 C-centre of curvature

Radius of curvature (R)

It is the radius of the sphere of which the mirror is a part.

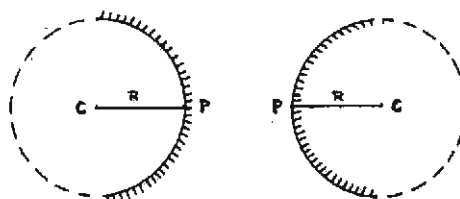


Fig. 6.22 R-radius of curvature

Principal axis

The line passing through the pole and the centre of curvature is called the principal axis.

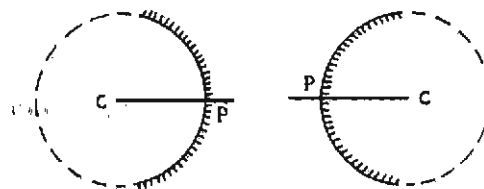


Fig.6.23 The line passing through C, P -Principal axis

Principal focus (F)

In a concave mirror, the light rays coming parallel to the principal axis after reflection will converge at a point on the principal axis. This point is called the **principal focus or focal point**.

In a convex mirror, the light rays coming parallel to the principal axis after reflection will appear to diverge from a point on the principal axis. This is called the **principal focus**.

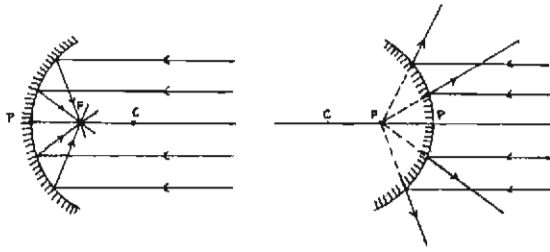


Fig. 6.24 F-principal focus

Focal length

The distance between the principal focus and the pole of the mirror is called focal length (f).

$Radius\ of\ curvature = 2 \times Focal\ length$

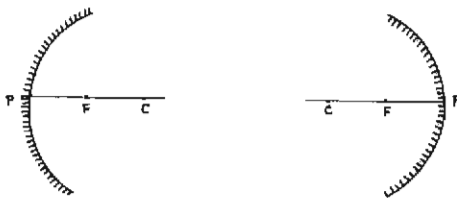


Fig. 6.25 PF-focal length

6.6.2 Images formed in Spherical mirrors

In order to draw the ray diagram to understand the nature and the location of the images formed by spherical mirrors we make use of the following constructions.

Construction: 1

Parallel rays of light are reflected through the principal focus.

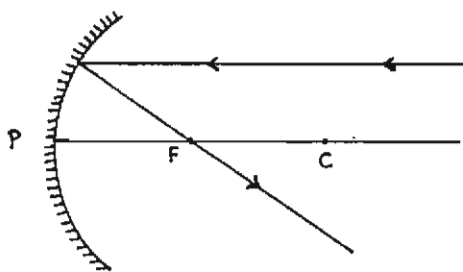


Fig. 6.26 Reflected light ray passing through the principal focus

Construction: 2

Rays of light passing through the principal focus are reflected parallel.

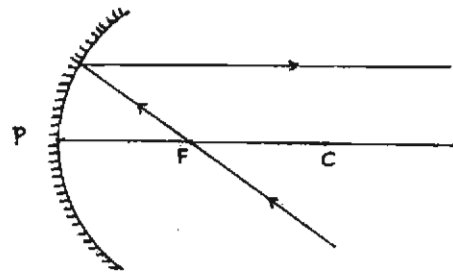


Fig. 6.27 Light ray reflected parallel to the principal axis

Construction: 3

A ray of light passing through the centre of curvature, after reflection will return along its own path.

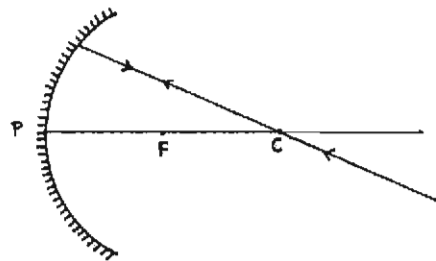


Fig. 6.28 Light ray passing through the centre of curvature

6.6.3 Images formed by concave mirrors

In the following cases, OB represents the object and IM represents the image.

1. Object between F and P

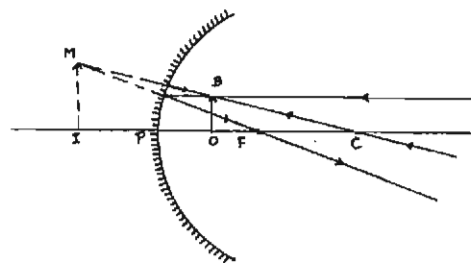


Fig. 6.29 Object between F and P

2. Object at F

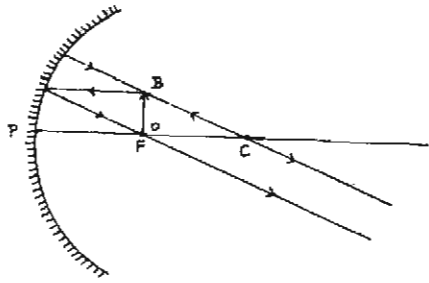


Fig.6.30 Object at F

3. Object between F and C

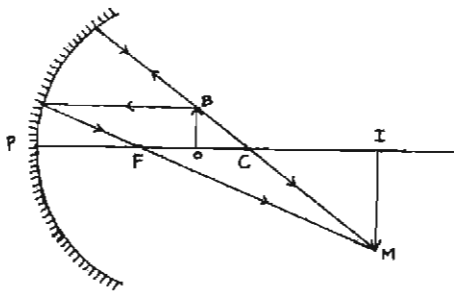


Fig.6.31 Object between F and C

4. Object at C

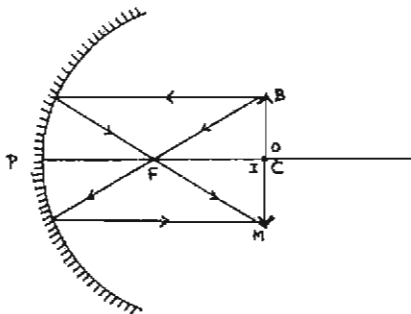


Fig.6.32 Object at C

5. Object beyond C

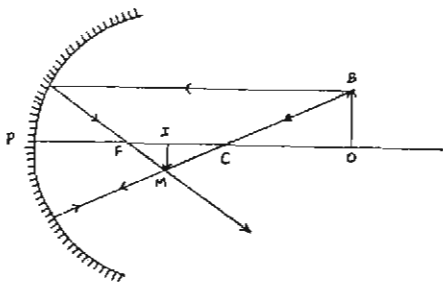


Fig.6.33 Object beyond C

6. Object at infinity

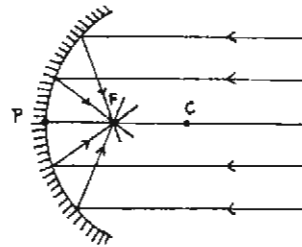


Fig.6.34 Object at infinity

6.6.4 Image formed by a convex mirror

Convex mirror

A convex mirror forms only a virtual image for any position of the object. Also the image is erect, formed behind the mirror between P and F and the image is smaller than the object (fig.6.35).

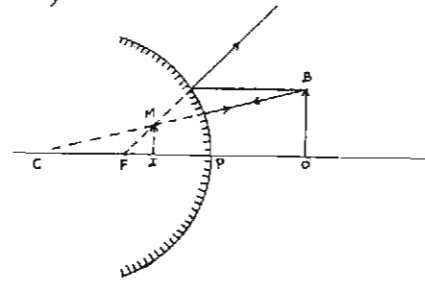


Fig.6.35 Virtual image formed by a convex mirror

6.6.5 Uses of spherical mirrors

Concave mirror is used

- i) as shaving mirror.
- ii) as doctor's head mirror.
- iii) as reflector in torches, head lights of cars and other vehicles.
- iv) in astronomical telescopes.

A **Convex mirror** is used as driver's mirror in vehicles to get a wide view as shown.

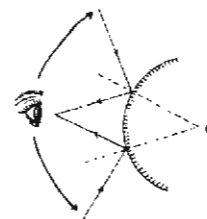


Table 6.1
Nature and position of images formed by concave mirrors

Object position	Image	
	position	Nature, size
At infinity	At principal focus F	diminished (point), real and inverted
Beyond C	Between F and C	diminished, real and inverted
At C	At C	same size, real, inverted
Between F and C	Beyond C	enlarged, real and inverted
At F	At infinity	enlarged, real and inverted.
Between P and F	Behind the mirror	no image since the reflected rays are parallel. enlarged, erect and virtual

6.7 Effect of light on plants

Photosynthesis

The process by which the green plants prepare their own food in the presence of sunlight, using chlorophyll is known as **photosynthesis**.

Role of light in photosynthesis

The leaf is made up of many layers of cells which contain the green colouring material called **chlorophyll**. The lower layer consists of tiny air holes called **stomata**. How do the raw materials from different places reach the green leaves? Let us see.

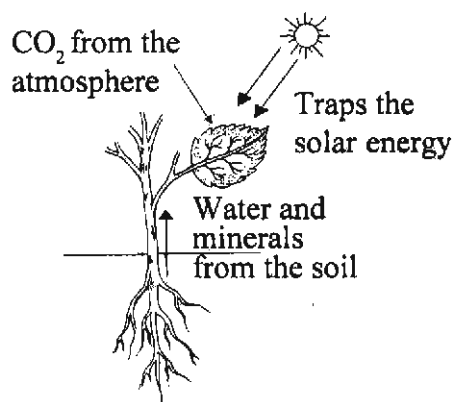


Fig.6.36 Photosynthesis in green plants

1. Water and mineral salts

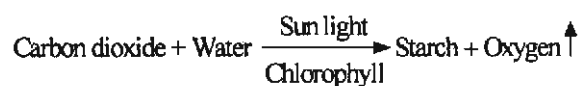
Water poured to the plant dissolves the mineral salts present in the soil forming mineral water. The root hairs absorb this mineral water. The xylem cells in the roots, stems and leaves form microscopic long tubes. They conduct the mineral water to the leaf cells containing chlorophyll.

2. Carbon dioxide

Carbon dioxide enters through the stomata.

3. Sun light

Chlorophyll is capable of absorbing light energy from the sun light and convert it into chemical energy. A series of reactions take place and at the end, starch is formed and oxygen is given out.



The food thus prepared is distributed to all parts of the plant from the leaves through the phloem cells.

SELF EVALUATION

I. Choose the correct answer

- The speed of light in air or vacuum is
a) 3,00,000 m/s b) 3×10^8 km/s c) 3×10^8 m/s d) 330m/s.
- Penumbra is formed due to
a) a source of light b) a point source of light
c) an extended source of light d) a source of sound.
- If the angle of incidence of a ray of light on a plane mirror is 30° , then the angle of reflection is _____.
a) 30° b) 45° c) 120° d) 60° .
- In a periscope, _____ mirrors are used.
a) concave b) convex c) plane d) spherical
- The geometric centre of the spherical surface of the mirror is called
a) centre of curvature b) pole
c) principal focus d) radius of curvature

II. Fill in the blanks

- The time taken for sun light to reach the earth is _____.
- The shadow of the object has the _____ shape as the object.
- When the moon comes between the sun and the earth, _____ eclipse is formed.
- The incident ray, the reflected ray and the normal lie in the _____.
- In a concave mirror, if the object is at F then the image is formed at _____.

III. Match the following

- | | | |
|--------------------|---|--------------------------|
| 11. Umbra | - | kaleidoscope. |
| 12. Plane mirror | - | driver's mirror. |
| 13. Periscope | - | a point source of light. |
| 14. Convex mirror | - | chlorophyll. |
| 15. Photosynthesis | - | submarines. |

IV. Give short answers

- What is rectilinear propagation of light?
- Define : the velocity of light.
- What happens to the nature of the image if the size of the pin hole increases in a pin hole camera?
- How are shadows formed?
- Which eclipse is seen very often?
- What is reflection of light?

22. What are regular and irregular reflections?
23. State the laws of reflections?
24. What is lateral inversion?
25. What is the size and nature of the image in a plane mirror?
26. Give the uses of plane mirrors.
27. What is the difference between concave and convex mirrors?
28. What is focal point?
29. Define: principal axis.
30. What is photosynthesis?

V. Give detailed answers

31. Explain the experiment to show that light travels in a straight line.
32. Explain the action of pin hole camera.
33. Explain the formation of umbra and penumbra.
34. How are solar and lunar eclipses formed?
35. State and explain the experiment to verify the laws of reflection of light.
36. State the properties of images formed by plane mirrors.
37. Explain the construction of a periscope.
38. Tabulate the nature and position of images formed by concave mirrors.
39. Explain the role of light in photosynthesis.

Problems

1. The radius of curvature of a concave mirror is 1m. What is the value of its focal length? (0.5m)
2. In a plane mirror, if the angle of incidence is 45° , what is the angle of reflection? (45°)
3. If the velocity of the light is 3×10^8 m/s, calculate the distance travelled by the light in 10 minute. (1.8×10^{11} m)
4. A star is 120 million km away from the earth. Calculate the time taken for the light from the star to reach the earth. (400 second)

Think over it

1. Can light change its direction if it does not meet a boundary of two media?
2. Why does a glass plate not form a shadow?
3. Why does an aeroplane flying high not form a shadow?
4. Are the laws of reflection same for both flat and curved surfaces?
5. You see the eyes of some one in front of a plane mirror. Will he see your eyes or not in the mirror?
6. Is the image seen in a movie screen real or virtual?
7. What happens to the image in a plane mirror, if the mercury coating is removed?

7. Sound

Turn on your television set and adjust the sound to a high pitch. When you place your palm on the speaker of the television set, what do you feel?

The answer for this question is that your palm will feel the vibrations of the sound.

If an excited tuning fork is held near your ear, you can hear the sound. Thus sound is produced when the objects vibrate.

7.1 Vibration as a source of sound

Activity 7.1

Place a ruler at the edge of a table (fig. 7.1).

Press its free end A hard and release your hand. You can hear the sound produced by the ruler.

From the above experiment, it is clear that sound is produced when the body produces to and fro motion. This quick to and fro motion is called **vibration**. Thus sound is produced due to vibrations caused by an object.

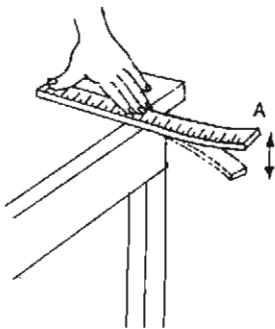


Fig.7.1 Vibrating body - source of sound

Vibrating bodies produce the sound. There are many ways of producing the sound. Some of them are as follows.

1. Plucking

When you pluck a stretched string, sound will be produced. The musical instruments like guitar, tambura etc., are of this type.

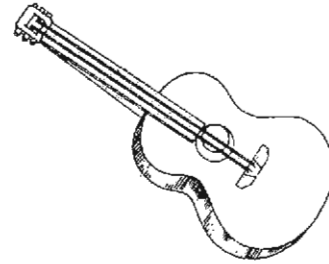


Fig.7.2 Sound by plucking

2. Blowing

If you blow air through a flute, nadaswaram etc., sound waves will be produced.

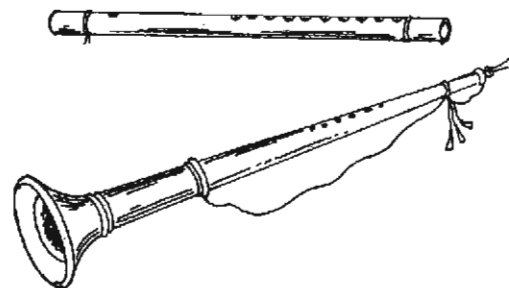


Fig.7.3 Sound by blowing

3. Striking

Sound can be produced by striking one object with another. Examples for this type are drums, tabla, thavil etc.,

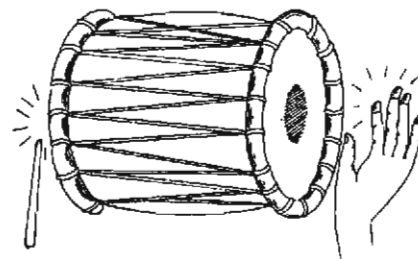


Fig.7.4 Sound by striking

4. Bowing

Sound can be produced by rubbing or bowing one object against another. In the case of a violin, a bow is made to rub against the string to produce the music.

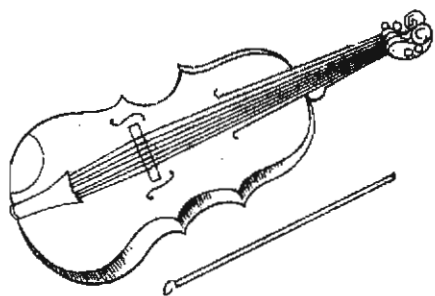


Fig.7.5 Sound by bowing

Activity 7.2

Note the vibration produced by various musical instruments like veena, shehnai, mridhangam, violin etc., and tabulate the nature of vibration in them.

7.1.2 Vibrations of a tuning fork

A tuning fork is made of steel. The two upper ends of the tuning fork are called the 'prongs' while the lower end is called the 'stem'.

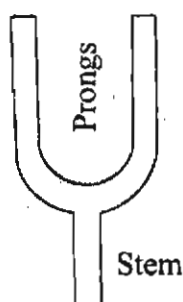


Fig.7.6 Tuning fork

Strike the prongs against a hard rubber pad and observe the vibrations. Hence, a vibrating tuning fork produces sound.

Definitions

1. Frequency (n)

It is the number of vibrations produced in one second by a vibrating body. The unit of frequency is **hertz** (Hz).

2. Period of oscillation (T)

The time taken by the vibrating body to make one full vibration or oscillation is called the period of oscillation. The unit of period is **second** (s).

3. Amplitude (a)

The maximum displacement of a vibrating body from its mean position is called the amplitude (a) as shown in the figure 7.7. The unit of amplitude is **metre** (m)

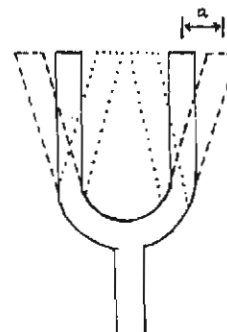


Fig.7.7 Amplitude of vibration

The relation between the frequency (n) and the period of oscillation (T) is obtained in the following way.

To make n oscillations, time taken
= 1 second

To make 1 oscillation, time taken T
= $\frac{1}{n}$ x 1 second

$$T = \frac{1}{n}$$

Therefore, period of oscillation is the reciprocal of the frequency.

7.2 Audible and inaudible sounds

We know that sound is produced by vibrating bodies. The number of vibrations produced in one second is called the frequency of vibrations. The unit of frequency is **hertz (Hz)**.

Audible sound

Sound waves of frequencies ranging from 20 Hz to 20,000 Hz are audible to human ear. This is known as the '**audible frequency range**'.

Inaudible sound

Vibrations having frequencies below 20 Hz are called '**infrasonic**'. The vibrations of the earth produced during an earthquake are infrasonic waves.

Sounds of frequencies greater than 20,000 Hz are known as '**ultrasonic**'. These vibrations are not audible to the human ear. Some animals such as bats and dogs can hear ultrasonic frequencies.

Bats can produce sounds of frequencies above 70,000 Hz.

7.2.1 Speech

The **voice box or larynx** helps us to speak. It consists of two elastic membranes called '**vocal cords**'. These cords are flexible and vibrate when air from the lungs strikes on them. Adjusting the mouth and the tongue can change the variation of sound. Place your hand gently on the throat and feel the vibrations while you speak.

Difference in pitch of sound produced by boys and girls

The vocal cords of boys are generally large when compared to girls and produce low-pitched sound. Due to this, the girls have shrill voices. Figure 7.8 shows the vocal cords of a boy and a girl.

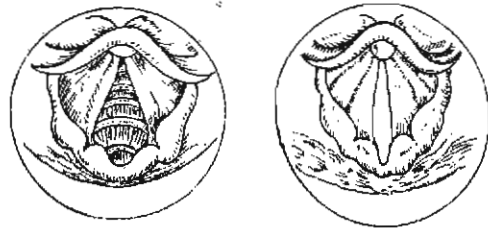


Fig.7.8 Vocal cords of a boy and a girl.

Activity 7.3

Stretch a thin sheet of rubber over the mouth of a funnel and tie it around the rim of the funnel. Cut out a narrow strip from its middle (fig. 7.9). Blow air into the funnel through the stem. You will notice that the rubber membrane vibrates and produces sound.



Fig.7.9 Sound production

7.2.2 Hearing

The compressions and rarefactions of air produced by sound reach the ear and cause vibrations on the ear drum. This in turn causes the three little hinged bones connected to it to vibrate.

The auditory nerves pick-up the vibrations and send them as impulses to the centre of hearing in the brain.

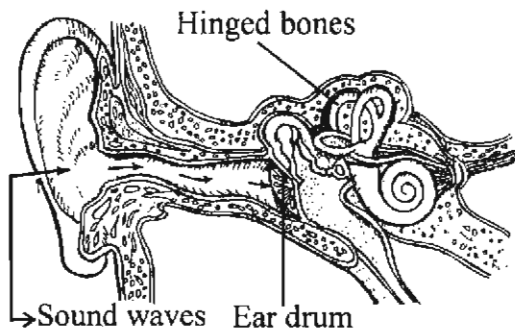


Fig.7.10 Structure of the ear

Baby's cry

Human ear is more sensitive to the frequency range 3000 Hz to 4000 Hz. It is interesting to note that this is also the frequency range of a baby's cry.

7.3 Propagation of sound

The particles of the medium through which sound passes are set into vibrations and the energy is transmitted in the form of waves.

7.3.1 Sound needs a medium to travel –Experiment

Can sound travel without a medium? To find the answer to this question, let us consider the following experiment (fig. 7.11).

An electric bell is placed inside a glass bell jar. When the bell rings, it produces sound waves which travel through the air inside the jar. They vibrate the glass walls and produce sound which travels again through air to reach our ears.

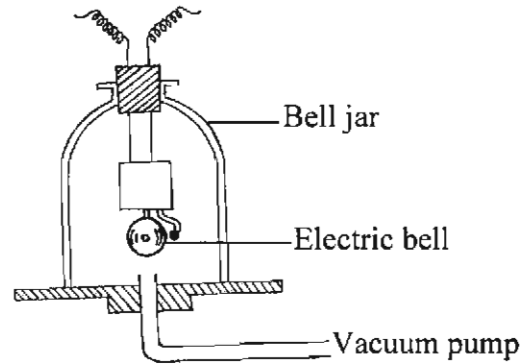


Fig.7.11 Bell jar experiment

Now a vacuum pump is connected to the bell jar and all the air from within the bell jar is pumped out. You can observe the bell working but you cannot hear the sound produced by it.

Thus, sound cannot travel in vacuum. It always needs a medium to travel.

Can you hear the sound on the moon?

Since the moon has no atmosphere, sound waves cannot travel in vacuum. Thus you cannot hear the sound on the moon.

The astronauts landed on the moon used their wireless sets to communicate with each other using radio waves.

7.3.2 Propagation of sound in gases

Consider an excited tuning fork . Notice that the prongs vibrate and produce sound.

As the prong moves forward, it causes air to be compressed. The compressed air pushes the particles of air around it and make the next layer of air to be compressed. As the prong moves backward, it causes the air to expand and thus causes rarefaction.

The compressions and rarefactions of air move outwards in all directions from the source (fig. 7.12).

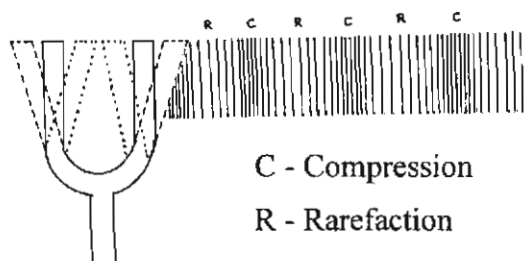


Fig.7.12 Propagation of sound in air

As sound waves travel through air, the air particles vibrate back and forth parallel to the direction of motion of the wave. Therefore, the sound waves are longitudinal in nature.

7.3.3 Propagation of sound through liquids

Fill a basin with water. Ask your friend to strike two metal rods together within the water in the basin. Keep your ear in contact with the outer surface of the basin and listen to the sound produced. Thus, the sound travels through the water and reaches your ear (fig. 7.13).

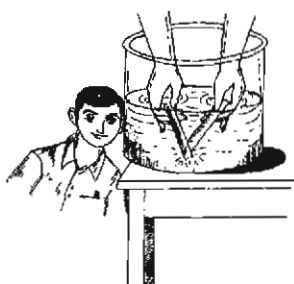


Fig.7.13 Propagation of sound in water

7.3.4 Propagation of sound in solids

Ask your friend to gently tap the metal stair case railing and listen to the sound propagated through air. Keep your ear in contact with the other end

of the metal railing and listen to the same sound propagated through the metal. Now you can notice that the sound reaches you faster with loud intensity (fig. 7.14).



Fig.7.14 Propagation of sound in solids

7.3.5 Velocity of sound

Velocity of sound is the distance travelled by the sound waves in one second.

The velocity of sound is much larger in liquids and solids than that in gases because the molecules of liquids and solids are closer than that of the gases.

Velocity of sound in various material media

1. The velocity of sound in air at 0° C is 331 m/s
2. The velocity of sound in water at 20° C is 1482 m/s
3. The velocity of sound in steel (iron) is 5000 m/s

7.4 Reflection of sound

When you shout standing at a distance from a tall rock, you can hear your voice after some time. This effect can be observed in closed halls and deep wells.

We know that light can be reflected

by a mirror. Sound can also be reflected in the same way. This can be explained by a simple experiment.

7.4.1 Experiment on reflection of sound

Fix a sheet of paper to a drawing board. Place two planks as shown in the figure. Place a hollow metal tube on one side and fix pins to keep it in position. Keep a ticking watch at one end of the tube. Place another metal tube on the other side and turn it till you hear the sound of the watch (fig.7.15). Mark the positions of the planks and tubes.

Measure the angles made by the tubes with the plane surface of the plank ON. The angle between the tube AB and the perpendicular plank ON is equal to the angle between the tube CD and the plank ON.

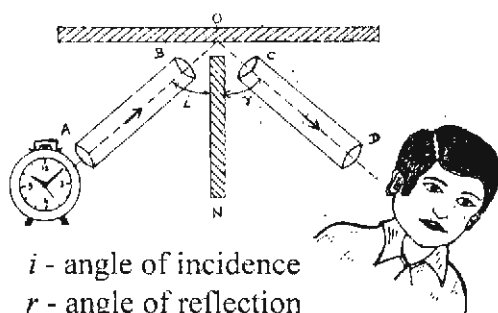


Fig. 7.15 Laws of reflection of sound

Thus, when sound is reflected by a plane surface, the angle of incidence (i) is equal to the angle of reflection (r).

Activity 7.4

Place a ticking clock inside a glass container. Close it with a smooth

plank. You cannot hear the ticking sound distinctly. Slowly lift the lid from one end. At a certain angle, the ticking sound is heard very clearly. It shows that sound is reflected by plane surfaces.

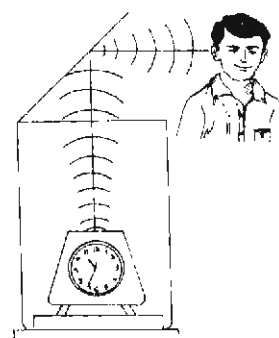


Fig. 7.16 Reflection of sound

7.4.2 Echo

When a person speaks in a closed room the sound waves spread in all directions. Some waves reach our ears directly. Some strike the walls and get reflected. They also reach our ears as shown in the figure 7.17. In a small room the direct waves and the reflected waves reach our ears at about the same time. When the room is big, the waves have to travel a longer distance. So they are not reflected immediately. If they take more than $\frac{1}{10}$ second to reach our ears, we hear the sound separately. This is called *echo*.

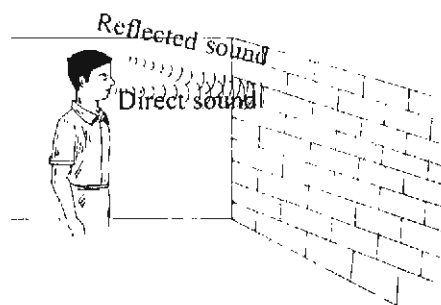


Fig. 7.17 Echo formation

We know that the velocity of sound in air is 340 m/s. The distance travelled in $\frac{1}{10}$ second is 34 metre. If the reflecting surface is beyond 17 metre, the original sound and reflected sound are heard separately.

Ultrasonic Scan

Ultrasonic waves are reflected by the boundaries of different substances. Within our body, incident ultrasonic waves are reflected from the boundaries between tissues, bones and fluids of different densities. 'Ultrasonic scan' is used by doctors to 'look' inside the human body.

7.4.3 Uses of Echoes

1) Sonar

The device SONAR (Sound Navigation and Ranging) works on the principle of reflection of sound waves. It is used to measure the depth of the sea.

The working of sonar can be explained as shown in the figure 7.18.

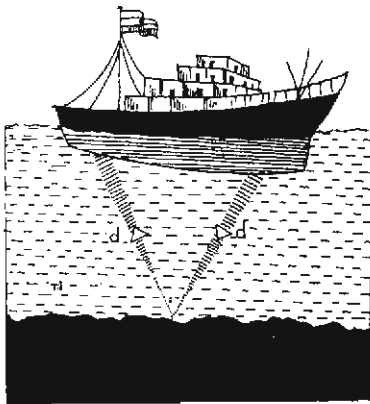


Fig. 7.18 Sonar

A sound signal of short wavelength is sent from the ship to the bottom of the sea using the sonar. After reflection from the floor of the sea, the signal returns to the ship.

The time taken by the sound signal to go to the bottom and return is noted as 't'. Let the total distance travelled by the sound to go to the bottom and return be '2d', where d is the depth of the sea. Let 'v' be the speed of the sound signal.

$$\begin{aligned} \text{Speed} &= \frac{\text{distance}}{\text{time}} \\ v &= \frac{2d}{t} \\ d &= \frac{vt}{2} \end{aligned}$$

The depth of the sea (d) = $\frac{vt}{2}$

2) Bats and whales

Bats, whales and other living creatures are able to navigate and locate prey by using echo sounding. They produce sounds of very high frequency. By receiving back the echoes, they are able to detect not only the direction but also the exact position of obstacles in their path (fig. 7.19).

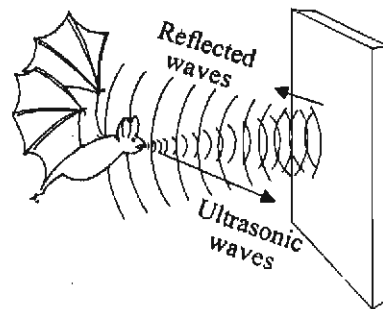


Fig. 7.19 Uses of echo-Bats

3) Ship's Siren

Echoes of ship's siren are used to

find the exact position of very large icebergs in its path.

7.5 Lightning and thunder

We know that the velocity of light is 3×10^8 m/s. It means that the light can travel a distance 3×10^8 metre in one second.

The velocity of sound in air at 20°C is nearly equal to 340 m/s. Hence sound can travel a distance 340 metre in one second.

Though the lightning and the thunder take place at the same time, due to difference in the velocities of the light and the sound, lightning can be seen early and later the thunder sound is heard.

7.5.1 Lightning formation

Lightning is an electrical discharge through the atmosphere due to the charges accumulated on the clouds.

The atmospheric air is continuously ionised by the action of the ultraviolet rays from the sun and the cosmic rays. As a result, the atmosphere always contains positive and negative ions. When the water droplets of the cloud fall through this electric field region, they get charged.

According to C.T.R. Wilson, the heavier droplets acquire negative charges and the lighter droplets acquire positive charges. This leads to the clustering of negative charges at the base of the cloud and the positive

charges at the top.

A discharge takes place between the charged surfaces of the same cloud or between two clouds when they pass one over the other. The flash produced by the discharge is called the '*lightning*'.

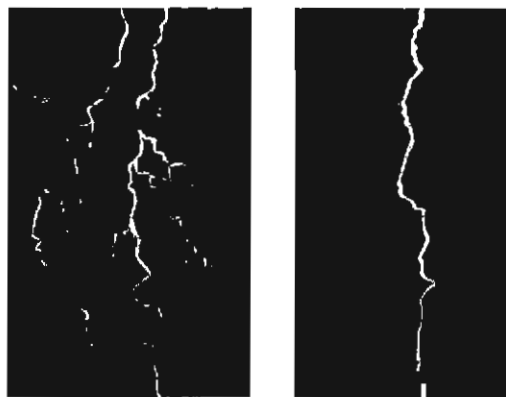


Fig.7.20 Lightning

7.5.2 Thunder formation

About 75% of the electrical energy of the lightning discharge is used up in heating the atmospheric gases in and around the flash.

The temperature of this region rises to about 10000 K in about a few micro second. As a result, a pressure wave, on expansion, gives rise to compressions and rarefactions, producing a violent sound called '*thunder*'.

Problem 7.1

You hear a thunder 3 second after a lightning. How far away the lightning occurred?

The velocity of sound in air is nearly 340 m/s.

Here the thunder sound is heard 3 second after a lightning flash.

The distance travelled by the sound in 3 second = 340×3
= 1020 metre
= 1.02 km

Hence, the lightning flash occurred at a height = 1.02 km.

Examples showing that the light travels faster than the sound

1. Firing of crackers

During the festival times and in other functions, crackers are fired. When the crackers are fired, they produce the light and the sound simultaneously. Since the light travels faster than the sound, we can see colourful light beams first and then the sound waves reach our ears.

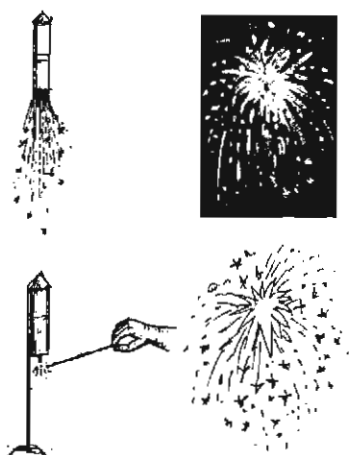


Fig.7.21 Firing of crackers

2. Bomb explosion

When an atom bomb is exploded, it gives large quantity of light, heat and harmful radiations. Since the light travels faster than the sound, at the explosion site light can be seen first and later the explosive sound can be heard.

7.6 Music and Noise

Music: In musical sounds, the waves are periodic and spaced out in an orderly manner. The musical sounds are pleasant to hear. Almost every one loves music.

Noise : It is the sound that is non-periodic and unpleasant to hear. Noise beyond a certain limit not only disturbs our minds but causes deafness also.

7.6.1 Sources of noise pollution

We live in a world filled with noise. Sounds produced by machine shops, busy traffic, rock concert are harmful to our ears. At home television, record players etc. produce noise.

When noise becomes intolerable, we call it as **noise pollution**. Noises of high intensity may produce irritation, psychological problems, hearing problem, headaches, dizziness and nausea, high blood pressure, nervousness etc.,

Methods of reducing noise pollution

1. We must avoid producing as well as hearing the unwanted noises.
2. When we listen to music with less volume, it calms the mind.
3. As noise affects our mental and physical health, the hospital areas have been declared as '**No sound zones**'.
4. Sound absorbing materials, windows, curtains, carpets for the floor are used to reduce noise pollution in factories, cinema theatres and music halls.

7.6.2 Differences between musical sounds and noise

S.No	Music	Noise
1.	The vibrations are regular and periodic.	The vibrations are irregular and non-periodic
2.	Musical sounds can be reproduced.	Noise cannot be reproduced easily.
3.	Pleasant to hear.	Unpleasant to hear.
4.	Veena, violin, flute, tabla, tuning fork, nadhaswaram, piano etc., are the few sources that produce music.	The sound of thunder, firing of crackers, breaking of glass, transport vehicles etc., produce the unpleasant noise.

7.7 Musical instruments

Before learning about the various types of musical instruments, let us see the characteristics of musical sounds.

7.7.1 Characteristics of musical sounds

Musical sounds have three characteristics. They are

1. Pitch
2. Intensity
3. Quality.

1. Pitch

Pitch depends on the frequency of the sound. If we press the first and the last keys of a harmonium or a piano, two sounds of different pitches are produced.

Activity 7.5

Fill glass bottles with water to different levels as shown in the figure 7.22. Blow air near the mouth of the bottles. Note the change in the pitch

according to the height of air columns.

It may be seen that the pitch is directly proportional to the frequency.

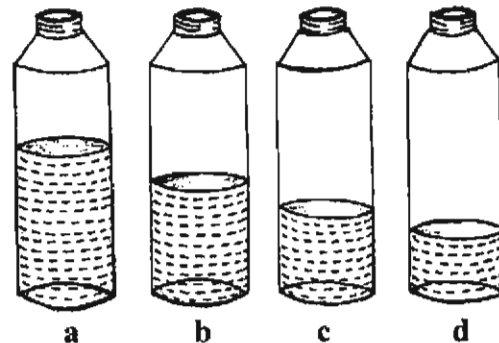


Fig.7.22 a) Larger pitch
d) Smaller pitch

Activity 7.6

Fix a rubber band at one end and hold the other end with your hand. Pluck the rubber band changing its length by stretching. Note the changes in the pitch.

It can be shown that the frequency of vibration decreases as its length increases.

Various notes in a guitar

A guitar player changes the length of the vibrating string by pressing the string against the neck of the instrument. When the length changes its frequency of vibration changes. Thus a musician is able to play many notes with one string.

2. Intensity

Intensity depends on the amplitude of vibration and the area of the vibrating body. Intensity or loudness is proportional to the square of the amplitude.

Activity 7.7

When the string of the sonometer is made to vibrate by plucking it gently with the fingers, a soft sound is heard. On plucking the string harder, a loud sound is heard. A sonometer is as shown in the figure 7.23.

Hence the intensity of the sound increases as the amplitude of vibration increases.

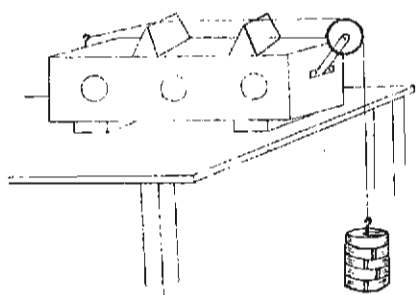


Fig.7.23 Sonometer

Activity 7.8

Have you seen the musical instrument shown in the figure 7.24.

Water is poured to different levels in several cups and sticks are used to strike the edge of the cups to produce sound. This instrument is called as 'jaladharangam'. Here, the intensity depends on the area of the vibrating body.



Fig. 7.24 Jaladharangam

3. Quality

Two notes of the same pitch and of the same loudness can sound differently. The sound produced by a veena is different from the sound produced by a flute. This is due to difference in the quality of the note.

7.7.2 Musical instruments

The sound that gives pleasing effect is called music. Musical sounds are produced by musical instruments. Musical instruments can be divided into three types according to the nature of the vibrating elements.

1. Stringed instruments

In a stringed instrument, vibrating stretched string produces the sound. The strings are made to vibrate by plucking or striking or bowing.

Examples

- Veena, guitar are the plucked string instruments.
- Piano is an example of struck string instrument.
- Violin is called bowed string instrument.

The pitch of the note is changed by changing the length and the tension of the stretched strings.

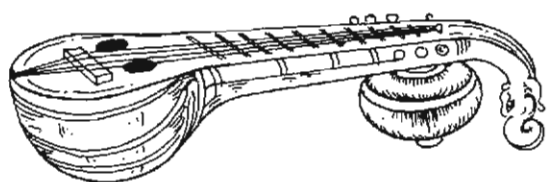


Fig.7.25 Stringed instrument

2. Wind instruments

The instruments that produce sound due to the vibration of air column are called wind instruments.

Examples

Flute, nadhaswaram, shehnai and clarinet etc., The note is changed by closing and opening the holes to alter the length of the vibrating air column.

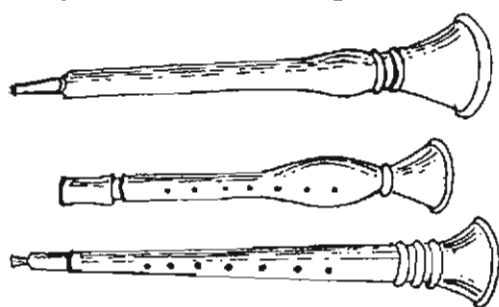


Fig.7.26 Wind instruments

3. Percussion instruments

In these instruments a membrane stretched over a frame is made to vibrate by striking with a stick or hand.

Examples

Mridhangam, tabla, drum etc.,

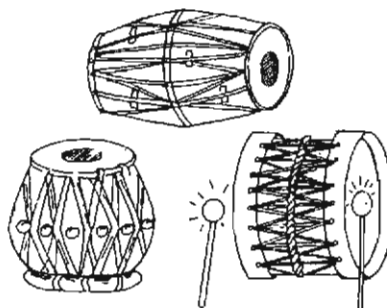


Fig.7.27 Percussion instruments

7.7.3 The benefits of music in our life

The following are some of the benefits of music in our life.

1. Music is very pleasant to hear.
2. Music gives mental peace.
3. Music can be used in the treatment of certain diseases.
4. Musical sounds can be reproduced at any time.
5. Music gives patience and can control anger.
6. In film industry, the various musical instruments play an important role.

Do you know?

Why there is a reverberation after a thunder?

When discharge takes place between two charged clouds, a loud noise called thunder is created. This noise is reflected by the earth and the clouds or the vapour layers available in the atmosphere several times and thus a reverberation is caused.

SELF EVALUATION

I. Choose the correct answer

- In _____ sound can be produced by striking one object with another.
i) flute ii) guitar iii) tabla iv) veena.
- Two upper ends of the tuning fork are called as _____.
i) stem ii) prongs iii) frequency iv) sonometer
- The unit of frequency is _____.
i) Hz ii) m iii) kg iv) s
- The Audible frequency range is _____.
i) below 20 Hz ii) above 20,000 Hz
iii) between 20Hz and 20,000 Hz iv) above 70,000 Hz
- The compressions and rarefactions are produced in _____.
i) light ii) electromagnetic waves iii) sound iv) heat

II. Fill in the blanks

- The velocity of sound in water at 20° C is _____.
- The minimum distance of the reflecting surface from the source of sound for echo to be heard in air clearly is _____.
- Sonar is used to measure the _____ of the sea.
- When noise becomes intolerable, we call it as _____.
- Pitch depends on the _____ of the sound.

III. Match the following

- | | | |
|-----------------|---|---------------------------|
| 11. Infrasonic | — | longitudinal in nature |
| 12. Sound waves | — | stringed instrument |
| 13. Sonar | — | noise |
| 14. Thunder | — | reflection of sound waves |
| 15. Violin | — | below 20 Hz |

IV. Give the short answers

- How is sound produced?
- Name the methods of producing sound.
- Define : Frequency of vibration.
- Define : Period of oscillation.
- Define : Amplitude of vibration.
- What are the frequency ranges of audible and inaudible sounds?
- Can you hear the sound on moon? Give the reason.
- What is the velocity of sound in air, water and iron?
- How bats and whales use the echo sounding method?

25. What are the harmful effects of noise pollution?
26. Give any two methods of reducing noise pollution.
27. Give some uses of music in our life.

V. Give the detailed answers

28. Explain the different methods of producing sound with examples.
29. Write a short notes on the voice box and explain the difference in the pitches of sound produced by boys and girls. Explain how we hear the sound?
30. Explain the experiment to show that sound needs a medium to travel.
31. Explain the propagation of sound in gases.
32. Explain the propagation of sound in liquids and solids.
33. Explain the experiment on reflection of sound.
34. How are echoes produced?
35. Explain the working of sonar.
36. Explain how the lightning and thunder are formed.
37. Distinguish between music and noise.
38. Write short notes on pitch, intensity and quality.
39. Write short notes on the different types of musical instruments.

Problems

1. The time taken by a vibrating particle to make one full vibration is 0.001 second. Calculate its frequency. (1000 Hz)
2. The time taken by the sound signal to go to the bottom of the sea and return is 20 second. The velocity of sound in water is 1500 m/s. Calculate the depth of the sea. (15 km)
3. You hear a thunder 4 second after a lightning. How far away the lightning occurred? (1.36 km)

Think over it

1. Why is the arrival of a train known in advance by keeping your ear to the rails?
2. Why the horn of a loud speaker is conical?
3. A teacher is teaching in a classroom. Will the sound intensity same to the students in front and in back benches?
4. When you tap the tabla at different points, is the sound same?

8. Electric charges at rest

The branch of science, which deals with the study of electric charges at rest is called 'electrostatics'. According to the electrostatic behaviour, materials can be divided into two categories. They are

1) conductors and 2) insulators.

This chapter deals with the study of electrical nature of matter, the forces between the charges, charging of bodies by friction, contact and induction and the working of electroscopes.

Electricity

By 600 BC, the Greeks had discovered that amber rubbed with cloth attracts light objects. The Greek word for amber is elektron from which we get the word electricity.

8.1 Conductors and Insulators

Conductors

Bodies which allow the charges to pass through them are called 'conductors'. eg. metals, human body, earth, graphite and charcoal etc.

Insulators

Bodies which do not allow the charges to pass through them are called 'insulators'.

eg. glass, mica, ebonite, plastic etc.

❖ **Charged bodies**

If charges are given to a body, then the body is said to be charged.

❖ **Uncharged bodies**

If charges are not given to a body, then it is said to be uncharged. Remember that in an uncharged body there are equal number of positive and negative charges.

8.1.1 Structure of an atom

Bodies are made up of molecules and molecules are in turn made up of atoms.

Every atom has a positively charged nucleus at its centre. Protons and neutrons are present in the nucleus. In the case of Hydrogen atom only there is no neutron inside the nucleus. Protons are positively charged particles and neutrons are neutral particles with no charge. The negatively charged particles called electrons are revolving around the nucleus in certain orbits.

In an atom, the number of protons is equal to the number of electrons. i.e. positive and negative charges are equal in number. Hence, an atom as a whole is neutral in nature.

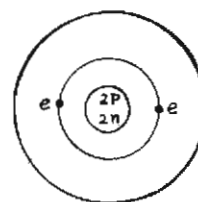
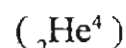


Fig. 8.1 A neutral atom of Helium



8.1.2 Charging of bodies

Experiment: 1

Take a few bits of paper on a table. Bring a plastic ruler near the paper bits.

Nothing will happen. Rub the ruler with a piece of wool and bring it near the bits of paper. What do you observe?

The pieces of paper jump up and stick to the ruler (fig. 8.2).

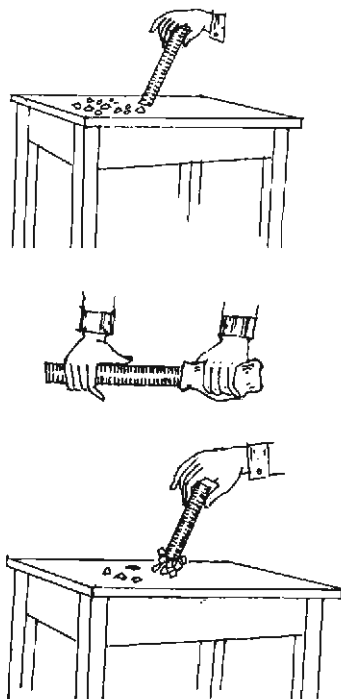


Fig. 8.2 Charging of a plastic ruler

Experiment: 2

Inflate a rubber balloon. Rub it against a woollen cloth and place it against a wall. What do you observe? You will see that the balloon sticks to the wall (fig. 8.3).

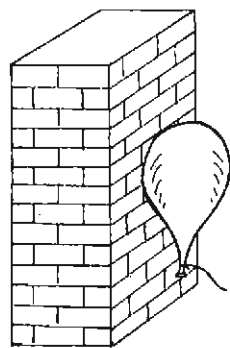


Fig. 8.3 Charging of a rubber balloon

From the above two experiments, we infer that the plastic ruler and the balloon undergo some change when they are rubbed with a woollen material. That is, in each case the object is charged by rubbing and it is said to possess an electric charge or static electricity.

Experiment: 3

Inflate two rubber balloons and they are rubbed against a woollen cloth. Bring the two rubber balloons very close to each other. What do you observe in this case? The balloons will be repelled. This is because the balloons have the same kind of charges when they are rubbed against a woollen cloth (fig. 8.4).

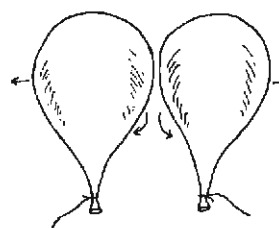


Fig. 8.4 Repulsive force between two charged balloons

Activity 8.1

Rub a plastic comb against a piece of wool and bring it near small bits of paper. What do you observe? The comb attracts the bits of paper (fig. 8.5).

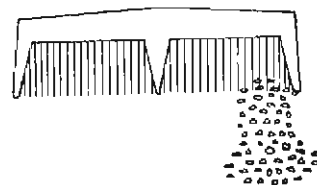


Fig. 8.5 The charged comb attracts the bits of paper

Activity 8.2

Explain why hairs on hands repel one another and get attracted with nylon when we wear nylon clothes ?

When we wear nylon clothes, due to friction, the hairs on our hands acquire some charges of the same kind. Due to this, the hairs on our hands repel one another.

The nylon clothes acquire the opposite charges. The charges on the hairs and the nylon clothes are opposite in nature. Therefore, they get attracted.

8.2 Types of charges

A glass rod rubbed with silk is suspended from a thread and another glass rod rubbed with silk is brought near it. The two rods repel each other (fig. 8.6).

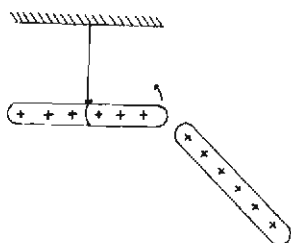


Fig. 8.6 Force of repulsion

An ebonite rod rubbed with fur is suspended from a thread and another ebonite rod rubbed with fur is brought near it. The two rods repel each other (fig. 8.7).

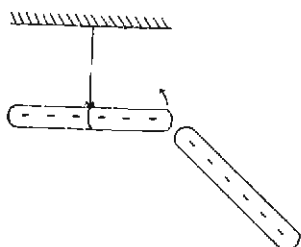


Fig. 8.7 Force of repulsion

A glass rod rubbed with silk is suspended by a piece of thread and an ebonite rod rubbed with fur is brought near it. It is found that the two rods attract each other (fig. 8.8).

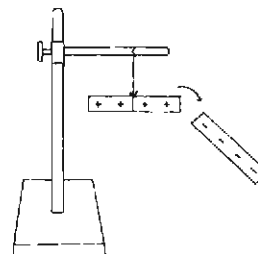


Fig. 8.8 Force of attraction

From the above experiments, it is clear that when a glass rod is rubbed with silk, some electrons in the outer most orbit of glass atoms get transferred to silk, thereby glass attains positive charge and the silk attains the negative charge.

In a similar way ebonite gains electrons when rubbed with fur and hence it becomes negatively charged. The fur becomes positively charged. Thus, there are two kinds of charges in nature. They are *the positive and negative charges*.

8.2.1 Force between two charges

From the above experiments, it is clear that the force between two like charges is repulsive and the force between the two unlike charges is attractive (fig. 8.9).

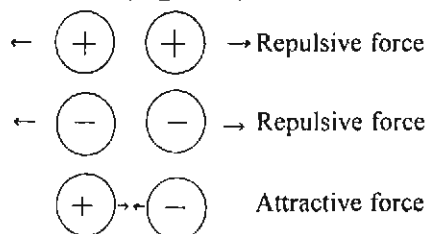


Fig. 8.9 Forces between charges

This electrostatic force between a proton and another proton will be repulsive because they are the positively charged particles. The force between an electron and another electron will be repulsive because they are the negatively charged particles. The force between an electron and a proton will be attractive.

The unit of charge is coulomb (C).
 The charge of an electron = $-e$
 $= -1.602 \times 10^{-19} \text{ C}$.
 The charge of a proton = $+e$
 $= +1.602 \times 10^{-19} \text{ C}$

Nuclear force

The force which overcomes the electrical force of repulsion between the protons and binds the protons and neutrons (which are called nucleons) inside the nucleus is called the nuclear force. Nuclear force is an attractive force.

Nuclear forces are not electrostatic forces and hence are charge independent. This force may be produced between protons or between protons and neutrons or between neutrons. It is very strong between two nucleons which are 10^{-15} metre apart.

8.3 Charging of bodies

Bodies can be charged by different methods. Some of them are

- 1) Charging by friction
- 2) Charging by contact and
- 3) Charging by induction.

8.3.1 Charging by friction

When a polythene strip is rubbed on wool, some of the outer electrons are transferred from the wool to the polythene. This means that the polythene has an extra number of electrons and hence it becomes negatively charged. The wool is positively charged.

This method is called ***charging by friction***.

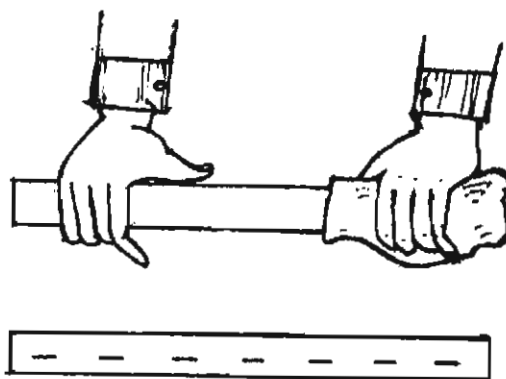


Fig. 8.10 Charging by friction

8.3.2 Charging by contact

Conduction is the process by which charges of same nature are passed on from a charged body to another by actual contact between two bodies.

Consider an ebonite rod rubbed with fur. The ebonite rod attains the negative charges. If this rod is made to touch an uncharged and insulated metal sphere, the charges flow to the sphere (fig. 8.11).

This method of charging an object by contact with a charged body is called '***conduction***'

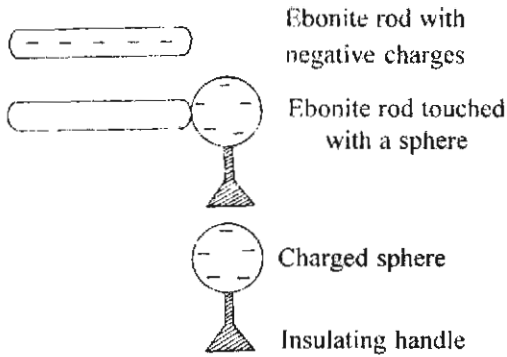


Fig. 8.11 Charging of a spherical conductor by contact

Activity 8.3

Inflate a rubber balloon. Rub it against a woollen cloth. Place the balloon near gentle stream of water from a tap. What do you observe?

The charged balloon will be attracted towards the stream of water (fig. 8.12).

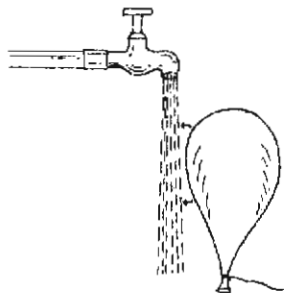


Fig. 8.12 Charged balloon attracted towards the stream of water

8.3.3 Charging by induction

Let a positive charge A be brought near an insulated conductor BC. The end B will be found negatively charged and the end C positively charged. If A is removed, the charges at B and C disappear. Thus the charging of BC is temporary.

Keeping A in the position, the end C is earthed as shown in the figure

8.13. The electrons from the earth will flow into the conductor C. So the positive charges at C are removed. On removing A, BC will be found negatively charged. Now the conductor BC is permanently charged.

These methods of charging are known as charging by *induction*.

‘The phenomenon of producing induced charges without making any contact with another charge is called electrostatic induction’.

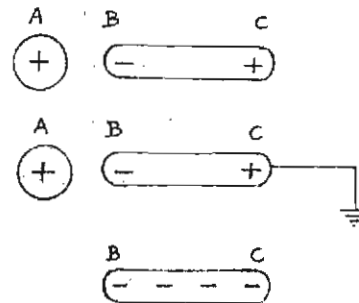


Fig. 8.13 Charging by induction

8.4 Charging and discharging of clouds

Before studying about charging and discharging of clouds, let us see the phenomenon of ‘action of points’

Surface charge density

If charges are given to a conical conductor as shown in the diagram, the charges accumulate at the pointed end.

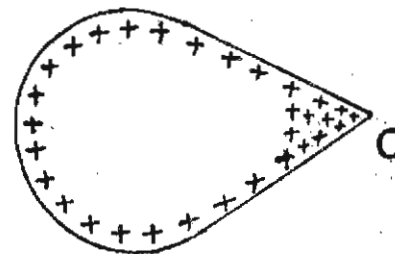


Fig.8.14 Accumulation of charges at the sharp point

Surface charge density is the charge per unit area. As a general rule, the greater the curvature at any point, greater is the surface charge density. Thus the charges have a tendency to accumulate at the sharp points of the conical conductor.

Action of points

Consider a conductor as shown in the figure 8.14. If positive charges are given to this conductor, the surface charge density is maximum at C. Therefore, the concentration of charge is maximum at the sharp point C. The air molecules, which come near the sharp point, get ionized. The positive ions are repelled and the sharp point attracts the negative ions. Thus, the charges on the sharp points get reduced.

The leakage of electric charges from the sharp points of a charged conductor is called 'action of points'.

8.4.1 Lightning conductor

During violent storms, we know that the lightning occurs due to the electrical discharge between the charged surfaces of the same cloud or between two clouds.

Benjamin Franklin discovered that the electric charges escape readily from sharp points. He applied his discovery to the invention of the lightning rod.

Working of a lightning conductor

Lightning conductor consists of grounded metal rod with sharp edges at top. When a positively charged cloud

approaches the lightning conductor, it induces negative charges on the sharp points of the lightning rod. The negative charges are leaked out into the air from the sharp points due to the action of points principle. These negative charges neutralise the positive charges on the cloud. Thus lightning flash is averted (fig. 8.15).

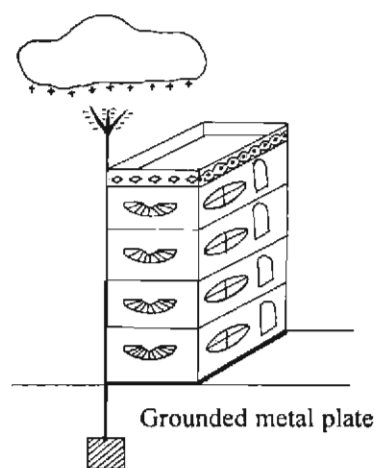


Fig. 8.15 Lightning conductor

If the flash is not prevented in this way, it will pass to the earth through the lightning conductor, which offers least resistance to it. Thus the lightning rods protect high-rise buildings from the lightning strokes.

Protection from lightning

For protection from a lightning, drop to your knees, bend forward placing your hands on your knees but not on the ground or stoop down to the ground.

8.5 Simple electroscope

An electroscope is an instrument for detecting the presence, nature and quantity of electric charge.

Construction

It consists of two thin gold leaves hanging from a brass rod. The other end of the brass rod is fitted to a metal disc D with a spherical knob.

The brass rod passes through a rubber cork fitted to the neck of a glass bell jar. A small cup containing calcium chloride soaked in sulphuric acid is placed to keep the air dry inside the jar (fig. 8.16).

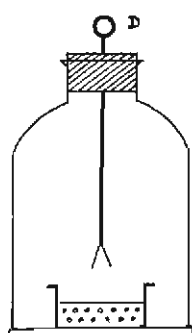


Fig. 8.16 A simple electroscope

Working

1. To test whether a body is charged or not

To find out whether the given body is charged or not, allow it to touch the spherical knob of the electroscope. If the leaves diverge, then the body is a charged one and if they do not diverge, the body has no charge.

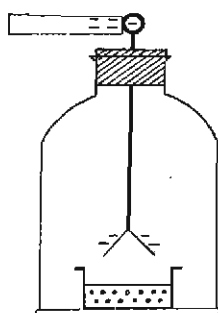


Fig. 8.17 Testing of charged and uncharged bodies

2. To test the nature of the charge on a given body

It is necessary to charge the electroscope either positively or negatively in order to detect the nature of charge on a given body. Let us consider a positively charged electroscope. Bring the given body in contact with the spherical knob of the electroscope. If the leaves diverge to a larger extent, the body has positive charge and if the divergence decreases, the body has a negative charge.

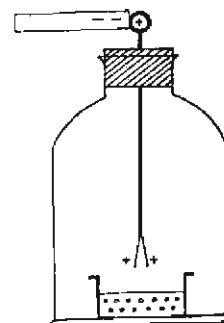
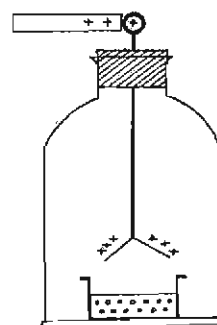
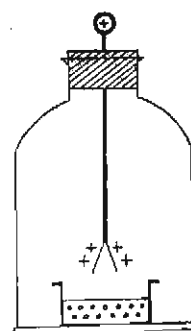


Fig. 8.18 Testing of charges using the electroscope

SELF EVALUATION

I. Choose the correct answer

1. A glass rod rubbed with _____ acquires positive charges.
i) wool ii) metal iii) silk iv) cotton.
2. A neutron is a _____ particle.
i) positively charged ii) negatively charged
iii) neutral iv) positively and negatively charged.
3. The material which do not conduct electric charges is _____.
i) graphite ii) copper iii) silver iv) mica.
4. Charges escape readily from _____.
i) blunt edges ii) sharp edges
iii) spherical conductors iv) circular edges
5. Lightning conductor was first constructed by _____.
i) Edison ii) Newton iii) Volta iv) Franklin.

II. Fill in the blanks

6. An ebonite rod rubbed with fur gets _____ charges.
7. Conductors are materials in which _____ move quite freely.
8. Force between two like charges is _____.
9. _____ is an instrument used for detecting electric charges.
10. Surface charge density is the charge per _____

III. Match the following

- | | | |
|---------------------------|---|----------------------|
| 11. Insulator | — | action of points |
| 12. Lightning conductor | — | negative |
| 13. Electroscope | — | ebonite |
| 14. Unlike charges | — | detection of charges |
| 15. Charge of an electron | — | attract. |

IV. Give short answers

16. What is electrostatics?
17. What are conductors? Give two examples.
18. What are insulators? Give two examples.
19. Name the types of electric charges.
20. Why atoms of matter are electrically neutral?

21. Name the methods by which a body can be electrically charged?
22. Explain charging by friction with an example?
23. What is electrostatic induction?
24. What is meant by action of points?
25. What is an electroscope?

V. Give detailed answers

26. Explain 'charging of bodies' with few examples.
27. Explain how charges are induced in bodies.
28. Explain the phenomenon of action points.
29. Explain the working of a lightning conductor.
30. Explain the construction and working of an electroscope.

Problems

1. If a neutral oxygen atom has 8 electrons in it, how many protons does it contain ? (8)
2. An object A repels the object B. B attracts the object C and C repels the object D. If the object D is positively charged, what kind of charge is present on the object A ? (Negative)
3. A carbon nucleus has 6 protons and 6 neutrons. What is the total charge of the carbon nucleus ? (+6e)

Think over it

1. Can we say a neutral body contains no charged particles?
2. Can we get negative charges without producing equal amount of positive charges?
3. If the positive charges become negative and the negative charges become positive, will the force between them change?
4. There are two charged particles A and B. Will there be a force on A or B or on both?
5. Two particles have unequal charges. Will the force on each particle same or different?
6. Tall buildings made of concrete and steel are frequently struck by lightning without any damage. Can you explain why this happens?

9. Levels of Organization

Plants and animals are living organisms. They vary in their shape, size and structure. They have certain common characteristics. They grow and reproduce. *Chlamydomonas* and *Amoeba* are unicellular organisms. Respiration, digestion and excretion are some of the metabolic activities. All these activities are performed by the single cell. There is no division of labour.

In multicellular organisms a group of cells perform single function. Lungs perform respiration and kidneys perform the function of excretion. Leaves perform the function of photosynthesis. Thus there is division of labour in higher plants and animals.

In the living pattern of unicellular organism to multicellular organism, there is gradual increase in complexity.

9.1 Cellular level of organization

Chlamydomonas and *Amoeba* are made up of only one cell. All the metabolic activities like digestion, respiration are carried out by the single cell itself. These animals and plants are called unicellular organisms.

9.1.1 Cell as the basic fundamental unit of life

All the living organisms, even though vary in their size, shape and structure are made up of living units called cells. Thus the cell is the basic unit of organism.

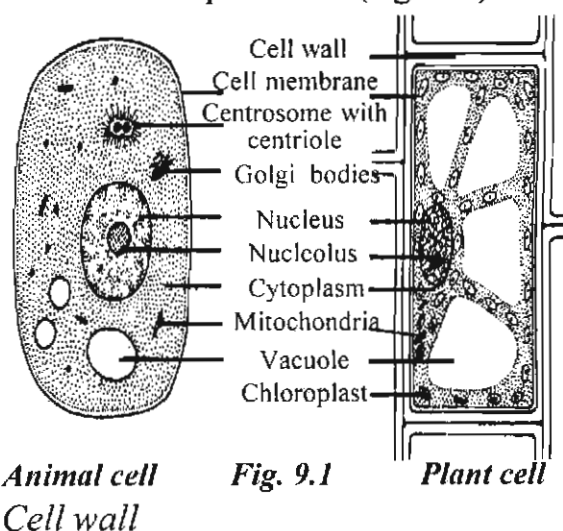
Cell may be defined as the structural and functional unit of a living organism.

9.1.2 Different types of cells

All living organisms are made up of different types of cells. They are differentiated according to their structure, position and function. The plant is made up of cells like parenchyma, collenchyma and sclerenchyma. Like wise, animals are also made up of cells like nerve cells, muscle cells, blood cells, epithelial cells and reproductive cells.

9.1.3 Organization of an animal cell and a plant cell

The cell consists of the parts like cell wall, plasma membrane, cytoplasm and its organelles and nucleus. Let us discuss in detail the structure of an animal and a plant cell (fig. 9.1).



Animal cell
Cell wall

Fig. 9.1

Plant cell

This is the outermost covering of the plant cell. It is made up of cellulose. The cell wall provides shape to the cell.