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2020 QR GUIDE

PREFACE

This book is developed in a holistic approach which inculcates comprehending and analytical skills. It will be helpfull for the students to understand higher secondary science in a better way and to prepare for competitive exams in future. This textbook is designed in a learner centric way to trigger the thought process of students through activities and to make them excel in learning science.

HOW TO USE THE BOOK

- This Science Textbook for eighth standard has 23 units.
- Each unit has simple activities that can be demonstrated by the teacher and also few group activities for the students to do under the guidance of the teacher.
- Infographics and info-bits are added to enrich the learner's scientific perception.
- The `Do you know?´ and `More to know´ placed in the units will be an eye opener.
- Glossary has been introduced to learn scientific terms.
- ICT corner and QR code are introduced in each unit for the digital native generation.

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QR GUIDE

UNIT 1

MEASUREMENT

Learning Objectives

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After the completion of this lesson, students will be able to:

- understand fundamental quantities and units.
- explain the system of units and measurements.
- analyse the different system of units.
- know about temperature, amount of substance, electric current and luminous intensity.
- explore the knowledge of accuracy in measurements.
- differentiate plane angle and solid angle.
- solve problems related to measurement.

Introduction

Physics is the study of nature and natural phenomena. Physics is considered as the base of all science subjects. It is based on experimental observations. The principles and observations allow us to develop a deeper understanding of nature. Scientific theories are valid, only if they are confirmed through various experiments. Theories in physics use many physical quantities that have to be measured.

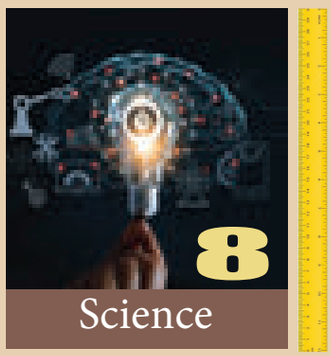
Measurement is the base of all scientific studies and experimentations. It plays a vital role in our daily life. It is the process of finding an unknown physical quantity by using a standard quantity. In this lesson, we will study about measurement in detail. We will also study about accuracy and precision, approximation and rounding off.

1.1 Unit Systems

We need three things for a perfect measurement. They are: an instrument, a standard quantity and an acceptable unit.

Activity 1

Measure the length and breadth of your science book using a ruler (scale) and compare your value with those of your friends.



Let us say that the length of the book be 30 cm. Here, the length is the physical quantity, ruler is the instrument, 30 is the magnitude and 'cm' is the unit. This process is called measurement.

In the above activity the values of all the students will not be same. Similarly, people in various parts of the world are using different systems of units for measurement. Some common systems of units are as follows.

1. FPS System (Foot for length, Pound for mass and Second for time)

2. CGS System (Centimetre for length, Gram for mass and Second for time)
3. MKS System (Meter for length, Kilogram for mass and Second for time)

DO YOU KNOW?

The 'CGS', 'MKS' and SI units are metric systems of units and 'FPS' is not a metric system. It is a British system of units.

1.2 International System of Units

In earlier days, scientists performed their experiments and recorded their results in their own system. Due to lack of communication, they couldn't organise experimental results of others. So, they planned to follow a uniform system for taking the measurements.

As you studied in the lower classes, in 1960, in the 11th General Conference on Weights and Measures at Paris in France, scientists recognised the need of using standard units for physical quantities. That was called as 'International System of Units' and is popularly known as SI System (abbreviated from the French name 'Systeme International'). Scientists, chose seven physical quantities as 'Base Quantities' and defined a 'Standard Unit' to measure each one. They are known as Base Units or Fundamental Units (Table 1.1)

Table: 1.1 Base Quantities and Units

Quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric Current	ampere	A
Amount of Substance	mole	mol
Luminous Intensity	candela	cd

You have already studied about length, mass and time in your lower classes. Now you are going to study about the other base quantities such as temperature, current, amount of substance and luminous intensity.

DO YOU KNOW?

In December, 1998, the National Aeronautics and Space Administration (NASA), USA, launched the Mars Climate Orbiter to collect data about the Martian climate. Nine months later, on September 23, 1999, the Orbiter disappeared while approaching Mars at an unexpectedly low altitude. An investigation revealed that the orbital calculations were incorrect due to an error in the transfer of information between the spacecraft's team in Colorado and the mission navigation team in California. One team was using the English FPS system of units for calculation, while the other team was using the MKS system of units. This misunderstanding caused a loss of 125 million dollars approximately.

1.2.1 Temperature

Identify, which of the following objects are hot and which of them are cold?

Figure 1.1 Hot and Cold Objects

We see a number of objects in our daily life. Some of them are cold and some of them are hot.

Some times we may say that two objects are equally hot or cold. But, there will be some difference in their hotness or coldness. How do you decide, which is hotter and which is colder? You need a reliable quantity to decide the degree of hotness or coldness of an object. That quantity is 'temperature'.

Temperature is a physical quantity that expresses the degree of hotness or coldness of a substance. Heat energy given to a substance will increase its temperature. Heat energy removed from a substance will lower its temperature.

Temperature is defined as a measure of the average kinetic energy of the particles in a system. The SI unit of temperature is kelvin. Thermometers are used to measure the temperature directly. Usually, thermometers are calibrated with some standard scales. Celsius, Fahrenheit, Kelvin are the most commonly used scales to measure temperature.

Activity 2

From the news paper or television, collect the highest and lowest temperature experienced in your nearest town or city for a week and record the values in a tabular column. Does this data remain same throughout the year?

1.2.2 Electric Current (I)

Flow of electric charges, in a particular direction is known as 'electric current'. The magnitude of electric current is the amount of electric charges flowing through a conductor in one second.

$$\text{Electric current} = \frac{\text{Amount of electric charge}}{\text{time}}$$

$$I = \frac{Q}{t}$$

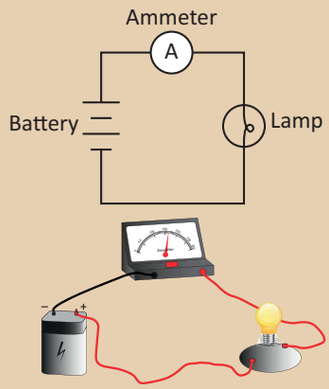
Electric charge is measured in coulumb. The SI unit of electric current is *ampere* and it is denoted as A.

If one coulomb of charge is flowing through a conductor in one second, then, the amount of current flowing is said to be one ampere. Ammeter is the device used to measure 'electric current' (Fig 1.2).

Figure 1.2 Ammeter

Activity 3

Connect a battery, an ammeter and a lamp in series as shown in the figure. Note the ammeter reading. It is the amount of current flowing in the circuit.



Problem 1

If 2 coulomb of charge flows through a circuit for 10 seconds, calculate the current.

Solution

Charge (Q) = 2 C; Time (t) = 10 s

$$I = \frac{Q}{t} = \frac{2}{10} = 0.2 \text{ A}$$

1.2.3 Amount of Substance

Amount of substance is a measure of the number of entities (particles) present in a substance. The entity may be an atom, molecule, ion, electron or proton etc.

M6M2GC

Generally, the amount of substance is directly proportional to the number of atoms or molecules.

Can you count the number of copper coins in the picture? We can count them easily. But, can you count the number of copper atoms in a coin? It is very difficult to count the number of atoms because they are not visible. The number of atoms or molecules in a substance is measured in mole. It is a SI uinit.

Figure 1.3 Copper coins

Mole is defined as the amount of substance, which contains 6.023×10^{23} entities. It is denoted as 'mol'.

More to Know

The number 6.023×10^{23} is also known as Avogadro Number.

1.2.4 Luminous Intensity

Figure 1.4 Photometer in day to day life

Have you seen these scenes on the television? What is the umpire doing? He is checking the intensity of light by using an instrument. The measure of the power of the emitted light, by a light source in a particular direction, per unit solid angle is called as luminous intensity. The SI unit of luminous intensity is candela and is denoted as 'cd'.

The light emitted from a common wax candle is approximately equal to one candela. Luminous intensity is measured by 'photometer' (Luminous Intensity Meter) which gives the luminous intensity in terms of candela directly.

Figure 1.5 Photometer

Info bits

Luminous flux or Luminous power is the measure of the perceived power of light. Its SI unit is 'lumen'.

One lumen is defined as the luminous flux of the light produced by the light source that emits one candela of luminous intensity over a solid angle of one steradian.

Apart from the seven fundamental units, we have two more units known as derived units, we will study about them now.

1.2.5 Plane angle

Plane angle is the angle made at the intersection of two straight lines or intersection of two planes. The SI unit of plane angle is 'radian' and is denoted as 'rad'.

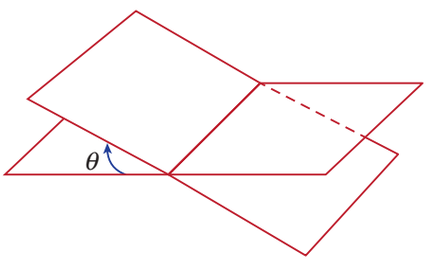


Figure 1.6 Plane angle

Radian is the angle subtended at the centre of a circle by an arc whose length is equal to the radius of the circle (Fig 1.7).

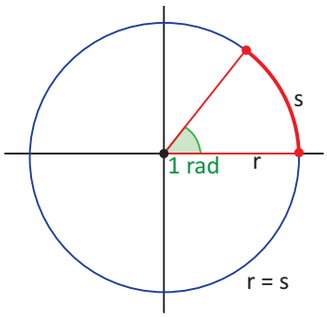


Figure 1.7 Radian

π radian = 180°

$$1 \text{ radian} = \frac{180^\circ}{\pi}$$

Problem 2

Convert 60° into radian.

Solution

We know that,

$$1^\circ = \frac{\pi}{180}$$

$$60^\circ = \frac{\pi}{\cancel{180}_{3}} \times \cancel{60} = \frac{\pi}{3} \text{ radian}$$

Problem 3

Convert $\frac{\pi}{4}$ into degrees.

Solution

We know that,

π radian = 180°

$$\frac{\pi}{4} \text{ radian} = \frac{180}{4} = 45^\circ$$

1.2.6 Solid angle

Solid angle is the angle formed by three or more planes intersecting at a common point. It can also be defined as 'angle formed at the vertex of the cone'. The SI unit of solid angle is 'steradian' and is denoted as 'sr'.

Steradian is the solid angle at the centre of a sphere subtended by a portion whose surface area is equal to the square of the radius of the sphere.

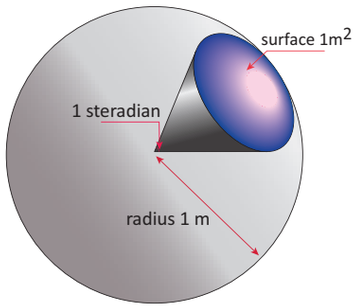


Figure 1.8 Steradian

DO YOU KNOW?

Until 1995, plane angle and solid angle were classified under supplementary quantities. In 1995, they were shifted to derived quantities.

Table 1.2 Difference between plane angle and solid angle

Plane Angle	Solid Angle
It is the angle made at the point of intersection of two lines or planes.	It is the angle by the intersection of three or more planes at a common point.
It is two dimensional.	It is three dimensional.
Its unit is radian.	Its unit is steradian.

1.3 Clocks

Clocks are used to measure time intervals. So many clocks are being used from the ancient time. Scientists have modified the mechanism of the clocks everytime to obtain accuracy.

1.3.1 Types of clock based on display

There are two types of clocks based on display. They are:

1. Analog clocks
2. Digital clocks

1. Analog clocks

Analog clocks look like a classic clock. It has three hands to show the time.

Hours hand

It is short and thick. It shows 'hour'.

Minutes hand

It is long and thin. It shows 'minute'.

Seconds hand

It is long and very thin. It shows 'second'. It makes one rotation in one minute and 60 rotations in one hour.

Analog clocks can be driven either mechanically or electronically.

Figure 1.9 Analog clock

Activity 4

Make a model of an analog clock using card board.

2. Digital clocks

A **digital clock** displays the time directly. It shows the time in numerals or other symbols. It may have 12 hours or 24 hours display. Recent clocks are showing date, day, month, year, temperature etc. Digital clocks are often called as electronic clocks.

Figure 1.10 Digital clock

Activity 5

Make a model of a digital clock using match sticks on a card board, with date and time.

1.3.2 Types of clock based on working mechanism

There are different types of clocks based on working mechanism.They are:

1. Quartz clock
2. Atomic clock

1. Quartz clock

These clocks are activated by 'electronic oscillations', which are controlled by a 'quartz crystal'. The frequency of a vibrating crystal is very precise. So, quartz clock is more accurate than mechanical clock. These clocks have an accuracy of one second in every 10^9 seconds.

Figure 1.11 Quartz clock

2. Atomic clock

These clocks make use of periodic vibrations occurring within the atom. These clocks have an accuracy of one second in every 10^{13} seconds. Atomic clocks are used in Global Positioning System (GPS), Global Navigation Satellite System (GLONASS) and International Time Distribution Services.

BYUQV4

Figure 1.12 Atomic clock

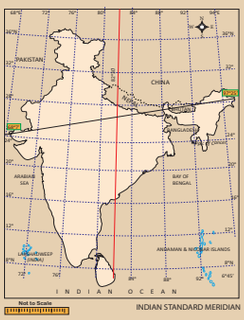
Activity 6

You may have heard about the 'Sun Dial'. Construct a sundial of your own and read out the values from morning to evening. Compare your values with modern clocks.

DO YOU KNOW?

Greenwich Mean Time (GMT) is the mean solar time at the Royal Observatory, located at Greenwich in London. It is measured at the longitude of zero degree. The Earth is divided into 24 zones, each of a width of 15 degree longitude. These regions are called as 'Time Zones'. Time difference between two adjacent time zones is 1 hour.

Indian Standard Time (IST)



The location of Mirzapur in Uttar Pradesh is taken as the reference longitude of the Indian Standard Time. It is located at 82.5 degree longitude.

IST = GMT + 5:30 hours

1.4 Accuracy in Measurements

We have seen that measurement is the base of all experiments in science and technology. The value of every measurement contains some uncertainty. These uncertainties are called as 'errors'. Error is defined as the difference between the real value and the observed value.

While taking measurements, errors should be minimum and the measured values should be precise and accurate. Both precision and accuracy may seen to be same. But, they are not similar.

Look at the arrows shot by three persons (Fig. 1.13). In the first image all the arrows are hit at the centre. In the second image, all the arrows are hit at the same place but not at the centre. It shows that first person is precise and accurate. The second person is precious but not accurate. But, the third person is neither precise nor accurate.

Accuracy is the closeness of a measured value to the actual value or true value. Precision is the closeness of two or more measurements to each other. While making measurements, accuracy is always desired. The measured value should be close to the true value.

NVGKJZ

1.5 Approximation

While we prepare a dish, we choose the ingredients approximately. We do not measure them accurately always. Similarly, it is not possible to set the exact value while taking measurements. Sometimes we take the approximate value. Approximation is the process of finding a number, which is

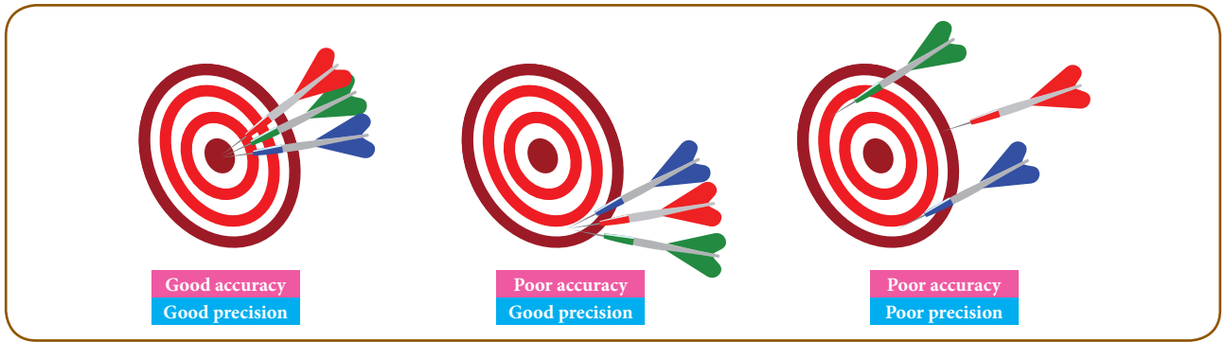


Figure 1.13 Accuracy and Precision

acceptably close to the exact value of the measurement of a physical quantity. It is an estimation of a number obtained by rounding off a number to its nearest place value.

When the data are inadequate, physicists are in need of an approximation to find the solution for problems. Approximations are usually based on certain assumptions having a scientific background and they can be modified whenever accuracy is needed.

Activity 7

Calculate the approximate 'heart beat' of a man in a day (Hint: Take number of heart beats per minute as 75, approximately).

1.6 Rounding off

Calculators are widely used in day to day life to do the calculations. The result given by a calculator has too many digits. Hence, the result containing more digits should be rounded off. The technique of rounding off is used in many areas of physics.

1.6.1 Rules for rounding off

- Decide which is the last digit to keep.
- Leave it the same, if the next digit is less than 5.
- Increase it by one, if the next digit is 5 or greater than 5.

Problem 4

Round off the number 1.864 to two decimal places.

Solution

We need to round off the number to two decimal places. So, the last digit to be kept is 6. Since the next digit is less than 5, we can retain 6 as it is. So the answer is 1.86.

Problem 5

Round off the number 1.868 to two decimal places.

Solution

We need to round off the number to two decimal places. So, the last digit to be kept is 6. Since the next digit is more than 5, we should increase the second digit by one. So, the answer is 1.87.

Points to Remember

- The need of standard units for physical quantities was recognised in the 11th General Conference on Weights and Measures in 1960.
- Length, mass, time, temperature, electric current, amount of substance and luminous intensity are called base quantities.
- Temperature is the measure of hotness or coldness of a substance. Its SI unit is *kelvin*.
- Electric charge is measured in coulumb and electric currect is measured in ampere.
- The SI unit of amount of substance is mole.
- Luminous intensity is measured in candela.
- Quartz clock uses the 'electronic oscillations' controlled by a 'quartz crystal'.
- Atomic clock uses the 'periodic vibrations occurring within the atom'.
- Accuracy is the closeness of a measured value to the actual value.
- Precision is the closeness of two or more measurements to each other.
- Approximation is the process of finding the solution by means of 'estimation'.

GLOSSARY

Amount of substance	Measure of number of entities (particles) present in a substance.
Calibration	Process of configuring an instrument in a particular range.
Electric current	Flow of electric charges (electrons) in a unit time.
Electronic Oscillation	Oscillations produced by an electronic circuit.
Luminous Intensity	Amount of light emitted by a light source in a particular direction per unit time.
Plane angle	Angle made at the point of intersection of two lines or planes.
Quartz Crystal	Crystal formed by Silicon and Oxygen (SiO_2).
Solid angle	Angle made at the point of intersection of three or more planes.

DNP9YR

TEXTBOOK EXERCISES

I. Choose the best answer.

1. Which one the following systems of unit is the British System of unit?
   a) CGS b) MKS c) FPS d) SI
2. Electric current is a _____quantity
   a) base b) supplementary
   c) derived d) professional
3. SI unit of temperature is _____
   a) celsius b) fahrenheit
   c) kelvin d) ampere
4. Luminous intensity is the intensity of _____
   a) laser light b) UV light
   c) visible light d) IR light
5. Closeness of two or more measured values is called as _____
   a) accuracy b) precision
   c) error d) approximation
6. Which one of the following statement is wrong?
   a) Approximation gives accurate value.
   b) Approximation simplifies the calculation.
   c) Approximation is very useful when little information is available.
   d) Approximation gives the nearest value only.

II. Fill in the blanks.

1. The solid angle is measured in _____.
2. The coldness or hotness of a substance is expressed by _____.
3. _____ is used to measure electric current.
4. One mole of a substance contains _____ atoms or molecules.
5. The uncertainty in measurement is called as _____.
6. The closeness of the measured value to the original value is _____.
7. The intersection of two straight lines gives us _____.

III. State true or false. If false, correct the statement.

1. Temperature is a measure of total kinetic energy of the particles in a system.
2. If one coulomb of charge is flowing in one minute, it is called 'ampere'.
3. Amount of substance gives the number of particles present in a substance.
4. Intensity of light coming from a candle is approximately equal to one 'candela'.
5. Quartz clocks are used in GPS devices.

6. Angle formed at the top of a cone is an example for 'plane angle'.
7. The number 4.582 can be rounded off as 4.58.

IV. Match the following.

Temperature	Closeness to the actual value
Plane angle	Measure of hotness or coldness
Solid angle	Closeness to two or more measurements
Accuracy	Angle formed by the intersection of three or more planes
Precision	Angle formed by the intersection of two planes

V. Consider the statements given below and choose the correct option.

1. **Assertion:** The SI system of units is the suitable system for measurements.
   Reason: The SI unit of temperature is kelvin.
2. **Assertion:** Electric current, amount of substance, luminous intensity are the fundamental physical quantities.
   Reason: They are independent of each other.
3. **Assertion:** Radian is the unit of solid angle.
   Reason: One radian is the angle subtended at the centre of a circle by an arc of length equal to its radius.
   a. Both assertion and reason are true and reason is the correct explanation of the assertion.
   b. Both assertion and reason are true but reason is not the correct explanation of the assertion.
   c. Assertion is true, but reason is false.
   d. Both assertion and reason are false.

VI. Answer very briefly.

1. How many base quantities are included in SI system?
2. Give the name of the instrument used for the measurement of temperature.
3. What is the SI unit of luminous intensity?
4. What type of oscillations are used in atomic clocks?
5. Mention the types of clocks based on their display.
6. How many times will the 'minute hand' rotate in one hour?
7. How many hours are there in a minute?

VII. Answer briefly.

1. What is measurement?
2. Name the three scales of temperature.
3. Define - Ampere.
4. What is electric current?
5. What do you mean by luminous intensity?
6. Define - Mole.
7. What are the differences between plane angle and solid angle?

VIII. Answer in detail.

1. List out the base quantities with their units.
2. Write a short note on different types of clocks.

IX. Higher Order Thinking Question.

1. Your friend was absent to school yesterday. You are enquiring about his absence. He told that he had fever and it was measured to be 100°C. Is it possible to have 100°C fever? If he is wrong, try to make him understand.

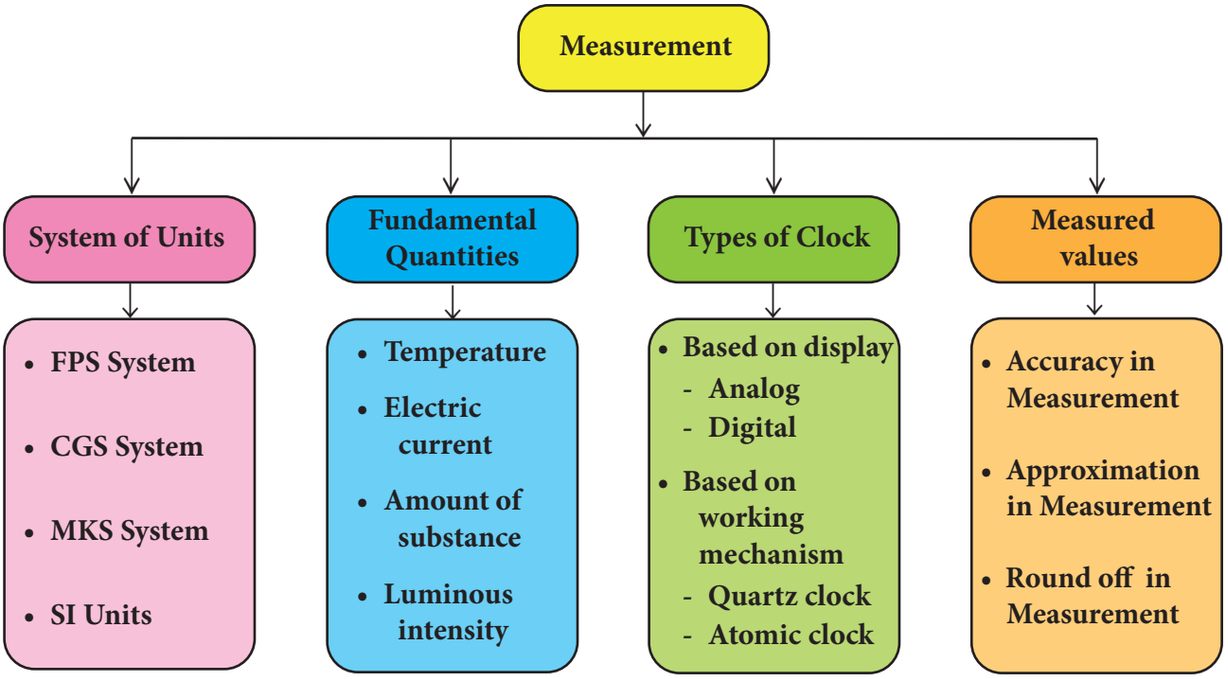
REFERENCE BOOK

1. Units and Measurements – John Richards, S. Chand publishing, Ram nagar, New Delhi.

INTERNET RESOURCES

1. http://www.npl.co.uk/reference/measurement-units/
2. http://www.splung.com/content/sid/1/page/units

Concept Map



ICT CORNER

Measurement

This activity enables the students to learn about the various types of Time keeping devices

Steps

- Open the Browser and type URL link given below (or) Scan the QR Code.
- Click and select the "History of time keeping devices"
- Options will be given. Select any content (Eg) Digital clock
- It gives clear understanding of the "History of time keeping devices"

Web link: https://playablo.com/Blog/5-fun-activities-to-teach-temperature-hot-and-cold-to-preschoolers/ https://en.wikipedia.org/wiki/History_of_timekeeping_devices

(or) scan the QR Code

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*Pictures are indicative only

UNIT 2

FORCE AND PRESSURE

Learning Objectives

QKB4NM

After the completion of this lesson, students will be able to:

- understand the concept of force and its effects.
- differentiate thrust and pressure.
- understand the characteristics of atmospheric and liquid pressure.
- apply pascal's law in day to day life.
- understand the applications of surface tension and viscosity.
- analyse friction in rest and motion.
- know about the ways of increasing and decreasing friction.
- solve numerical problems related to force and pressure.

Introduction

We see many objects in our daily life. Some of them are moving and some of them are at rest. A ball at rest, moves when it is kicked. Similarly when we push or pull objects which are at rest, they begin to move. This push or pull is called force. A force acting in a particular area, produces pressure. For example when we fasten a nail on the wall, pressure is exerted. Not only solids, gases and liquids also exert pressure. Pressure exerted by liquids and gases finds application in different fields. Hydraulic lift and hydraulic break are working due to liquid pressure. In this lesson you will study about force and pressure. You will also study about surface tension viscosity and friction.

2.1 Force

We do so many activities in our daily life like, opening a door, kicking a football, striking a carrom coin etc., To do these activities an external agency is needed. This external agency is called force. Force can either set an object at rest into motion or bring a moving object to rest. It can even change the shape and size of certain objects.

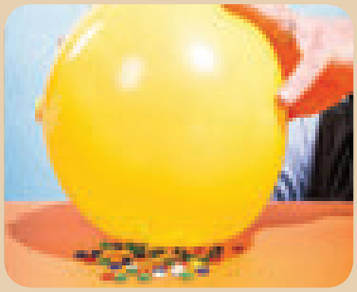
Force is defined as an external agency which changes or tends to change the state of rest or the state of uniform motion of a body or the direction of a moving body or the shape of a body. Force is a vector quantity, which has magnitude and direction. It is measured by a unit called 'newton' (N).

2.1.1 Effects of Force

Observe the strokes a batsman in cricket game. If he wants to hit the cricket ball to the boundary, the striking force on the ball must be greater. So, the greater the force you apply on a body, greater will be its effect on it.

Activity 1

Fix a matrix of sharp pins on a wooden board in rows and columns. Take a big blown up balloon. Place it gently over the pins and place a small book on the top of the balloon. Will the balloon burst? Will the pins prick the balloon?



If you prick a blown up balloon with a single pin it will burst. But, this did not happen even though many more pins were pricking the balloon. A single pin produces a large pressure over a small area. But, when large number of pins prick a body, each pin exerts very little pressure on the balloon, as the applied force gets distributed over a large surface of the body. So, the balloon will not burst.

Thus, we can conclude that the effect of a force depends on the magnitude of the force and the area over which it acts. The force acting perpendicularly on any given surface area of a body is known as thrust. It is measured by the unit newton.

2.2 Pressure

The effect of force can be measured using a physical quantity called pressure. It can be defined as the amount of force or thrust acting perpendicularly on a surface of area of one square meter of a body.

$$\text{Pressure} = \frac{\text{Thrust (or) Force}}{\text{Area}} \quad \text{ie., } P = \frac{F}{A}$$

The SI unit of pressure is pascal (named after the French scientist Blaise Pascal).

1 pascal = 1 Nm^{-2}

Pressure exerted by a force depends on the magnitude of the force and the area of contact.

Problem 1

The average weight of an elephant is 4000 N. The surface area of the sole of its foot is 0.1m^2. Calculate the pressure exerted by one foot of an elephant.

Solution

Average weight of the elephant = 4000 N

Weight of one leg = Force exerted by one leg
= 4000/4 = 1000 N

Area of the sole of one foot = 0.1 m^2

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$= \frac{1000}{0.1} = 10000 \ \frac{N}{m^2} = 10^4 \ Nm^{-2}$$

Pressure exerted by one leg of the elephant is 10,000 newton on one square metre.

The effect of pressure can be increased by increasing the thrust or by decreasing the surface area of the body. The axe, nail, knife, injection needle, bullet etc., are having sharp fine edges so as to exert a larger pressure on a smaller area of the body in order to produce maximum effect.

Examples

1. More number of wheels are provided for a heavy goods-carrier for decreasing the pressure thereby increasing the area of contact on the road.
2. Broader straps are provided on a back-pack for giving less pressure on the shoulders by providing a larger area of contact with the shoulder.

Figure 2.1 Bags with broader straps

It is very difficult for us to walk on sand. But, camels can walk easily on it because they have large padded feet, which increase the area of contact with the sandy ground. This reduces the pressure and enables them to walk easily on the sand.

2.3 Pressure exerted by Air

You all know very well that air fills the space around us. This envelope of air is called as atmosphere. It extends upto many kilometres above the surface of the Earth. All objects on the surface of the Earth experience the thrust or force due to this atmosphere.

The amount of force or weight of the atmospheric air that acts downward on unit surface area of the surface of the Earth is known as **atmospheric pressure**. It can be measured using the device called **barometer**. The barometer was invented by **Torricelli**.

Atmospheric pressure decreases with altitude from the surface of the Earth. It can be measured by the height of the mercury column in a barometer. The height of the mercury column denotes the atmospheric pressure at that place at a given time in 'millimetre of mercury'. Even if you tilt the tube at various angles, you will see that the level of mercury will not vary. At sea level, the height of the mercury column is around 76 cm or 760 mm. The pressure exerted by this mercury column is considered as the pressure of magnitude 'one atmosphere' (1 atm).

One atmospheric pressure (1 atm) is defined as the pressure exerted by the mercury column of height 76 cm in the barometer. It is equal to $1.01 \times 10^5 Nm^{-2}$.

In the SI system 1 atm = 1,00,000 pascal (approximately). SI unit of atmospheric pressure is Nm^{-2} or pascal.

More to know

Cooking in a place located at a higher altitude is difficult. Why? At a higher altitude, due to lack of atmospheric pressure the boiling point of a substance reduces. So, water boils even at 80°C. The thermal energy that is produced at this temperature is not sufficient enough for baking or cooking. So, cooking is difficult at higher altitude.

Activity 2

Take a conical flask and a well boiled egg, after removing its shell. Place the egg on the mouth of the flask. It will not enter the flask. Now take a piece of paper. Burn it and drop it inside the flask. Wait for a few seconds to burn fully. Now, keep the egg on the mouth of the flask. Wait for a few minutes. What do you observe?

When the paper is burning in the flask, the oxygen present in the air inside the conical flask is used up for its combustion. This reduces the pressure of the air in the flask. The air in the atmosphere tends to occupy the low pressure region in the flask. So, it rushes through the mouth of the flask, thus pushing the egg into the flask.

2.4 Force and Pressure in Liquids

You would have noticed that an upward force is exerted by water on a floating or a partly submerged body. This upward force is called **buoyant force**. This phenomenon is known as **buoyancy**. This force is not only exerted by liquids, but also by gases.

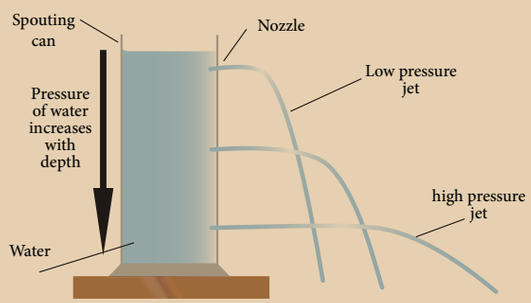
This upward force decides whether an object will sink or float. If the weight of the object is less than the upward force, then the object will float. If not, it will sink.

2.4.1 Pressure exerted by Liquids

Liquids exert a pressure not only on the base of the container/vessel in which they are kept, but also on the side walls. The pressure exerted by a liquid depends on the depth of the point of observation considered in it.

Activity 3

Take a plastic bottle. Punch three holes on its side in the same direction, but at different heights. Now pour some water into it and let it flow through the holes. Observe the flow of water. Water from the lowest hole comes out with the greatest force and the water from the topmost hole comes out with the least force.



This activity confirms that the pressure in a liquid varies with the depth of the point of observation in it.

Activity 4

Take a glass tube that is open at both ends. Fix a rubber balloon at the lower end of the tube. Pour some water into the tube and observe the balloon. Now, pour some more water into the balloon and again observe the balloon. The balloon starts bulging outwards.

This shows that the pressure exerted by a liquid at the bottom of a container depends on the height of the liquid column in it.

Activity 5

Take a plastic bottle. Punch three holes on its sides at the same height from its base. Now, pour some water into it and let it flow through the holes. Observe the flow of the water. Water comes out from all the holes with the same force and falls on the ground/ table, at the same distance from the bottle.

Thus, we can conclude that liquids exert the same pressure in all directions, at a given depth.

DO YOU KNOW?

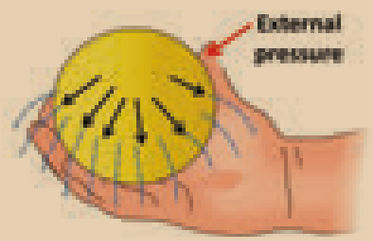
Why dams are made stronger and broader at the bottom than at the top?

Why do scuba divers wear a special suit while they go into deep sea levels?

2.4.2 Pascal's Law

Activity 6

Take a rubber ball and fill it with water. Make tiny holes on its surface with a pin at different points. Press anywhere on the ball. What do you observe?



You can see identical streams of water flowing in all directions from the holes. This is due to the fact that the pressure, which is applied on the liquid, is equally transmitted in all direction. This concept was first given by the French scientist Blasie Pascal.

Pascal's law states that the pressure applied at any point of a liquid at rest, in a closed system, will be distributed equally through all directions of the liquid.

Applications of Pascal's Law

The applications of Pascal's law are:

- In automobile service stations, the vehicles are lifted upward using the hydraulic lift which works as per Pascal's law.
- Automobile brake system works according to Pascal's law.
- The hydraulic press is used to compress the bundles of cotton or cloth so as to occupy less space.

2.5 Surface Tension

Activity 7

Take some water in a beaker and spread a tissue paper on the surface of the water. Gently place the paper clip on the tissue paper. Observe what happens to the paper pin after some time.

After a few moments the tissue paper will submerge and the paper clip will make a small depression on the surface of the water. It will instantly begin to float on the surface, even though it is denser than water.

How is it possible? This is because the water molecules on the surface which tend to contract themselves like the molecules of an elastic membrane. A force exists on them, which tends to minimize the surface area of water. The paper clip is balanced by the molecules on the water surface that is now behaving like a stretched elastic membrane. So, it does not submerge.

Have you ever wondered why rain drops are spherical in nature? How does the water rise upward in a tree or plant against the force of gravity? These are all due to surface tension.

Surface tension is the property of a liquid. The molecules of a liquid experience a force, which contracts the extent of their surface area as much as possible, so as to have the minimum value. The amount of force acting per unit length, on the surface of a liquid is defined as surface tension. Its unit is Nm^{-1}.

2.5.1 Applications of surface tension

Surface tension is the reason for many events we see in our daily life.

- In plants, water molecules rise up due to surface tension. Xylem tissues are very narrow vessels present in plants. Water molecules are absorbed by the roots and these vessels help the water to rise upward due to 'capillarity action', which is caused by the surface tension of water.
- During heavy storm, ships are damaged due surface tension of water. By pouring oil or soap powder into the sea, sailors reduce its impact.
- Water strider insect slides on the water surface easily due to the surface tension of water.

Figure 2.2 Water strider

2.6 Viscous Force or Viscosity

Activity 8

Take a small quantity of different kinds of liquid like coconut oil, honey, water and ghee etc., Place one drop of each liquid on a separate glass plate. Now gently raise one end of the glass plate, so as to allow the liquid to slide down the smooth surface of the plate. Observe the speed of each liquid.

Each liquid moves with a different speed. Water flows faster than other liquids. Coconut oil flows with a moderate speed. Ghee flows very slowly. Between the layers of the liquid, which is in motion, there is a frictional force parallel to the layers of the liquid. This frictional force opposes the motion of the liquid layers while they are in motion.

The frictional force acting between the successive layers of the liquid which acts in order to oppose the relative motion of the layer

is known as viscous force. Such a property of a liquid is called viscosity. Viscous force is measured by the unit called poise in CGS system and $kgm^{-1}s^{-1}$ or Nsm^{-2} in SI system.

2.7 Friction

We walk on roads without falling. But, we tend to fall when we walk on wet surfaces. Why? We walk on the roads safely because of the friction between the feet and the road. But, the friction is less when we walk on wet surface and so we tend to fall.

Frictional force or friction arises when two or more bodies in contact move or tend to move, relative to each other. It acts always in the opposite direction of the moving body. This force is produced due to the geometrical dissimilarities of the surface of the bodies, which are in relative motion. Friction can produce the following effects.

- Friction opposes motion.
- It causes wear and tear of the surfaces in contact.
- It produces heat.

2.7.1 Types of Friction

Friction can be classified into two basic types: static friction and kinetic friction.

Static friction

The friction experienced by the bodies, which are at rest is called static friction. Eg. All the objects are rigidly placed to be at rest on the earth.

Kinetic friction

Friction existing during the motion of bodies is called kinetic friction. Kinetic friction can be further classified into sliding friction and rolling friction.

When a body slides over the surface of another body, the friction acting between the surfaces in contact is called sliding friction. When a body rolls over another surface, the friction acting between the surfaces in contact is called rolling friction. Rolling friction is less than sliding friction. That is why wheels are provided in vehicles, trolleys, suitcases etc.

2.7.2 Factors affecting Friction

Some of the factors which affect friction are given below.

a. Nature of a surface

Moving an object on a rough surface will be difficult, but we can eassily move it on a smooth surface. It is because, friction varies between the surfaces.

b. Weight of the body

It is easy to pedal your cycle without any load on its carrier. With a load placed on its carrier, it is difficult to move it because the weight on the carrier increases the friction between the surface of the tyre and the road.

c. Area of contact

For a given weight, the friction is directly related to the area of contact between the two surfaces. If the area of contact is greater, then, the friction will be greater too.

A road roller has a broad base, so it offers more friction on the road. But, a cycle has the least friction, since the area of contact of the tyre with the surface of the road is less.

2.7.3 Advantages of Friction

Friction is necesary for our day to day activities. It is desirable in most of the situations of our daily life.

- We can hold objects in our hand due to friction.
- We can walk on the road because of friction. The friction between footwear and the ground help us to walk without slipping.
- Writing on the paper with a pen is easy due to friction.
- Automobiles can move safely due to friction between the tyres and the road. Brakes can be applied due to frictional resistance on brake shoes.
- We are able to light a matchstick, sew clothes, tie a knot or fix a nail on the wall because of friction.

Though friction makes our life easy, it has some negative effects also. So, it is called as 'necessary evil'.

2.7.4 Disadvantages of Friction

- Friction wears out the surfaces rubbing with each other, like screws and gears in machines or soles of shoes.
- An excess amount of effort has to be given to overcome the friction while operating a machine. This leads to wastage of energy.
- Friction produces heat, which causes physical damage to the machines.

2.7.5 Increasing and decreasing Friction

a. Area of contact

Friction can be increased by increasing the area of the surfaces in contact. For example, brake shoes in a cycle have to be adjusted so that they are as close as possible to the rim of the wheel, in order to increase the friction.

b. Using lubricants

A substance which reduces the frictional force is called a lubricant. Eg. Grease, coconut oil, graphite, castor oil, etc. The lubricants fill up the gaps in the irregular surfaces between the bodies in contact. This provides a smooth layer thus preventing a direct contact between their rough surfaces.

c. Using ball bearing

Since rolling friction is smaller than sliding friction, sliding is replaced by rolling with the usage of ball bearings. For the same reason, lead shots are used in the bearing of a cycle hub.

Points to Remember

- Force acting on a body tends to change its state of rest or of motion or its shape. The SI unit of force is newton.
- Force acts only when two or more objects interact with one other.
- The effect of force can be measured using the physical quantity called pressure.
- Liquids, gases and air also exert pressure.
- All objects on the surface of the Earth experience a constant thrust or force due to the atmosphere.
- Atmospheric pressure can be measured by a device called barometer.
- Friction is the force that opposes the motion of an object.
- Friction is caused by irregularities on the surfaces, which are in contact.
- Friction depends on the nature of the surfaces and mass of the bodies in contact.
- Friction is classified into two types: static friction and kinetic friction. Kinetic friction can be further classified as rolling friction and sliding friction.
- Surface tension is the tendency of liquid surfaces to shrink to have minimum surface area as mush as possible.
- When liquids are flowing there is a frictional force between the layers of the liquid, which oppose their relative motion. This force is called viscous force and the phenomenon is known as viscosity.
- Viscosity is measured by the unit called poise in CGS system and $kgm^{-1}s^{-1}$ and Nsm^{-2} in SI.

A-Z GLOSSARY

Buoyant force	An upward force exerted by liquid on a floating body.
Force	Ation of push or pull.
Friction	Force produced due to the geometrical dissimilarities of the surface of the bodies which are in relative motion.
Pressure	Force acting on unit area.
Surface tension	Force which contracts the surface area of the liquids.
Thrust	Force acting perpendicularly on any given surface area.

TEXTBOOK EXERCISES

HHMB6Q

I. Choose the best answer.

1. If we apply force against the direction of motion of the body, then the body will
   a) stop moving
   b) move with an increased speed
   c) move with a decreased speed
   d) move in a different direction
2. Pressure exerted by a liquid is increased by
   a) the density of the liquid
   b) the height of the liquid column
   c) Both a and b
   d) None of the above
3. Unit of pressure is
   a) Pascal b) Nm^{-2}
   c) Poise d) Both a and b
4. The value of the atmospheric pressure at sea level is
   a) 76 cm of mercury column
   b) 760 cm of mercury column
   c) 176 cm of mercury column
   d) 7.6 cm of mercury column
5. Pascal's law is used in
   a) hydraulic lift
   b) brake system
   c) pressing heavy bundles
   d) All the above
6. Which of the following liquids has more viscosity?
   a) Grease b) Water
   c) Coconut oil d) Ghee
7. The unit of viscosity is
   a) Nm^2 b) poise c) $kgms^{-1}$ d) No unit

II. Fill in the blanks.

1. The pressure of a liquid column _____ with the depth of the column.
2. Hydraulic lift works under the principle of _____.
3. The property of _____ of a liquid surface enables the water droplets to move upward in plants.
4. A simple barometer was first constructed by _____.

III. State true or false. If false, correct the statement.

1. Force acting on a given area is called pressure.
2. A moving body comes to rest due to friction alone.
3. A body will sink if the weight of the body is greater than the buoyant force.
4. One atmosphere is equivalent to 1,00,000 newton force acting on one square metre.
5. Rolling friction is slightly greater than the sliding friction.
6. Friction is the only reason for the loss of energy.
7. Liquid pressure decreases with the decrease of depth.
8. Viscosity depends on the pressure of a liquid.

IV. Match the following.

a.

Static friction	Viscosity
Kinetic friction	Least friction
Rolling friction	Objects are in motion
Friction between the liquid layers	Objects are sliding
Sliding friction	Objects are at rest

b.

Barometer	reduce friction
Increasing area of contact	Atmospheric pressure
Decreasing area of contact	cause of friction
Lubricants	increases friction
Irregular surface	decreases friction

V. Complete the analogy.

1. Knot in a thread : _____ friction :: Ball bearing : _____ friction
2. Downward force : Weight :: Upward force offered by liquid : _____

VI. Numerical Problem.

1. A stone weighs 500 N. Calculate the pressure exerted by it, if it makes contact with a surface of area 25 cm^2.

VII. Consider the statements given below and choose the correct option.

1. **Assertion:** Sharp knives are used to cut the vegetables.
   Reason: Sharp edges exert more pressure.
2. **Assertion:** Broad straps are used in bags.
   Reason: Broad straps last for long.
3. **Assertion:** Water strider slides easily on the surface of water.
   Reason: Water strider experiences less buoyant force.
   a. Both assertion and reason are true and reason is the correct explanation of assertion.
   b. Both assertion and reason are true, but reason is not the correct explanation of assertion.
   c. Assertion is true, but reason is false.
   d. Both assertion and reason are false.

VIII. Answer very briefly.

1. Give two examples to verify that a force changes the shape of a body.
2. Give two examples to verify that a force tends to change the static condition of a body.
3. How do you feel when you touch a nail immediately after it is hammered into a wooden plank? Why?
4. How does the friction arise between the surfaces of two bodies in relative motion?
5. Name two instruments which help to measure the pressure of a fluid.
6. Define one atmosphere.
7. Why are heavy bags provided with broad straps?
8. How does surface tension help a plant?
9. Which has greater viscosity, oil or honey? Why?

IX. Answer briefly.

1. Define friction. Give two examples of the utility of friction in day to day life.
2. Mention any three ways of minimising friction.
3. State Pascal's law and mention its applications.
4. Why is a ball bearing used in a cycle hub?

X. Answer in detail.

1. Friction is a necessary evil - Explain.
2. Give the different types of friction and explain each with an example.
3. Describe an experiment to prove that friction depends on the nature of a surface.
4. Explain how friction can be minimised.
5. Describe an experiment to prove that the pressure in a liquid increases with depth.

XI. Higher Order Thinking Questions.

1. Why is it not advisable to use a fountain pen while travelling in an aeroplane?
2. Is there any possibility of making a special device to measure the magnitude of friction directly?
3. Vidhya feels that mercury is costly. So, instead of mercury she wants to use water as a barometric liquid. Explain the difficulty of constructing a water barometer.

XII. Project Work.

Observe the devices, gadgets or things around you. List out the types of friction involved in each device. How would you minimise the friction? Record your observations and discuss your results with your classmates.

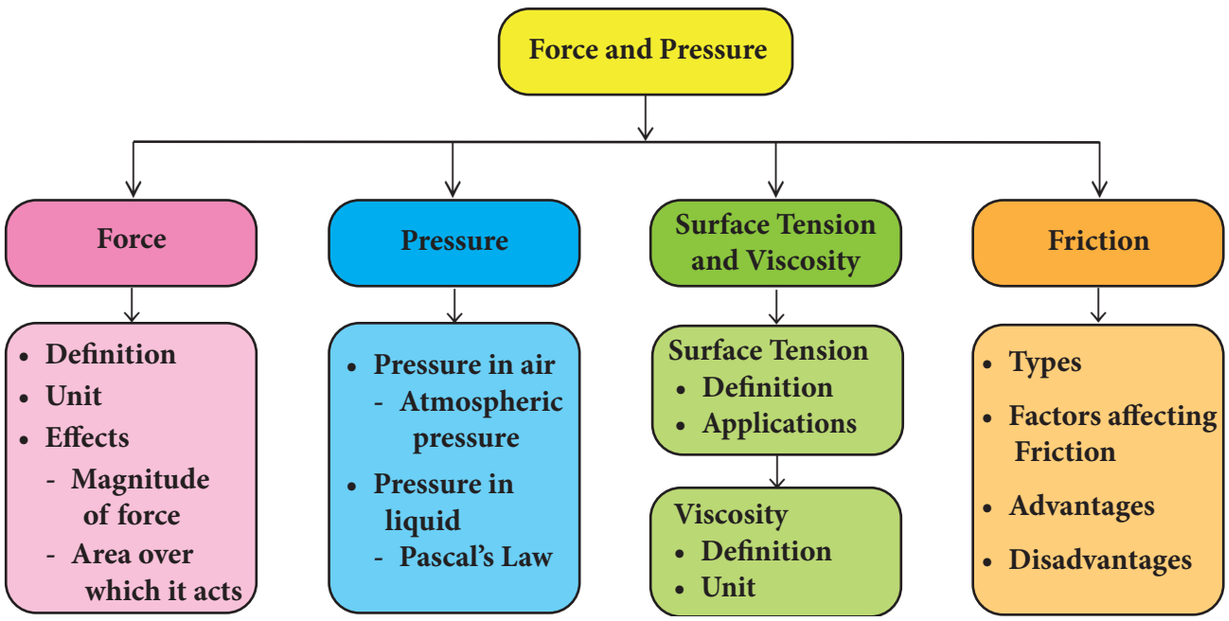
REFERENCE BOOKS

1. Fundamentals of Physics (English, Hardcover) David Halliday & Jearl Walker.
2. Principles of Physics, International Student Version (English, Paperback) Jearl Walker, David Halliday, Robert Resnick.
3. Concepts of Physics (Volume-1) 1st Edition (English, Paperback) H. C. Verma.
4. Fundamentals of Physics (English, Hardcover) David Halliday

INTERNET RESOURCES

1. https://www.youtube.com/watch?v=Oe6bDTL3YQg
2. https://www.youtube.com/watch?v=KndNN28OcEI
3. https://www.youtube.com/watch?v=-B5IBoZ08-I
4. https://www.stufftoblowyourmind.com/videos/51302-stuff-to-blow-your-kids-mind-atmospheric-pressure-video.htm

Concept Map



ICT CORNER

Force and Pressure

This activity helps to learn about the Fluid pressure & Pascal's Law

Steps

- Open the Browser and type the URL link given below (or) Scan the QR Code.
- Select the "Fluid Pressure and Pascal's Law" .You can view this page.
- You can view this page .Touch the play button.
- To get more idea about the Pascal's Law for fluid pressure through Experiment.

B359_8_SCIENCE_EM

Web link: https://www.youtube.com/watch?v=dx2P7i1GPaw (or) scan the QR Code

UNIT 3

LIGHT

Learning Objectives

UE95VL

After the completion of this lesson, students will be able to:

- acquire knowledge about various types of mirrors.
- understand image formation in spherical mirrors.
- know about the applications of spherical mirrors.
- acquire knowledge about laws of reflection.
- compare regular and irregular reflections.
- understand the working principle of kaleidoscope and periscope.
- understand refraction and dispersion of light.

Introduction

Lofty mountains covered with greenish vegetation, magnificent trees reaching the clouds, beautiful streams drifting down the valleys, bluish sea water roaring towards the coast and the radiant sky in the morning being filled with golden red color, all give delight to our eyes and peace to our mind. But, can we see them all without light? No, because, we can see things around us only when the light reflected by them reaches our eyes. What is light?

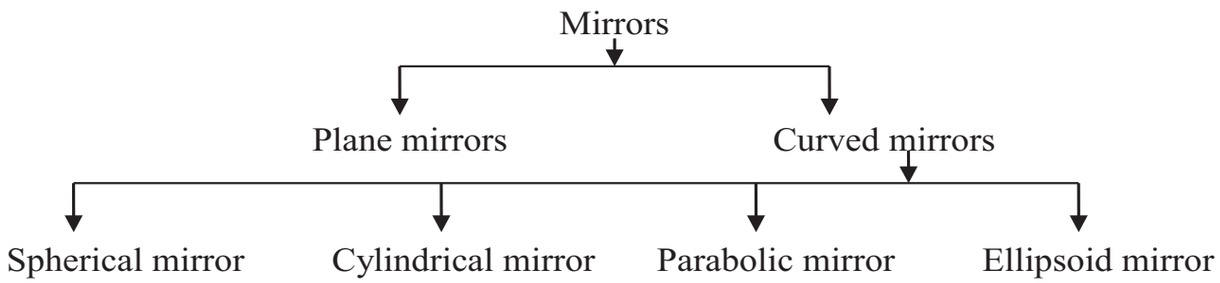
Light is a form of energy and it travels in a straight line. You have studied in your lower classes, how it is reflected by the polished surfaces such as plane mirrors. This reflecting property of light is applied in various devises that we use in our daily life. In this lesson, you will study about types of mirrors like spherical mirrors and parabolic mirrors. You will also study about the laws of reflection and the laws of refraction and some of the optical instruments, such as periscope and kaleidoscope, which work on these principles.

3.1 Mirrors

We use mirrors in our daily life for various purposes. Mainly, we use them for beautifying us. The mirror is an optical device with a polished surface that reflects the light falling on it. A typical mirror is a glass sheet coated with aluminium or silver on one of its sides to produce an image. Mirrors have a plane or curved surface. Curved mirrors have surfaces that are spherical, cylindrical, parabolic and ellipsoid. The shape of a mirror determines the type of image it forms. Plane mirrors form the perfect image of an object. Whereas, curved mirrors produce images that are either enlarged or diminished.

DO YOU KNOW?

Method of coating a glass plate with a thin layer of reflecting metals was in practice during the 16th century in Venice, Italy. They used an amalgam of tin and mercury for this purpose. Nowadays, a thin layer of molten aluminium or silver is used for coating glass plates that will then become mirrors.



3.1.1 Spherical mirrors

Spherical mirrors are one form of curved mirrors. If the curved mirror is a part of a sphere, then it is called a 'spherical mirror'. It resembles the shape of a piece cut out from a spherical surface. One side of this mirror is silvered and the reflection of light occurs at the other side.

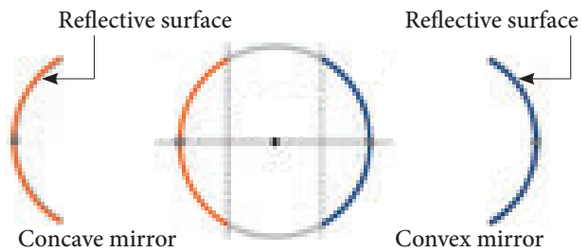


Figure 3.1 Sperical mirrors

Concave mirror

A spherical mirror, in which the reflection of light occurs at its concave surface, is called a concave mirror. *These mirrors magnify the object placed close to them.* The most common example of a concave mirror is the make-up mirror.

Convex mirror

A spherical mirror, in which the reflection of light occurs at its convex surface, is called a convex mirror. *The image formed by these mirrors is smaller than the object.* Most common convex mirrors are rear viewing mirrors used in vehicles.

DO YOU KNOW?

Convex mirrors used in vehicles as rear-view mirrors are labeled with the safety warning: 'Objects in the mirror are closer than they appear'. This is because inside the mirrors, vehicles will appear to be coming at a long distance.

3.1.2 Parabolic mirrors

A parabolic mirror, which is in the shape of a parabola, is one type of curved mirror. It has a concave reflecting surface and this surface directs the entire incident beam of light to converge at its focal point.

In the same way, light rays generated by the source placed at the focal point will fall on this surface and they will be diverged in a direction, which is parallel to the principal axis of the parabolic mirror. Hence, the light rays will be reflected to travel a long distance, without getting diminished.

Parabolic mirrors, also known as parabolic reflectors, are used to collect or project light energy, heat energy, sound energy and radio waves. They are used in reflecting telescopes, radio telescopes and parabolic microphones. They are also used in solar cookers and solar water heaters.

Figure 3.2 Parabolic mirror

DO YOU KNOW?

The principle behind the working of a parabolic mirror has been known since the Greco-Roman times. The first mention of these structures was found in the book, 'On Burning Mirrors', written by the mathematician Diocles. They were also studied in the 10th century, by a physicist called Ibn Sahl. The first parabolic mirrors were constructed by Heinrich Hertz, a German physicist, in the form of reflector antennae in the year 1888.

3.2 Terms related to Spherical Mirrors

In order to understand the image formation in spherical mirrors, we need to know about some of the terms related to them.

Center of Curvature

It is the center of the sphere from which the mirror is made. It is denoted by the letter **C** in the ray diagrams. (A ray diagram represents the formation of an image by the spherical mirror. You will study about them in the higher classes).

Pole

It is the geometric centre of the spherical mirror. It is denoted by the letter **P**.

Radius of Curvature

It is the distance between the center of the sphere and the vertex. It is shown by the letter **R** in ray diagrams (*The **vertex** is the point on the mirror's surface where the principal axis meets the mirror.* It is also called as '**pole**').

Principal Axis

The line joining the pole of the mirror and its center of curvature is called principal axis.

Focus

When a beam of light is incident on a spherical mirror, the reflected rays converge (concave mirror) at or appear to diverge from (convex mirror) a point on the principal axis. This point is called the 'focus' or 'principal focus'. It is also known as the focal point. It is denoted by the letter **F** in ray diagrams.

Focal length

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

There is a relation between the focal length of a spherical mirror and its radius of curvature. The focal length is half of the radius of curvature.

$$\text{Focal length} = \frac{\text{Radius of curvature}}{2}.$$

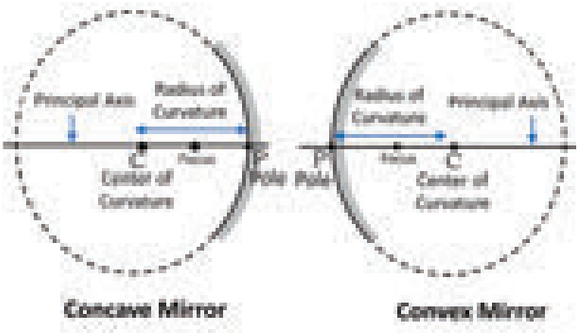


Figure 3.3 Terms related to a spherical mirror

Problem 1

The radius of curvature of a spherical mirror is 20 cm. Find its focal length.

Solution

Radius of curvature = 20 cm

$$\text{Focal length (f)} = \frac{\text{Radius of curvature}}{2}$$

$$= \frac{R}{2} = \frac{20}{2} = 10 \text{ cm}$$

Problem 2

Focal length of a spherical mirror is 7 cm. What is its radius of curvature?

Solution

Radius of curvature (R) = 2 × Focal length

= 2 × 7 = 14 cm

3.3 Images formed by Spherical Mirrors

Images formed by spherical mirrors are of two types: real image and virtual image. Real images can be formed on a screen, while virtual images cannot be formed on a screen. Image formed by a convex mirror is always erect, virtual and diminished in size. As a result, images formed by these mirrors cannot be projected on a screen.

The characteristics of an image are determined by the location of the object. As the object gets closer to a concave mirror, the image gets larger, until attaining approximately the size of the object, when it reaches the centre of curvature of the mirror. As the object moves away, the image diminishes in size and gets gradually closer to the focus, until it is reduced to a point at the focus when the object is at an infinite distance from the mirror. The size and nature of the image formed by a convex mirror are given in Table 3.1.

Concave mirrors form a real image and it can be caught on a screen. Unlike convex mirrors, concave mirrors show different image types. Depending on the position of the object in front of the mirror, the position, size and nature of the image will vary. Table 3.2 provides a summary of images formed by a concave mirror.

You can observe from the table that a concave mirror always forms a real and inverted image except when the object is placed between the focus and the pole of the mirror. In this position, it forms a virtual and erect image.

Activity 1

Take a curved silver spoon and see the image formed by it. Now, turn it and find the image formed. Do you find any difference? Find out the reason.

Table 3.1 Image formed by a convex mirror

Position of the Object	Position of the Image	Image Size	Nature of the Image
At infinity	At F	Highly diminished, point sized	Virtual and erect
Between infinity and the pole (P)	Between P and F	Diminished	Virtual and erect

Table 3.2 Image formed by a concave mirror

Position of the Object	Position of the Image	Image Size	Nature of the Image
At infinity	At F	Highly diminished	Real and inverted
Beyond C	Between C and F	Diminished	Real and inverted
At C	At C	Same size as the object	Real and inverted
Between C and F	Beyond C	Magnified	Real and inverted
At F	At infinity	Highly magnified	Real and inverted
Between F and P	Behind the mirror	Magnified	Virtual and erect

3.4 Applications of Curved Mirrors

Concave mirror

1. Concave mirrors are used while applying make-up or shaving, as they provide a magnified image.
2. They are used in torches, search lights and head lights as they direct the light to a long distance.
3. They can collect the light from a larger area and focus it into a small spot. Hence, they are used in solar cookers.
4. They are used as head mirrors by doctors to examine the eye, ear, nose and throat as they provide a shadow-free illumination of the organ.
5. They are also used in reflecting telescopes.

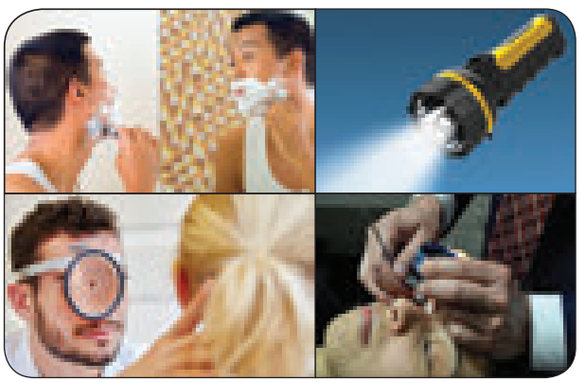


Figure 3.4 Uses of concave mirror

Convex mirror

1. Convex mirrors are used in vehicles as rear view mirrors because they give an upright image and provide a wider field of view as they are curved outwards.
2. They are found in the hallways of various buildings including hospitals, hotels, schools and stores. They are usually mounted on a wall or ceiling where hallways make sharp turns.
3. They are also used on roads where there are sharp curves and turns.

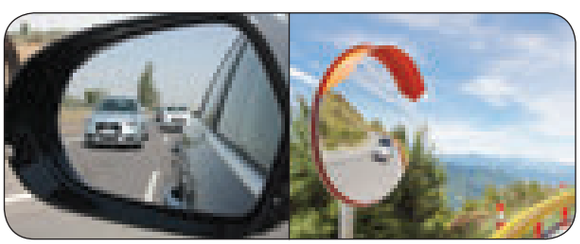


Figure 3.5 Uses of Convex mirror

Activity 2

List out various convex and concave mirrors used in daily life.

3.5 Laws of Reflection

Activity 3

Take a plane mirror and focus the light coming from the Sun on a wall. Can you see a bright spot on the wall? How does it occur? It is because the light rays falling on the mirror are bounced onto the wall. Can you produce the same bright spot with the help of any other object having a rough surface?

Not all the objects can produce the same effect as produced by the plane mirror. A ray of light, falling on a body having a shiny, polished and smooth surface alone is bounced back. This bouncing back of the light rays as they fall on the smooth, shiny and polished surface is called reflection.

Reflection involves two rays: incident ray and reflected ray. The incident ray is the light ray in a medium falling on the shiny surface of a reflecting body. After falling on the surface, this ray returns into the same medium. This ray is called the reflected ray. An imaginary line perpendicular to the reflecting surface, at the point of incidence of the light ray, is called the normal.

The relation between the incident ray, the reflected ray and the normal is given as the laws of reflection. The laws of reflection are as follows:

- The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane.

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- The angle of incidence (i) and the angle of reflection (r) are always equal.

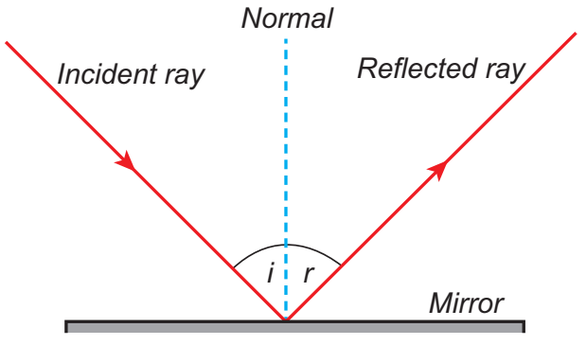


Figure 3.6 Reflection of light

DO YOU KNOW?

Silver metal is the best reflector of light. That is why a thin layer of silver is deposited on the side of materials like plane glass sheets, to make mirrors.

3.6 Types of Reflection

We have learnt that not all bodies can reflect light rays. The amount of reflection of light depends on the nature of the reflecting surface of the body. Based on the nature of the surface, reflection can be classified into two types namely, regular reflection and irregular reflection.

3.6.1 Regular reflection

When a beam of light (collection of parallel rays) falls on a smooth surface, it gets reflected. After reflection, the reflected rays will be parallel to each other. Here, the angle of incidence and the angle of reflection of each ray will be equal. Hence, the law of reflection is obeyed in this case and thus a clear image is formed. This reflection is called 'regular reflection' or 'specular reflection'. Example: Reflection of light by a plane mirror and reflection of light from the surface of still water.

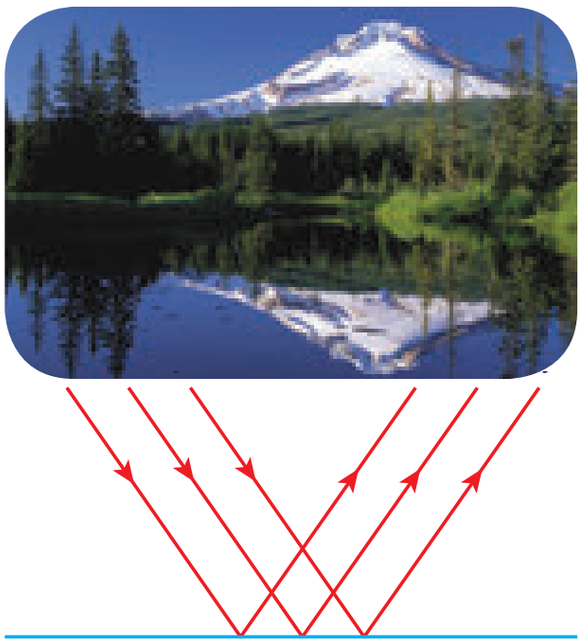


Figure 3.7 Regular reflection

3.6.2 Irregular reflection

In the case of a body having a rough or irregular surface, each region of the surface is inclined at different angles. When light falls on such a surface, the light rays are reflected at different angles. In this case, the angle of incidence and the angle of reflection of each

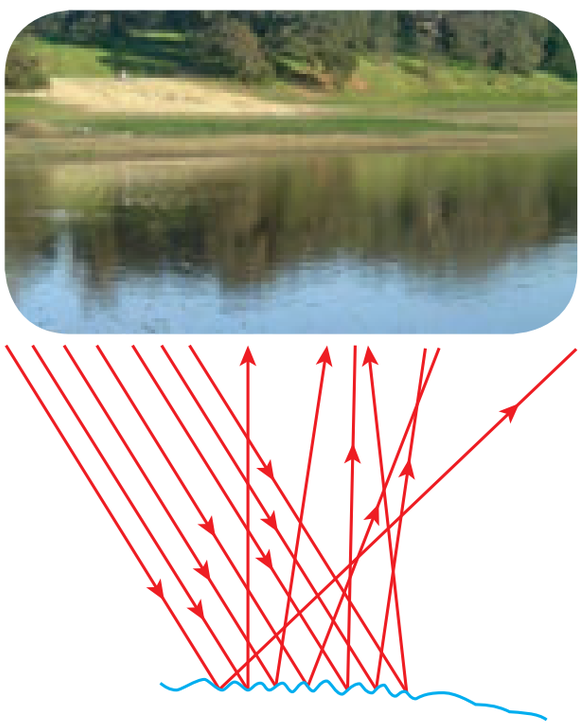


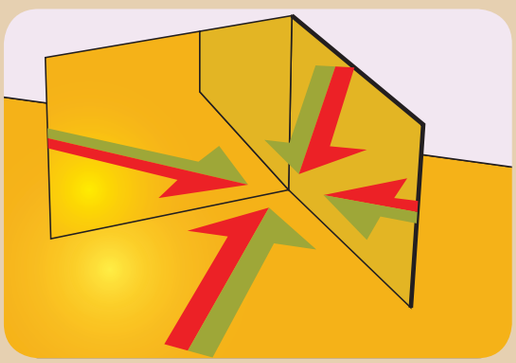
Figure 3.8 Irregular reflection

ray are not equal. Hence, the law of reflection is not obeyed in this case and thus the image is not clear. Such a reflection is called 'irregular reflection' or 'diffused reflection'. Example: Reflection of light from a wall.

3.7 Multiple Reflections

Activity 4

Take two plane mirrors and keep them perpendicular to each other. Place an object between them. You can see the images of the object. How many images do you see in the mirrors? You can see three images. How is it possible to have three images with two mirrors?



In the activity given above, you observed that for an object kept in between two plane mirrors, which were inclined to each other, you could see many images. This is because, the 'image' formed by one mirror acts as an 'object' for the other mirror. The image formed by the first mirror acts as an object for the second mirror and the image formed by the second mirror acts as an object for the first mirror. Thus, we have three images of a single body. This is known as multiple reflection. This type of reflections can be seen in show rooms and saloons.

The number of images formed, depends on the angle of inclination of the mirrors. If the angle between the two mirrors is a factor of 360°, then the total number of reflections is finite. If θ (Theta) is the angle of inclination of the plane mirrors, the number of images formed is equal to $\frac{360^\circ}{\theta} - 1$. As you decrease this angle, the number of images formed increases. When they are parallel to each other, the number of images formed becomes infinite.

Problem 3

If two plane mirrors are inclined to each other at an angle of 90°, find the number of images formed.

Solution

Angle of inclination = 90°

$$\text{Number of images formed} = \frac{360^\circ}{\theta} - 1$$

$$= \frac{360^\circ}{90^\circ} - 1 = 4 - 1 = 3$$

3.7.1 Kaleidoscope

It is a device which functions on the principle of multiple reflection of light, to produce numerous patterns of images. It has two or more mirrors inclined to each other. It can be designed from inexpensive materials. The colourful image patterns formed by this will be pleasing to you. This instrument is used as a toy for children.

Figure 3.9 Kaleidoscope

Activity 5

Take three equal sized plane mirror strips and arrange them in such a way that they form an equilateral triangle. Cover the sides of the mirrors with a chart paper. In the same manner cover the bottom of the mirrors also. Put some coloured things such as pieces of bangles and beads inside it. Now, cover the top portion with the chart paper and make a hole in it to see. You can wrap the entire piece with coloured papers to make it attractive. Now, rotate it and see through its opening. You can see the beautiful patterns.

Caution: Be careful while handling the glass pieces. Do this under the supervision of your teacher.

3.7.2 Periscope

It is an instrument used for viewing bodies or ships, which are over and around another body or a submarine. It is based on the principle of the law of reflection of light. It consists of a long outer case and inside this case mirrors or prisms are kept at each end, inclined at an angle of 45°. Light coming from the distant body, falls on the mirror at the top end of the periscope and gets reflected vertically downward. This light is reflected again by the second mirror kept at the bottom, so as to travel horizontally and reach the eye of the observer. In some complex periscopes, optic fibre is used instead of mirrors for obtaining a higher resolution. The distance between the mirrors varies depending on the purpose.

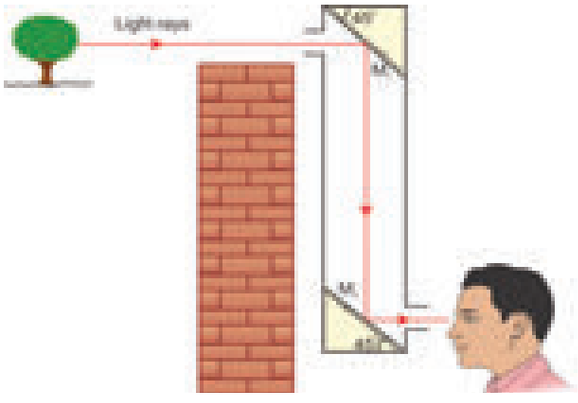


Figure 3.10 Periscope

Uses

- It is used in warfare and navigation of the submarine.
- In military it is used for pointing and firing guns from a 'bunker'.
- Photographs of important places can be taken through periscopes without trespassing restricted military regions.
- Fibre optic periscopes are used by doctors as endoscopes to view internal organs of the body.

Figure 3.11 Submarine with Periscope

3.8 Refraction of Light

We know that when a light ray falls on a polished surface placed in air, it is reflected into the air itself. When it falls on a transparent material, it is not reflected completely, but a part of it is reflected, a part of it is absorbed and most of the light passes through it. Through air, light travels with a speed of 3×10^8 m s^{-1}, but it cannot travel with the same speed in water or glass, because, optically denser medium such as water and glass offer some resistance to the light rays.

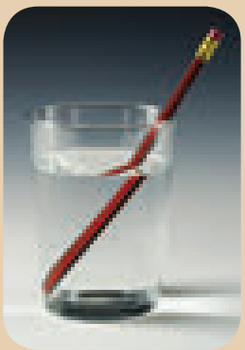
So, light rays travelling from a rarer medium like air into a denser medium like glass or water are deviated from their straight line path. This bending of light about the normal, at the point of incidence; as it passes from one transparent medium to another is called refraction of light.

When a light ray travels from the rarer medium into the denser medium, it bends towards the normal and when it travels from

the denser medium into the rarer medium, it bends away from the normal. You can observe this phenomenon with the help of the activity given below.

Activity 6

Take a glass beaker, fill it with water and place a pencil in it. Now, look at the pencil through the beaker. Does it appear straight? No. It will appear to be bent at the surface of the water. Why?



In this activity, the light rays actually travel from the water (a denser medium) into the air (a rarer medium). As you saw earlier, when a light ray travels from a denser medium to a rarer medium, it is deviated from its straight line path. So, the pencil appears to be bent when you see it through the glass of water.

3.8.1 Refractive Index

Refraction of light in a medium depends on the speed of light in that medium. When the speed of light in a medium is more, the bending is less and when the speed of light is less, the bending is more.

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The amount of refraction of light in a medium is denoted by a term known as refractive index of the medium, which is the ratio of the speed of light in the air to the speed of light in that particular medium. It is also known as the absolute refractive index and it is denoted by the Greek letter 'μ' (pronounced as 'mew').

$$\mu = \frac{\text{Speed of light in air (c)}}{\text{Speed of light in the medium (v)}}$$

Refractive index is a ratio of two similar quantities (speed) and so, it has no unit. Since, the speed of light in any medium is less than its speed in air, refractive index of any transparent medium is always greater than 1. Refractive indices of some common substances are given in Table 3.3.

Table 3.3 Refractive Index of substances

Substances	Refractive index
Air	1.0
Water	1.33
Ether	1.36
Kerosene	1.41
Ordinary Glass	1.5
Quartz	1.56
Diamond	2.41

In general, the refractive index of one medium with respect to another medium is given by the ratio of their absolute refractive indices.

$$1\mu_2 = \frac{\text{Absolve refractive index of the second medium}}{\text{Absolve refractive index of the first medium}}$$

$$1\mu_2 = \frac{\frac{c}{V_2}}{\frac{c}{V_1}} \quad \text{or} \quad 1\mu_2 = \frac{V_1}{V_2}$$

Thus, the refractive index of one medium with respect to another medium is also given by the ratio of the speed of light in the first medium to its speed in the second medium.

Problem 4

Speed of light in air is 3×10^8 m s^{-1} and the speed of light in a medium is 2×10^8 ms^{-1}. Find the refractive index of the medium with respect to air.

Solution

$$\text{Refractive index } (\mu) = \frac{\text{Speed of light in air (c)}}{\text{Speed of light in the medium (v)}}$$

$$\mu = \frac{3 \times 10^8}{2 \times 10^8} = 1.5$$

Problem 5

Refractive index of water is 4/3 and the refractive index of glass is 3/2. Find the refractive index of glass with respect to the refractive index of water.

Solution

$$ {}_{w}\mu_{g} = \frac{\text{Refractive index of glass}}{\text{Refractive index of water}} $$

$$ = \frac{\frac{3}{2}}{\frac{4}{3}} = \frac{9}{8} = 1.125 $$

3.8.2 Snell's Law of Refraction

Refraction of light rays, as they travel from one medium to another medium, obeys two laws, which are known as Snell's laws of refraction. They are given below:

i) The incident ray, the refracted ray and the normal at the point of intersection, all lie in the same plane.

ii) The ratio of the sine of the angle of incidence (i) to the sine of the angle of refraction (r) is equal to the refractive index of the medium, which is a constant.

$$ \frac{\sin i}{\sin r} = \mu $$

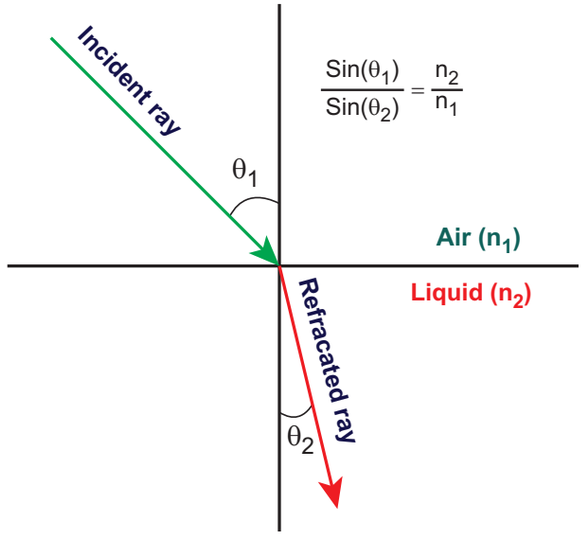
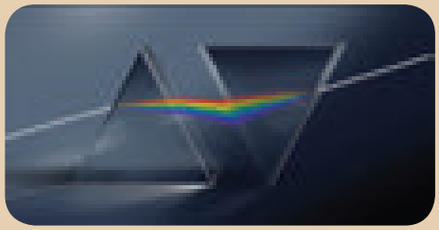


Figure 3.12 Snell's Law

3.9 Dispersion

Activity 7

Place a prism on a table and keep a white screen near it. Now, with the help of a torch, allow white light to pass through the prism. What do you see? You can observe that white light splits into seven colored light rays namely, violet, indigo, blue, green, yellow, orange and red (VIBGYOR) on the screen. Now, place another prism in its inverted position, between the first prism and the screen. Now, what do you observe on the screen? You can observe that white light is coming out of the second prism.



In this activity, you can see that the first prism splits the white light into seven coloured light rays and the second prism recombines them into white light, again. Thus, *it is clear that white light consists of seven colours.* You can also recall Newton's disc experiment, which you studied in standard VII.

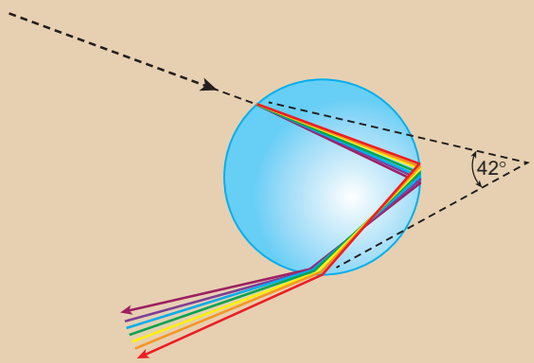
Splitting of white light into its seven constituent colours (wavelength), on passing through a transparent medium is known as dispersion of light.

Why does dispersion occur? It is because, light of different colours present in white light have different wavelength and they travel at different speeds in a medium. You know that refraction of a light ray in a medium depends on its speed. As each coloured light has a different speed, the constituent coloured lights are refracted

at different extents, inside the prism. *Moreover, refraction of a light ray is inversely proportional to its wavelength.*

Thus, the red coloured light, which has a large wavelength, is deviated less while the violet coloured light, which has a short wavelength, is deviated more.

The formation of rainbow is an example of dispersion of white light. This can be seen on the opposite side of the Sun. After rainfall, large number of droplets still remain suspended in the air. When white light passes through them, it is split into seven colours. Dispersion of white light from a large number of droplets eventually forms a rainbow.



Points to Remember

- Mirror is an optical device with a polished surface that reflects the light falling on it.
- Curved mirrors have surfaces that are spherical, cylindrical, parabolic and ellipsoid.
- If the curved mirror is a part of a sphere, then it is called a 'spherical mirror'.
- A spherical mirror, in which the reflection of light occurs at its concave surface, is called a concave mirror.
- A spherical mirror, in which the reflection of light occurs at its convex surface, is called a convex mirror.
- The focal length of a spherical mirror is half of its radius of curvature.
- Real images can be formed on a screen, while virtual images cannot be formed on a screen.
- Concave mirrors form a real image and it can be caught on a screen.
- Concave mirrors are used as make-up mirrors.
- Convex mirrors are used in vehicles as rear view mirrors.
- Based on the nature of the surface, reflection can be classified into two types namely, regular reflection and irregular reflection.
- The number of images formed by a mirror depends on the angle of inclination of the mirrors.

A-Z GLOSSARY

Center of Curvature	The center of the sphere from which the mirror is made.
Dispersion of light	Splitting of white light into its seven constituent colours (wavelength).
Focal length	Distance between the pole and the principal focus.
Focus	Point where the reflected rays converge at or appear to diverge from a point on the principal axis.
Kaleidoscope	Device which produces numerous and wonderful image patterns.
Periscope	Instrument used for viewing objects, which are over and around another body.
Pole	Point on the mirror's surface where the principal axis meets the mirror.
Principal Axis	Line joining the pole of the mirror and its center of curvature.

Radius of Curvature	Distance between the center of the sphere and the vertex.
Reflection	Bouncing back of the light rays as they fall on the smooth, shiny and polished surface.
Refraction of light	Bending of light about the normal, at the point of incidence; as it passes from one transparent medium to another.
Refractive index	Ratio of the speed of light in the air to the speed of light in that particular medium.

TEXTBOOK EXERCISES

ML5WHN

I. Choose the best answer.

1. Which of the following has curved reflecting surface?
   a) plane mirrors b) spherical mirrors
   c) simple mirrors d) None of the above
2. The spherical mirror with a reflecting surface curved inward is called
   a) convex mirror b) concave mirror
   c) curved mirror d) None of the above
3. The spherical mirror used as a rear view mirror in the vehicle is
   a) concave mirror b) convex mirror
   c) plane mirror d) None of the above
4. The imaginary line passing through the centre of curvature and pole of a spherical mirror is called
   a) centre of curvature b) pole
   c) principal axis d) radius curvature
5. The distance from the pole to the focus is called
   a) pole length b) focal length
   c) principal axis d) None of the above
6. If the image and object distance is same, then the object is placed at
   a) infinity b) at F
   c) between f and P d) at C
7. If the focal length of a spherical mirror is 10 cm, what is the value of its radius of curvature?
   a) 10 cm b) 5 cm c) 20 cm d) 15 cm

II. Fill in the blanks.

1. The spherical mirror used in a beauty parlour as make-up mirror is _____.
2. Geometric centre of the spherical mirror is _____.
3. Nature of the images formed by a convex mirror is _____.
4. The mirror used by the ophthalmologist to examine the eye is _____.
5. If the angle of incidence is 45°, then the angle of reflection is _____.
6. If an object is placed between two mirrors which are parallel to each other, the number of images formed is _____.

III. Match the following.

Convex mirror	Radio telescopes
Parobolic mirror	Rear – view mirror
Snell's law	Kaleidoscope
Dispersion of light	sin i/sin r =μ
Refractive index	Rainbow

IV. Answer briefly.

1. Define focal length.
2. Give any two applications of a concave and convex mirror.
3. State the laws of reflection.
4. Define the refractive index of a medium.
5. State Snell's law of refraction

V. Answer in detail.

1. Explain the images formed by a concave mirror.
2. What is reflection? Write a short note on regular and irregular reflection.
3. Explain the working of a periscope.
4. What is dispersion? Explain in detail.

VI. Numerical problems.

1. The radius of curvature of a spherical mirror is 25 cm. Find its focal length.
2. If two plane mirrors are inclined to each other at an angle of 45°, find the number of images formed.
3. Speed of light in air is 3×10^8 m s^{-1} and the refractive index of a medium is 1.5. Find the speed of light in the medium.

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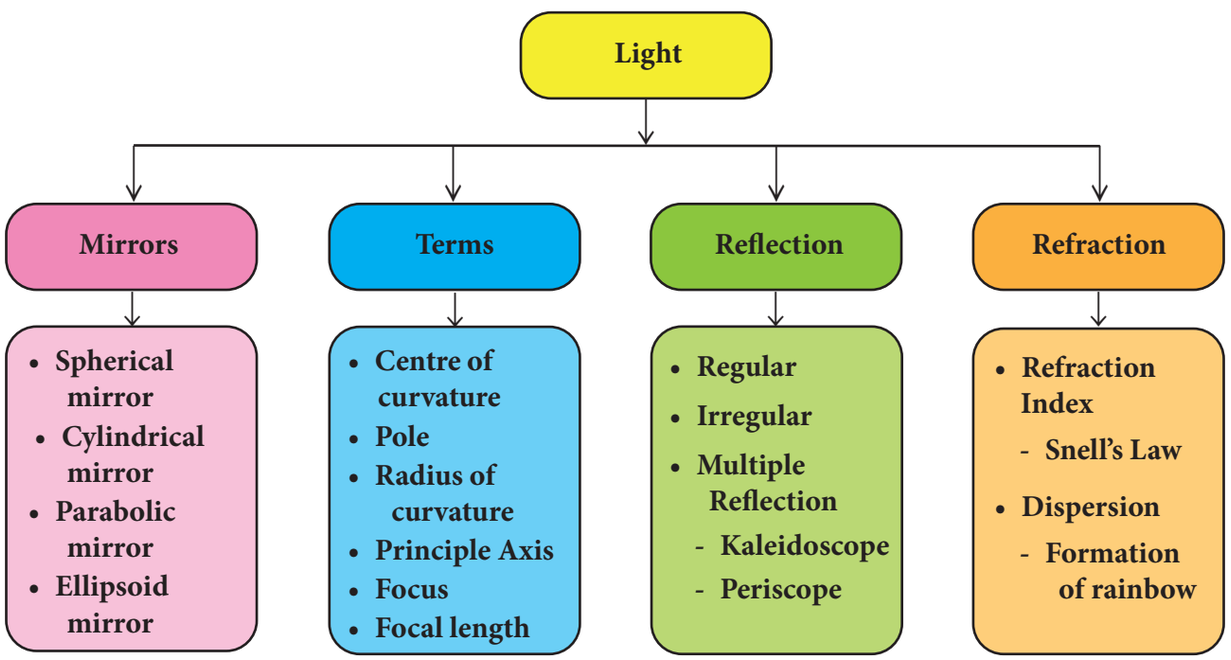
INTERNET RESOURCES

1. https://farside.ph.utexas.edu
2. https://britannica.com
3. https://studyread.com
4. https://sciencelearn.org

Concept Map



UNIT 4

HEAT

Learning Objectives

After the completion of this lesson students will be able to:

- understand the effects of heat.
- explain the transfer of heat.
- know about calorimetry.
- calculate heat capacity and specific heat capacity of substances.
- list out the functions of thermostat.
- know about the working of thermos flask.

Introduction

All the substances in our surrounding are made up of atoms and molecules. These atoms and molecules are always at vibratory motion. Due to this motion, substances have an energy known as heat energy. This energy flows from hot substances to cold substances or from hot region to cold region of a substance. When heat energy is supplied to any substance it increases the energy of the atoms and molecules in it and so they start to vibrate. These atoms and molecules which vibrate make other atoms and molecules to vibrate. Thus, heat energy is transferred from one part of the substance to other part. We can see this heat energy transfer in our daily life also. Heat energy brings about lot of changes. You will learn about them in this lesson. You will also study about transfer of heat and measurement of heat change.

4.1 Effects of Heat

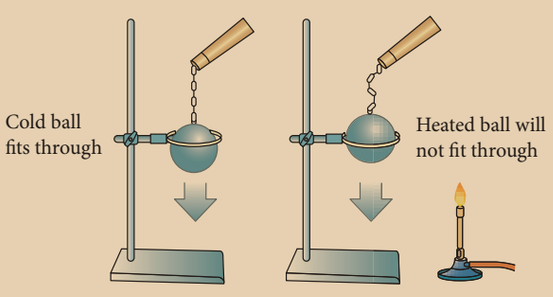
When heat energy is supplied to any substance, it brings about many changes. There are three important changes that we can see in our daily life. They are:

- Expansion
- Increase in temperature
- Change in state

4.1.1 Expansion

Activity 1

Take a metal ball and a metal ring of suitable diameter. Pass the metal ball through the ring. You can observe that the metal ball can easily go through it. Now heat the metal ball and then try to pass it through the ring. It will not pass through the ring. Keep the metal ball on the ring for some time. In few minutes, it will fall through the ring.



Why didn't the ball go through the ring initially but went through it after some time? When the ball is heated the atoms in the ball gain heat energy. They start vibrating and force each other apart. As a result an expansion takes place. That's why the ball did not go through the ring. After some time, as the ball lost the heat energy to the surrounding it came back to its original size and it went through the ring. This shows that heat energy causes expansion in solids. This expansion takes place in liquids and gases also. It is maximum in gases.

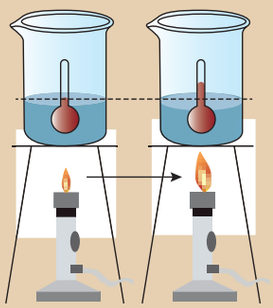
DO YOU KNOW?

Electric wires used for long distance transmission of electricity will expand during day time and contract at night. That is why they will not be set very tightly. If they are set very tightly they will break when they cool at night.

4.1.2 Rise in Temperature

Activity 2

Take a cup of water and note its temperature. Heat the water for few minutes and note the temperature again. Do you find any increase in the temperature? What caused the temperature change?



When the water is heated, water molecules receive heat energy. This heat energy increases the kinetic energy of the molecules.When the molecules receive more energy, the temperature of the water increases. This shows that heat energy causes increase in temperature.

4.1.3 Change of State

Activity 3

Take few ice cubes in a container and heat them for some time. What happens? The ice cubes melt and become water. Now heat the water for some time. What do you observe? The volume of water in the vessel decreases. What do you understand from this activity?

In ice cubes the force of attraction between the water molecules is more. So they are close together. When we heat them the force of attraction between the molecules decreases and the ice cubes become water. When we heat the water, the force of attraction decreases further. Hence they move away from one another and become vapour. Since water vapour escape to the surrounding, water level decreases further. From this we understand that heat energy causes change in the state of the substances. When heat energy is removed, changes take place in reverse direction.

If heat energy is supplied to or taken out from a substance, it will undergo a change from one state of matter to another.

One of the following transformations may take place due to heat energy.

- Solid to Liquid (Melting)
- Liquid to Gas (Vapourisation)
- Solid to Gas (Sublimation)
- Gas to Liquid (Condensation)
- Liquid to Solid (Freezing)
- Gas to Solid (Deposition)

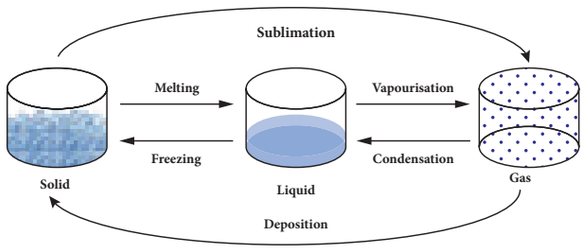


Figure 4.1 Change of state in Water

Water is the only matter on the Earth that can be found naturally in all three states - Solid, Liquid and Gas.

4.2 Transfer of Heat

If heat energy is supplied to any substance, it will be transferred from one part of the substance to another part. It takes place in different ways depending on the state of the substance. Three ways of heat transfer are:

- Conduction
- Convection
- Radiation

4.2.1 Conduction

Activity 4

Take some hot water in a cup and put a silver spoon in it. Leave the spoon inside the water for some time. Now touch the other end of the spoon. Do you feel the heat?

How did the other end of the spoon become hot? It is because heat in the hot water is transferred from one end to other end of the spoon. In solid substances such as silver spoon, atoms are arranged very closely. Hot water molecules which are vibrating transfer the heat energy to the atoms in the spoon and make them vibrate. Those atoms make other atoms to vibrate and thus heat is transferred to the other end of the spoon.

In conduction heat transfer takes place between two ends of the same solid or through two solid substances that are at different temperatures but in contact with one another. Thus, we can define conduction as the process of heat transfer in solids from the region of higher temperature to the region of lower temperature without the actual movement of atoms or molecules.

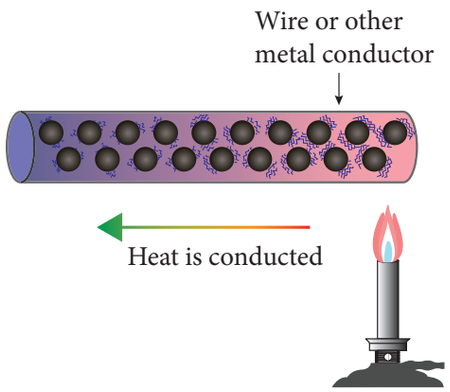


Figure 4.2 Conduction in Solids

All metals are **good conductors** of heat. The substances which does not conduct heat easily are called **bad conductors or insulators**. Wood, cork, cotton, wool, glass, rubber, etc are insulators.

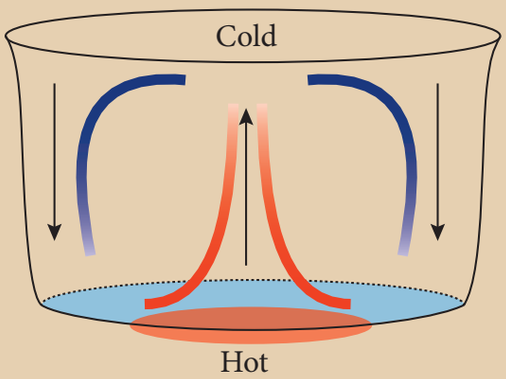
Conduction in daily life

- We cook food in vessels made up of metals. When the vessel is heated, heat is transferred from the metal to the food.
- When we iron dresses, heat is transferred from the iron to the cloth.
- Handles of cooking utensils are made up of plastic or wood because they are poor conductors of heat.
- The temperature inside igloo (snow house) is warm because snow is a poor conductor of heat.

4.2.2 Convection

Activity 5

Take some water in a vessel and heat it on a stove. Touch the surface of the water. It will be cold. Touch it after some time. It will be hot now. How did the heat which was supplied at the bottom reach the top?



When water in the vessel is heated, water molecules at the bottom receive heat energy and move upward. Then the molecules at the top comes down and get heated. This kind of heat transfer is known as convection. This is how air in the atmosphere is also heated. Thus, the form of heat transfer from places of high temperature to places of low temperature by the actual movement of molecules is called convection. Convection takes place in liquids and gases.

Convection in daily life

- Formation of land breeze and sea breeze is due to convection of air.
- Wind flows from one region to another region by convection.
- In hot air balloons heat is transferred by convection and so the balloon raises.
- In refrigirators, cool air moves downward and replaces the hot air because of convection.

4.2.3 Radiation

Radiation is the third form of heat transfer. By conduction, heat is transferred through solids, by convection heat is transferred through liquids and gases, but by radiation heat can be transferred through empty space even through vacuum. Heat energy from the Sun reaches the Earth by this form of heat transfer. Radiation is defined as the way of heat transfer from one place to another in the form of electromagnetic waves.

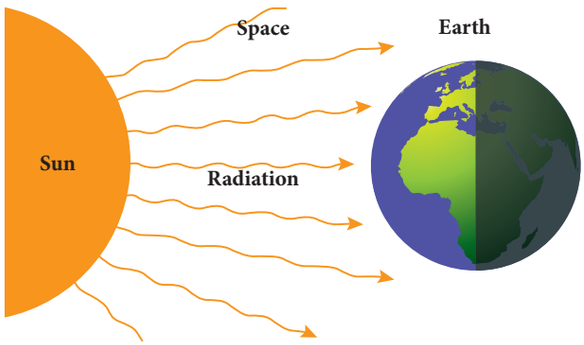


Figure 4.3 Heat transfer by radiation

Radiation in daily life

- Heat energy from the Sun reaches the Earth by radiation.
- While standing near fire we feel the heat which is transferred as radiation.
- Black surfaces absorb heat radiation. So that the bottom of the cooking vessels are painted black.
- White colour reflects heat radiation. That's why we are advised to wear white cloth during summer.

DO YOU KNOW?

Heat transfer by radiation is visible to our eyes. When a substance is heated to 500°C the radiation begins to become visible to the eye as a dull red glow, and it is sensed as warmth by the skin. Further heating rapidly increases the amount of radiation, and its perceived colour becomes orange, yellow and finally white.

4.3 Calorimetry

We studied about the effects of heat energy. When heat energy is supplied to substances, physical changes take place in them. Solid form of water (ice) is changed to liquid form, and liquid form of water is changed to gaseous form. These are all the physical changes due to heat energy. Similarly, heat energy produces chemical changes also. To know more about the physical and chemical changes that take place in substances, we need to measure the amount of heat involved. The technique used to measure the amount of heat involved in a physical or a chemical process is known as calorimetry.

4.3.1 Temperature

Temperature is a physical quantity which expresses whether an object is hot or cold. It is measured with the help of thermometer. There are three scales to measure the temperature. They are:

- Celcius scale
- Fahrenheit scale
- Kelvin scale

Among these three scales, Kelvin scale is the most commonly used one. You will study about this elaborately in Standard IX.

4.3.2 Unit of Heat

We know that heat is a form of energy. The unit of energy in SI system is joule. So, heat is also measured in joule. It is expressed by the symbol J. The most commonly used unit of heat is calorie. One calorie is the amount of heat energy required to raise the temperature of 1 gram of water through 1°C. The relation between calorie and joule is given as, 1 calorie = 4.186 J.

DO YOU KNOW?

The amount of energy in food items is measured by the unit kilo calorie.

1 kilo calorie = 4200 J (Approximately).

4.3.3 Heat capacity

Activity 6

Take some amount of water and cooking oil in two separate vessels. Heat them till they reach a particular temperature (Caution: Heat the oil under the supervision of your teacher). Which one is heated first? Water will take more time to get heated. Why?

In general, the amount of heat energy gained or lost by a substance is determined by three factors. They are:

- Mass of the substance
- Change in temperature of the substance
- Nature of the material of the substance

Different substances require different amount of heat energy to reach a particular temperature. This nature is known as heat capacity of a substance. Heat capacity is defined as the amount of heat energy required by a substance to raise its temperature by 1°C or 1 K. It is denoted by the symbol C'.

Heat capacity

$$= \frac{\text{Amount of heat energy required (Q)}}{\text{Raise in temperature } (\Delta T)}$$

$\therefore C' = Q / \Delta T$

The unit of heat capacity is cal / °C. In SI system, it is measured in JK^{-1}.

DO YOU KNOW?

Water has higher heat capacity than most other substances. This accounts for the use of water as common coolant. 100 g of water can take away more heat than 100 g of oil.

Problem 1

The temperature of a metal ball is 30° C. When an energy of 3000 J is supplied, its temperature raises by 40° C. Calculate its heat capacity.

Solution

Heat capacity, $C' = Q / \Delta T$

Here, $Q = 3000$ J

$\Delta T = 40°C - 30°C = 10°C$ or 10 K

$C' = 3000 / 10 = 300$ JK^{-1}

The heat capacity of the metal ball is 300 JK^{-1}.

Problem 2

The energy required to raise the temperature of an iron ball by 1 K is 500 JK^{-1}. Calculate the amount of energy required to raise its temperature by 20 K.

Solution

Heat capacity, $C' = Q / \Delta T$

$Q = C' \times \Delta T$

Here, $C' = 500$ JK^{-1}

$\Delta T = 20$ K

$\therefore Q = 500 \times 20 = 10000$ J.

The amount of heat energy required is 10000 J.

4.3.4 Specific heat capacity

When the heat capacity of a substance is expressed for unit mass, it is called specific heat capacity. Specific heat capacity of a substance is defined as the amount of heat energy required to raise the temperature of 1 kilogram of a substance by 1°C or 1 K. It is denoted by the symbol C.

Specific heat capacity

$$= \frac{\text{Amount of heat energy required (Q)}}{\text{Mass} \times \text{Raise in temperature } (\Delta T)}$$

$\therefore C = Q / m \times \Delta T$

The SI unit of specific heat capacity is J kg^{-1} K^{-1}.

Problem 3

An energy of 84000 J is required to raise the temperature of 2 kg of water from 60° C to 70° C. Calculate the specific heat capacity of water.

Solution

Specific heat capacity, $C = Q / m \times \Delta T$

Here, $Q = 84000$ J

$m = 2$ kg

$\Delta T = 70° C - 60° C = 10° C$ or 10 K

$C = 84000 / 2 \times 10 = 4200$ J kg^{-1} K^{-1}

The Specific heat capacity of water is 4200 J kg^{-1} K^{-1}.

Problem 4

The specific heat capacity of a metal is 160 J $kg^{-1}K^{-1}$. Calculate the amount of heat energy required to raise the temperature of 500 gram of the metal from 125° C to 325° C.

Solution

Specific heat capacity, $C = Q / m \times \Delta T$

$Q = C \times m \times \Delta T$

Here, $C = 160$ J kg K^{-1}

$m = 500$ g $= 0.5$ kg

$\Delta T = 325° C - 125° C = 200° C$ or 200 K

$= 160 \times 0.5 \times 200 = 16000$ J.

The amount of heat energy required is 16000 J.

4.4 Calorimeter

A calorimeter is a device used to measure the amount of heat gained or lost by a substance. It consists of a vessel made up of metals like copper or aluminium which are good conductors of heat and electricity.

Q9C5H3

The metallic vessel is kept in an insulating jacket to prevent heat loss to the environment. There are two holes in it. Through one hole a thermometer is inserted to measure the

temperature of the contents. A stirrer is inserted through another hole for stirring the content in the vessel. The vessel is filled with liquid which is heated by passing current through the heating element. Using this device we can measure the heat capacity of the liquid in the container.

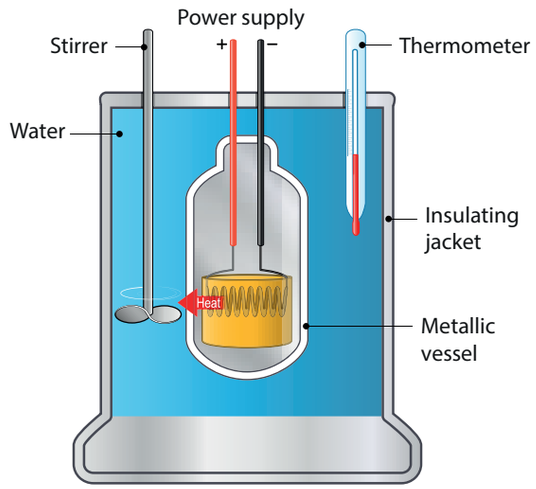


Figure 4.4 Calorimeter

DO YOU KNOW?

The world's first ice-calorimeter was used in the year 1782 by Antoine Lavoisier and Pierre-Simon Laplace, to determine the heat generated by various chemical changes.

4.5 Thermostat

A thermostat is a device which maintains the temperature of a place or an object constant. The word thermostat is derived from two Greek words, 'thermo' meaning heat and 'static' meaning staying the same. Thermostats are used in any device or system that gets heated or cools down to a pre-set temperature. It turns an appliance or a circuit on or off when a particular temperature is reached. Devices which use thermostat include building heater, central heater in a room, air conditioner, water heater, as well as kitchen equipments including oven and refrigerators. Sometimes, a thermostat functions both as the sensor and the controller of a thermal system.

Figure 4.5 Thermostat

4.6 Thermos flask (Vacuum flask)

The thermos flask (Vacuum flask) is an insulating storage vessel that keeps its content hotter or cooler than the surroundings for a longer time. It is primarily meant to enhance the storage period of a liquid by maintaining a uniform temperature and avoiding the possibilities of getting a bad taste.

DO YOU KNOW?

The vacuum flask was invented by Scottish scientist Sir James Dewar in 1892. In his honour it is called as Dewar flask. It's also known as Dewar bottle.

Working of Thermos flask

A thermos flask has double walls, which are evacuated. It is silvered on the inside. The vacuum between the two walls prevents heat being transferred from the inside to the outside by conduction and convection.

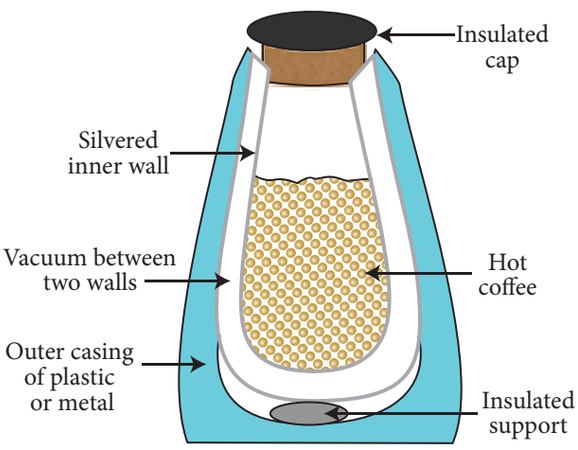


Figure 4.6 Thermos flask

With very little air between the walls, there is almost no transfer of heat from the inner wall to the outer wall or vice versa. Conduction can only occur at the points where the two walls meet, at the top of the bottle and through an insulated support at the bottom. The silvered walls reflect radiated heat back to the liquid in the bottle.

Points to Remember

- Heat is a form of energy which is transferred from one part to another part of a substance.
- Heat transfer causes expansion, increases temperature and changes the state of the substance.
- When thermal energy is supplied to a solid, the atoms or molecules present in it gain energy and vibrate more vigorously about their fixed positions, forcing each other further apart.
- Melting, vapourisation, sublimation, condensation, freezing and deposition are the change of states that take place due to heat energy.
- Heat transfer takes place in three ways: conduction, convection and radiation.
- Conduction occurs in solids, convection in liquids and gases, and radiation takes place in vaccum.
- Capacity of substances to gain or loose heat energy is determined by three factors: mass of the substance, change in temperature and nature of the substance.
- There are three scales to measure temperature: Celcius scale, Fahrenheit scale and Kelvin scale.
- Calorimeter measures the heat capacity of water.

A-Z GLOSSARY

Calorimeter	A device which measures the heat capacity of liquids.
Calorimetry	The technique used to measure the amount of heat involved in a physical or a chemical process.
Conduction	The process of heat transfer in solids from a region of higher temperature to a region of lower temperature without the actual movement of molecules.
Convection	The form of heat transfer from places of high temperature to places of low temperature by the actual movement of liquid or gas molecules.
Heat capacity	Amount of heat energy required to raise the temperature of a substance by 1° C or 1 K.
Radiation	The form of heat transfer from one place to another place in the form of electromagnetic waves.
Specific heat capacity	Amount of heat energy required to raise the temperature of 1 kilogram of a substance by 1° C or 1 K.
Temperature	Physical quantity which expresses whether an object is hot or cold.
Thermos flask	An insulating storage vessel that keeps its content hotter or cooler than the surroundings for a longer time.
Thermostat	A temperature sensing device that turns an appliance or circuit on or off when a particular temperature is reached in it.

TEXTBOOK EXERCISES

L6I2M4

I. Choose the best answer.

1. Heat is a form of _____.
   a) electrical energy
   b) gravitational energy
   c) thermal energy
   d) None of these
2. If you apply some heat energy to a substance, which of the following can take place in it?
   a) Expansion
   b) Increase in temperature
   c) Change of state
   d) All the above.
3. Which of the following substances will absorb more heat energy?
   a) Solid b) Liquid
   c) Gas d) All the above
4. If you apply equal amount of heat to a solid, liquid and gas individually, which of the following will have more expansion?
   a) Solid b) Liquid
   c) Gas d) All of them
5. The process of converting a liquid into a solid is called_____.
   a) sublimation b) condensation
   c) freezing d) deposition
6. Conduction is the way of heat transfer which takes place in a_____.
   a) solid b) liquid
   c) gas d) All of them

II. Fill in the blanks.

1. A calorimeter is a device used to measure the_____.
2. _____ is defined as the amount of heat required to raise the temperature of 1kg of a substance by 1°C.
3. A thermostat is a device which maintains _____.
4. The process of converting a substance from gaseous state to solid state is called _____.
5. If you apply heat energy, the temperature of a system will _____.
6. If the temperature of a liquid in a container is decreased, then the interatomic distance will _____.

III. State True or False. If false, correct the statement.

1. The applied heat energy can be realised as an increase in the average kinetic energy of the molecules.
2. The dimensions of a substance are increased if the temperature of the substance is decreased.
3. The process of converting a substance from solid state to gaseous state is called condensation.
4. Convection is the process by which the thermal energy flows in solids.
5. The amount of heat gained by a substance is equal to the product of its mass and latent heat.
6. In a thermos flask, the silvered walls reflect and radiate the heat outside.

IV. Match the following.

Conduction	Liquid
Convection	Gas to liquid
Radiation	Solid to gas
Sublimation	Vaccum
Condensation	Solid

V. Consider the statements given below and choose the correct option.

1. **Assertion:** Radiation is a form of heat transfer which takes place only in vacuum.

   Reason: The thermal energy is transferred from one part of a substance to another part without the actual movement of the atoms or molecules.

2. **Assertion:** A system can be converted from one state to another state.

   Reason: It takes place when the temperature of the system is constant.

a. Both assertion and reason are true and reason is the correct explanation of assertion.

b. Both assertion and reason are true, but reason is not the correct explanation of assertion.

c. Assertion is true, but the reason is false.

d. Assertion is false, but the reason is true.

VI. Answer briefly.

1. What are the applications of conduction in our daily life?
2. What are the effects of heat?
3. Name three types of heat transfer.
4. What is conduction?
5. Write a note on convection.
6. Define specific heat capacity.
7. Define one calorie.

VII. Answer in detail.

1. With the help of a neat diagram, explain the working of a calorimeter.
2. Write a note on thermostat.
3. Explain the working of thermos flask.

VIII. Higher Order Thinking Questions.

1. Why does the bottom of a lake not freeze in severe winter though the surface is all frozen?
2. Which one of the following statements about thermal conductivity is correct? Give reason.

   a) Steel > Wood > Water

   b) Steel > Water > Wood

   c) Water > Steel > Wood

   d) Water > Wood > Steel

IX. Numerical Problems.

1. An iron ball requires 1000 J of heat to raise its temperature by 20°C. Calculate the heat capacity of the ball.
2. The heat capacity of the vessel of mass 100 kg is 8000 J/°K. Find its specific heat capacity.

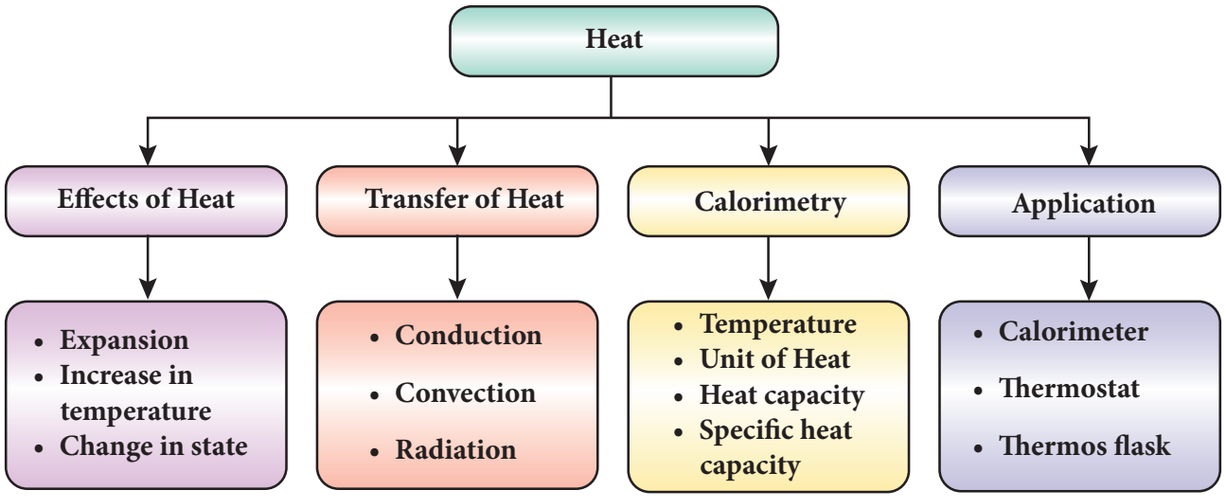
REFERENCE BOOKS

1. Fundamentals of Statistical and Thermal Physics - F.Reif
2. Statistical Thermodynamics and Microscale Thermo -physics - Carey
3. Heat, Thermodynamics and Statistical Physics - BrijLal and Dr. N. Subramaniyam
4. Thermodynamics and an Introduction to Thermos-statistics byHerbert Hallen
5. Fundamentals of Engineering Thermo dynamics by Michael Moran

INTERNET RESOURCES

1. https://www.explainthatstuff.com/thermostats.html
2. https://youtu.be/8-nLHWpgDsM
3. https://youtu.be/rYwgsF_haAg
4. https://youtu.be/EwzkYTfHFbo

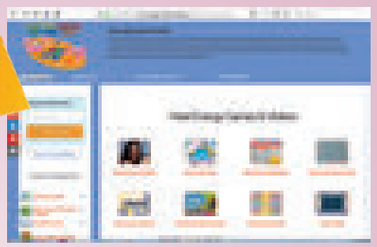
Concept Map



ICT CORNER

Heat

Through this activity you will learn about heat energy through Interactive games.

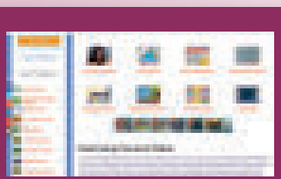


Step 1 Open the Browser and type the URL given below

Step 2 You can see lot of games about heat energy.

Step 3 For example, click "Heat Energy match it" game. You will see the match words in the screen. Play and learn about heat energy.

Step 4 Likewise you can explore all the games.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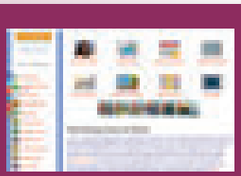
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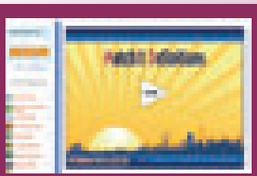
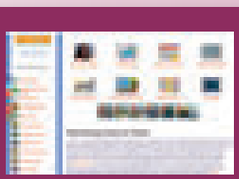

Step3


Step4

Browse in the link:

https://www.learninggamesforkids.com/heat-energy-games.html

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UNIT 5

ELECTRICITY

Learning Objectives

T6X2D6

After the completion of this lesson, students will be able to:

- know about the basic properties of electric charges.
- explain the transfer of charges between two objects.
- understand the working of electroscope.
- recognise the effects of electric current.
- assemble different electric circuits.
- list out the applications of electricity.

Introduction

All things we use in our life are made up of elements. Each element is made up of atoms which is the smallest unit. John Dalton, the scientist considered that atoms cannot be divided further. But, it was found out later through Rutherford's gold foil experiment that atoms are made up of particles like proton, electron and neutron. Movement of electrons in a material constitutes electric current and generates an energy called electric energy or electricity. We use this energy in our life for various needs. Electric bulbs, fans, elctric iron box, washing machines and refrigirators are some of the appliances which work with the help of electricity. In this lesson we will study about electric charges and how they are transferred. This lesson will also cover electric circuits and the effects of electric current.

5.1 Atom

An atom consists of proton, electron and neutron which are called sub-atomic particles. Proton and neutron are found inside the nucleus which is at the centre of an atom. Electrons revolve around the nucleus in different paths called orbits. In an atom, the number of protons and the number of electrons will be equal. There is a force of attraction between the protons in the nucleus and the electrons in the orbits. Electrons in the inner orbits are strongly attracted by the protons and they cannot be removed from the atom easily. But, the electrons in the outermost orbits are loosely bound and they can be easily removed from the atom.

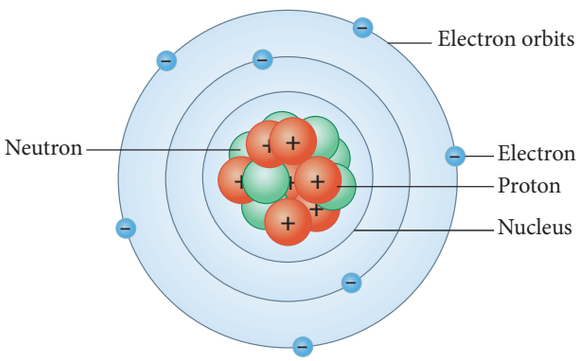


Figure 5.1 Atom model

5.2 Charges

Charge or electric charge is the basic property of matter that causes objects to attract or repel each other. It is carried by the subatomic particles like protons and electrons. Charges can neither be created nor be destroyed. There are two types of charges: positive charge and negative charge. Protons carry positive charge and the electrons carry negative charge. There is a force of attraction or repulsion between the charges. Unlike charges attract each other and like charges repel each other.

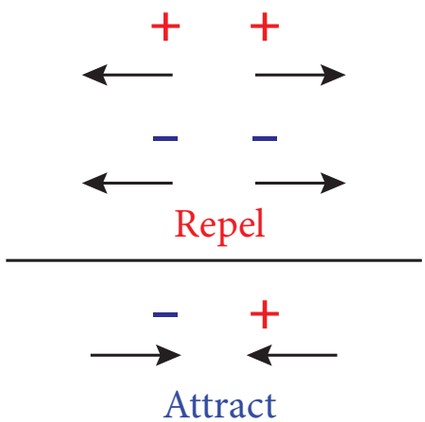


Figure 5.2 Attraction and repulsion between charges

Electric charge is measured in coulomb (C). Small amount of charge that can exist freely is called elementary charge (e). Its value is 1.602×10^{-19} C. This is the amount of charge possessed by each proton and electron. But, protons have positive elementary charge (+e) and electrons have negative elementary charge (-e). Since protons and electrons are equal in number, an atom is electrically neutral.

5.3 Transfer of Charges

As we saw earlier, electrons (negative electric charges) in the outermost orbit of an atom can be easily removed. They can be transferred from one substance to another. The substance which gains electrons become negatively charged and the substance which looses electrons becomes positively charged. Transfer of charges takes place in the following ways.

E5F2F1

- Transfer by Friction
- Transfer by Conduction
- Transfer by Induction

5.3.1 Transfer by Friction

Activity 1

Take a comb and place it near some pieces of paper. Are they attracted by the comb? No. Now comb your dry hair and place it near them. What do you see? You can see that the paper pieces are attracted by the comb now. How is it possible?

Comb rubbed with hair gains electrons from the hair and becomes negatively charged. These electrons are accumulated on the surface of the comb. When a piece of paper is teared into bits, positive and negative charges are present at the edges of the bits. Negative charges in the comb attract positive charges in the bits. So, the paper bits are moving towards the comb. While combing hair, charges are transferred from the hair to comb due to friction. If the hair is wet, the friction between the hair and the comb reduces which will reduce the number of electrons transferring from hair to comb. Hence, rubbing certain materials with one another can cause the build-up of electrical charges on the surfaces. From this it is clear that charges are transferred by friction.

Figure 5.3 Charges in comb.

DO YOU KNOW?

A neutral object can become positively charged when electrons get transferred to another object; not by receiving extra positive charges.

Similar effect can be seen when we rub few materials with one another. When a glass rod is rubbed with a silk cloth the free electrons in the glass rod are transferred to silk cloth. It is because the free electrons in the glass rod are less tightly bound as compared to that is in silk cloth. Since the glass rod looses electrons, it has a deficiency of electrons and hence acquires positive charge. But, the silk cloth has excess of electrons. So, it becomes negatively charged.

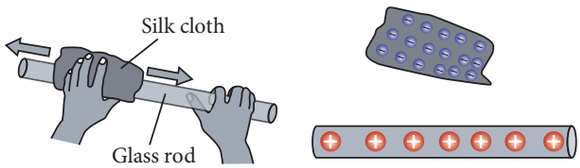


Figure 5.4 Transfer of charges in glass rod

When an ebonite rod (rod made by vulcanized rubber) is rubbed with fur, the fur transfers electrons to the ebonite rod because the electrons in the outermost orbit of the atoms in fur are loosely bound as compared to the ebonite rod. The ebonite rod which has excess electrons becomes negatively charged and the fur which has deficiency of electrons is positively charged.

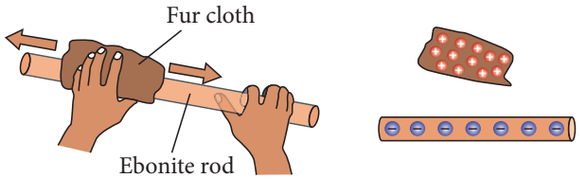
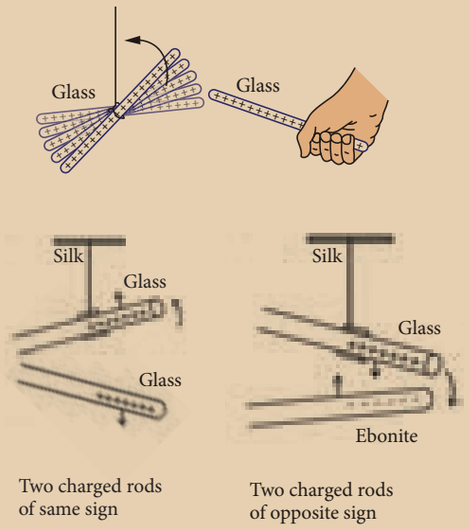


Figure 5.5 Transfer of charges in ebonite rod

From these we know that when two materials are rubbed together, some electrons may be transferred from one material to the other, leaving them both with a net electric charge.

DO YOU KNOW?

If a positively charged glass rod is brought near another glass rod, the rods will move apart as they repel each other. If a positively charged glass rod is brought close to a negatively charged ebonite rod, the rods will move toward each other as they attract. The force of attraction or repulsion is greater when the charged objects are closer.



5.3.2 Transfer by Conduction

Activity 2

Take a sheet of paper. Turn it into a hollow cylinder. Tie one end of the cylinder with a silk thread and hang it from a stand. Now take an ebonite rod and charge it by rubbing it with a woollen cloth. Bring this charged ebonite rod near the paper cylinder. The cylinder will be attracted by the rod. If you touch the paper cylinder by the charged rod, you will see the paper cylinder repelling the rod. Can you say the reason?

When the ebonite rod is rubbed with woollen cloth, electrons from the woollen cloth are transferred to the ebonite rod. Now ebonite rod will be negatively charged. When

it is brought near the paper cylinder, negative charges in the rod are attracted by the positive charges in the cylinder. When the cylinder is touched by the rod, some negative charges are transferred to the paper. Hence, the negative charges in the rod are repelled by the negative charges in the cylinder.

Thus, we can say that charges can be transferred to an object by bringing it in contact with a charged body. This method of transferring charges from one body to other body is called transfer by conduction.

DO YOU KNOW?

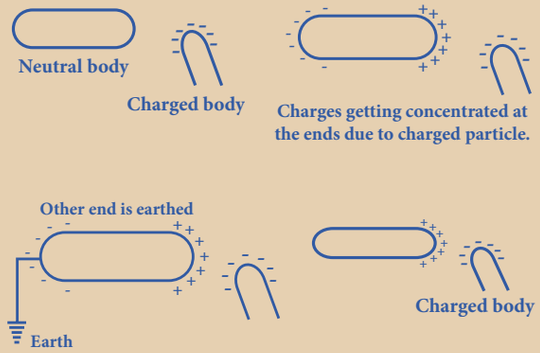
The materials which allow electric charges to pass through them easily are called conductors of electricity. For example, metals like aluminium, copper are good conductors of electricity. Materials which do not allow electric charges to pass through them easily are called insulators. Rubber, wood and plastic are insulators.

5.3.3 Transfer by Induction

We saw that we can charge an uncharged object when we touch it by a charged object. But, it is also possible to obtain charges in a body without any contact with other charged body. The process of charging an uncharged body by bringing a charged body near to it but without touching it is called induction. The uncharged body acquires an opposite charge at the near end and similar charge at the farther end.

Activity 3

Bring a negatively charged plastic rod near a neutral rod. When the negatively charged plastic rod is brought close to the neutral rod, the free electrons move away due to repulsion and start piling up at the farther end. The near end becomes positively charged due to deficit of electrons. When the neutural rod is grounded, the negative charges flow to the ground. The positive charges at the near end remain held due to attractive forces and the electrons inside the metal becomes zero. When the rod is removed from the ground, the positive charges continue to be held at the near end. This makes the neutral rod a positively charged rod.



Similarly, when a positively charged rod is brought near an uncharged rod, negatively charged electrons are attracted towards it. As a result there is excess of electrons at nearer end and deficiency of electrons at the farther end. The nearer end of the uncharged rod becomes negatively charged and far end is positively charged.

5.4 Flow of Charges

Suppose you have two metallic spheres; one having more negative charge (excess of electrons) and the other having more positive charge (deficiency of electrons). When you connect them both with the help of a metallic wire, excess electrons from the negatively charged sphere will start flowing towards the positively charged sphere. This flow continues till the number of electrons in both the sphere is equal. Here, the positively charged sphere is said to be at higher potential and the negatively

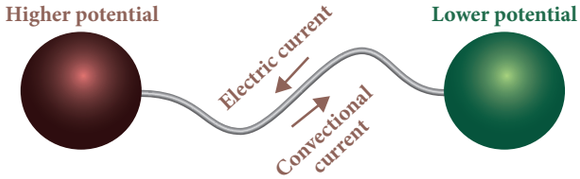


Figure 5.6 Transfer of charges

charged sphere is said to be at lower potential. Hence, electrons flow from lower potential to higher potential. This is known electric current (flow of electrons). The difference between these potentials is known as potential difference, commonly known as voltage.

Before the discovery of electrons, it was considered that electric current is due to the flow of positive charges. Flow of positive charge is called conventional current. Conventional current flows from higher potential to lower potential.

5.5 Electroscope

An electroscope is a scientific instrument used to detect the presence of electric charge on a body. In the year 1600, British physician William Gilbert invented the first electroscope. It is the first electrical instrument. There are two types of electroscope: pith-ball electroscope and gold-leaf electroscope. An electroscope is made out of conducting materials, generally metal. It works on the principle that like charges repel each other. In a simple electroscope two metal sheets are hung in contact with each other. They are connected to a metal rod that extends upwards, and ends in a knob at the end.

The first electroscope developed in 1600 by William Gilbert was called versorium. The versorium was simply a metal needle allowed to pivot freely on a pedestal. The metal would be attracted to charged bodies brought near.

If you bring a charged object near the knob, electrons will either move out of it or into it. This will result in charges accumulating on the metal leaves inside the electroscope. If a negatively charged object is brought near the top knob of the electroscope, it causes free electrons in the electroscope to move down into the leaves, leaving the top positive. Since both the leaves have negative charge, they repel each other and move apart. If a positive object is brought

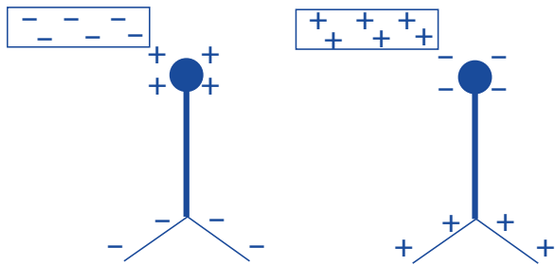


Figure 5.7 Movement of charges in electroscope

near the top knob of the electroscope, the free electrons in the electroscope start to move up towards the knob. This means that the bottom has a net positive charge. The leaves will spread apart again now.

5.5.1 Gold leaf electroscope

The gold-leaf electroscope was developed in 1787 by a British scientist named Abraham Bennet. Gold and silver are used in electroscope because they are the best conductors of electric current.

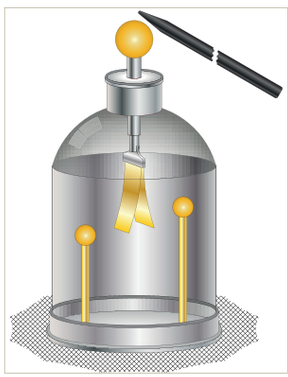


Figure 5.8 Gold leaf electroscope

Structure of Electroscope

It is made up of a glass jar. A vertical brass rod is inserted into the jar through a cork. The top of the brass rod has a horizontal brass rod or a brass disc. Two gold leaves are suspended from the brass rod inside the jar.

Working of Electroscope

When the brass disc of the electroscope is touched by a charged object, electric charge gets transferred to the gold leaf through the rod. This results in gold leaves moving away from each other. This happens because both the leaves have similar charges.

Charging

Transfer of charge from one object to another is called charging. In case of the gold leaves, charge is transferred through the brass rods.

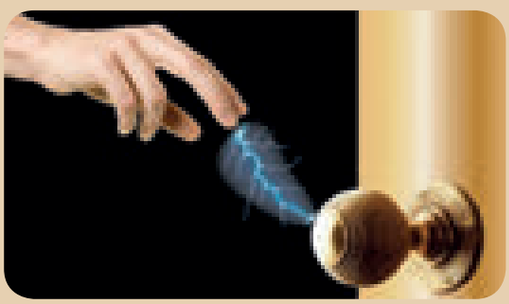
Electrical discharge

The gold leaves resume their normal position after some time. This happens because they lose their charge. This process is called electrical discharge. The gold leaves would also be discharged when someone touches the brass rod with bare hands. In that case, the charge is transferred to the earth through the human body.

5.6 Lightning and Thunder

Activity 4

Rub your foot on a carpet floor and touch a door knob. What do you feel? Do you feel the shock in your hand? Why does this happen?



Getting a shock from a door knob after rubbing your foot on a carpet floor, results from discharge. Discharge occurs when electrons on the hand are quickly pulled to the positively charged doorknob. This movement of electrons, which is felt as a shock, causes the body to lose negative charge. Electric discharge takes place in a medium, mostly gases. Lightning is another example of discharge that takes place in clouds.

Lightning is produced by discharge of electricity from cloud to cloud or from cloud to ground. During thunderstorm air is moving upward rapidly. This air which moves rapidly, carries small ice crystals upward. At the same time, small water drops move downward. When they collide, ice crystals become positively charged and move upward and the water drops become negatively charged and move downward. So the upper part of the cloud is positively charged and the lower part of the cloud is negatively charged. When they come into contact, electrons in the water drops are attracted by the positive charges in the ice crystals. Thus, electricity is generated and lightning is seen.

Sometimes the lower part of the cloud which is negatively charged comes into contact with the positive charges accumulated near the mountains, trees and even people on the earth. This discharge produces lot of heat and sparks that results in what we see as lightning. Huge quantities of electricity are discharged in lightning flashes and temperatures of over 30,000°C or more can be reached. This extreme heating causes the air to expand explosively fast and then they contract. This expansion and contraction create a shock wave that turns into a booming sound wave, known as thunder.

DO YOU KNOW?

Lightning's extreme heat will vaporize the water inside a tree, creating steam that may burn out the tree.

Sometimes lightning may be seen before the thunder is heard. This is because the distance between the clouds and the surface is very long and the speed of light is more than the speed of sound.

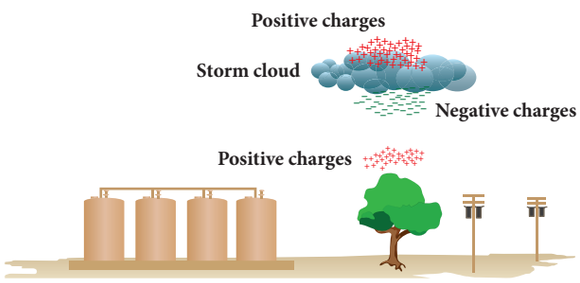


Figure 5.9 Formation of Lightning

DO YOU KNOW?

During lightning and thunder, we should avoid standing in ground or open spaces. You should make yourself as small as possible by squating. It is however safe to stay inside a car because the car acts as a shield and protects us from the electric field generated by the storm.

5.6.1 Earthing

A safety measure devised to prevent people from getting shocked if the insulation inside electrical devices fails is called earthing. Electrical earthing can be defined as the process of transferring the discharge of electrical energy directly to the earth with the help of low-resistance wire.

We get electrical energy from different sources. Battery is one such source. We use it in wall clocks, cell phones etc. For the working of refrigerators, air conditioners, washing machines, televisions, laptops and water heaters we use domestic power supply. Usually an electric appliance such as a heater, an iron box, etc. are fitted with three wires namely live, neutral and earth. The earth wire is connected to the metallic body of the appliance. This is done to avoid accidental shock.

Suppose due to some defect, the insulation of the live wire inside an electric iron is burnt then the live wire may touch the metallic body of the iron. If the earth wire is properly connected to the metallic body, current will pass into the earth through earth wire and it will protect us from electric shock. The earth, being a good conductor of electricity, acts as a convenient path for the flow of electric current that leaks out from the insulation.

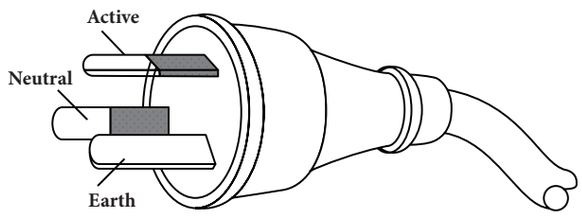


Figure 5.10 Live, neutral and earth wire

5.6.2 Lightning Arresters

Lightning arrestor is a device used to protect buildings from the effects of lightning. Lightning conductor consists of a metallic lightning rod (in the form of spikes) that remains in air at the top of the building. Major portion of the metal rod and copper cable are installed in the walls during its construction. The other end of the rod is placed deep into the soil. When lightning falls, it is attracted by the metallic rods at the top of the building. The rod provides easy route for the transfer of electric charge to the ground. In the absence of lightning arrestors, lightning will fall on the building and the building will be damaged.

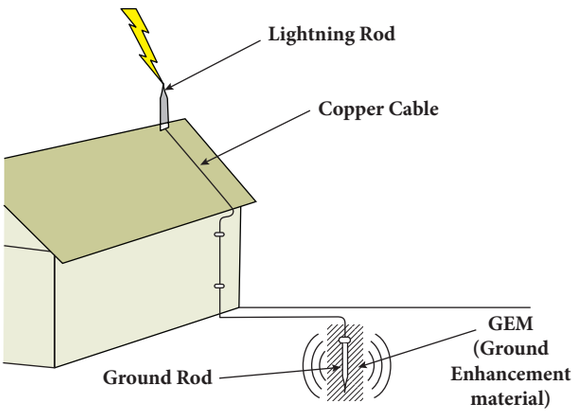


Figure 5.11 Lightning arresters

5.7 Electric Circuits

We saw that when two oppositely charged spheres are connected by a metal wire, electrons flow from the sphere which is at lower potential to the sphere at higher potential. Similarly, if two terminals of a battery which are at different potential are connected by a metallic wire, electrons will flow from negative terminal to positive terminal. The path through which electrons flow from one terminal to another terminal of the source, is called electric circuit.

A simple circuit consists of four elements: a source of electricity (battery), a path or conductor through which electricity flows (wire), a switch to control the circuit and an electrical resistor (lamp) which is any device that requires electricity to operate.

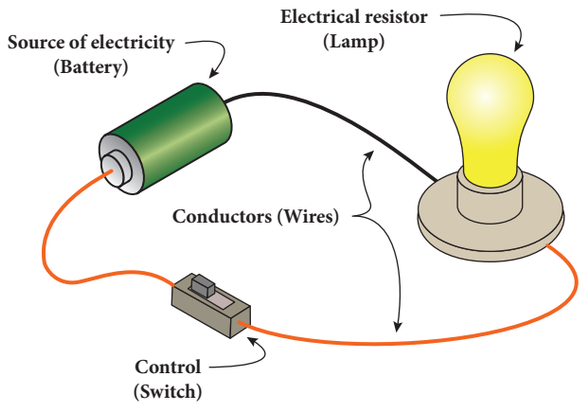
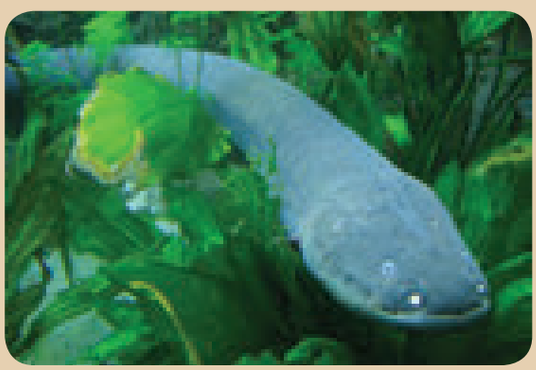


Figure 5.12 Simple electric circuit

The above figure shows a simple circuit containing a battery, two wires, key and an electric bulb. The source can be a battery or the electric outlet in your room. The electrical resistor refers to the device that consumes the energy. Control (key) is the mechanism that is used to start, stop and regulate the electric current. When the key is on, electrons from the battery flow through the circuit from the negative terminal through the wire conductor, then through the bulb and finally back to the positive terminal. The light glows when current is flowing through its filament. There are two basic ways in which we can connect these components. They are: series and parallel.

The electric eel is a species of fish which can give electric shocks of upto six hundred fifty watts of electricity. But if the eel repeatedly shocks, its electric organs become completely discharged. Then a person can touch it without being shocked.



5.7.1 Series Circuit

A series circuit is one that has more than one resistor (bulb) but only one path through which the electrons can travel. From one end of the battery the electrons move along one path with no branches through the resistors (bulbs) to the other end of the cell. All the components in a series circuit are connected end to end. So, current through the circuit remains same throughout the circuit. But, the voltage gets divided across the bulbs in the circuit. In the following series circuit two bulbs are used as resistors.

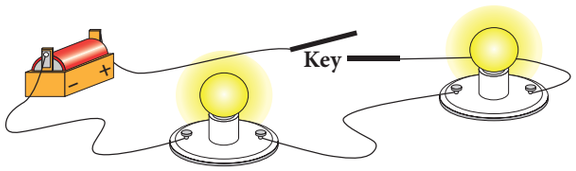


Figure 5.13 Series circuit

In this series circuit, charges (electrons) from the battery have only one path to travel. Here battery, key and two bulbs are connected in series. Charges flow from the battery to each bulb, one at a time, in the order they are wired to the circuit. If one bulb in the circuit is unscrewed, the current flow to another bulb would be interrupted. We put serial lights during festivals. If the lights are in a series circuit, one burned out bulb will keep all the lights off. If the number of bulbs in a circuit with a battery increases, the light will be dimmer because many resistors are acting on the same power from the battery.

We saw that in series circuit same current travels through every resistance and the voltage will be different across each resistance. Let us consider three bulbs connected in series. Let I be the current through the circuit and V_1, V_2, V_3 be the voltage across each bulb. The supply voltage V is the total of the individual voltage drops across the resistances (bulbs).

$$V = V_1 + V_2 + V_3$$

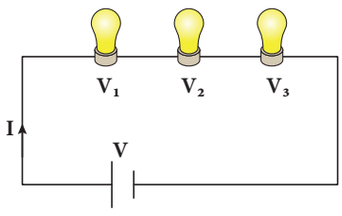


Figure 5.14 Voltage in series circuit

5.7.2 Parallel Circuit

In a parallel circuit, there is more than one resistor (bulb) and they are arranged on many paths. This means charges (electrons) can travel from one end of the cell through many branches to the other end of the cell. Here, voltage across the resistors (bulbs) remains the same but the current flowing through the circuit gets divided across each resistor.

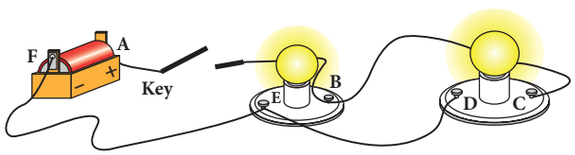


Figure 5.15 Parallel circuit

In the above diagram, current can flow in two paths: ABEFA and ABCDEFA. Here, it is clear that electricity from the cell can take either path ABEFA or path ABCDEFA to return to the cell. From the diagram you will notice that even when one resistor (bulb) burns out, the other bulbs will work because the electricity is not flowing through only one path. All the light bulbs in our homes are connected in parallel circuit. If one bulb burns out, the other bulbs in the rooms will still work. The bulbs in a parallel circuit do not dim out as in series circuits. This is because the voltage across one branch is the same as the voltage across all other branches.

Let us consider three bulbs connected in series. Let V be the voltage across the bulbs and I_1, I_2, I_3 be the current across each bulb. The current I from the battery is the total of the individual current flowing through the resistances (bulbs).

$$I = I_1 + I_2 + I_3$$

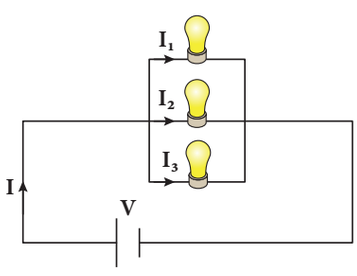


Figure 5.16 Current in parallel circuit

Table 5.1 Difference between series and parallel circuits

Series circuit	Parallel circuit
Same amount of current flows through all the components.	The current flowing through each component combines to form the current flow.
Voltage is different across different components.	Sum of the through each component will be the voltage drawn from the source.
Components are arranged in a line.	Components are arranged parallel to each other.
If one component breaks down, the whole circuit will burn out.	Other components will function even if one component breaks down.

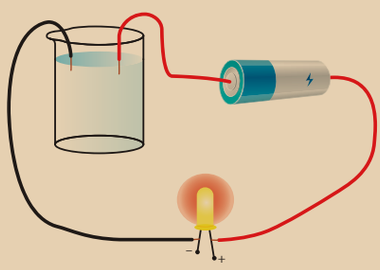
5.8 Effects of Current

When current is flowing through a conductor it produces certain effects. These are known as effects of electric current. These effects result in conversion of electrical energy into different forms of energies such as heat energy, mechanical energy, magnetic energy, chemical energy and so on.

5.8.1 Chemical effect of current

Activity 5

Take two pieces of wire, an LED light and a battery, and make a simple electric circuit. Take some water in a glass and put the wires in the water as shown in the figure. Does the LED bulb glow? What do you understand from this?



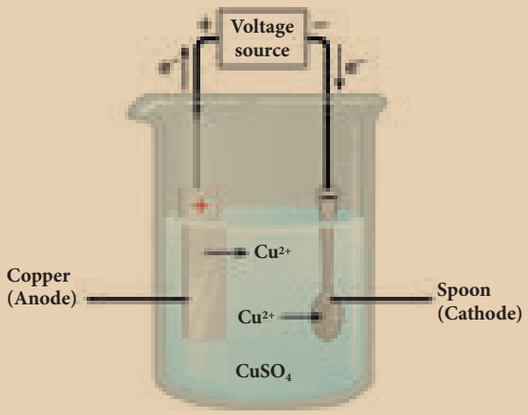
We know that electricity is conducted by metals. This activity shows that liquids also conduct electricity. When electric current is passed through a conducing solution, some chemical reactions take place in the solution. This chemical reactions produce electrons which conduct electricity. This is called chemical effect of electric current. The decomposition of molecules of a solution into positive and negative ions on passing an electric current through it, is called electrolysis. Electrolysis has a number of applications. It is used in extraction and purification of metals. The most general use of electrolyte is electroplating.

Electroplating

Electroplating is one of the most common applications of chemical effects of electric current. The process of depositing a layer of one metal over the surface of another metal by passing electric current in called electroplating.

Activity 6

Take a glass jar and fill it with copper sulphate solution. Take a copper metal plate and connect it to the positive terminal of battery. Connect an iron spoon to the negative terminal of the battery. Now, dip them in the copper sulphate solution. When electric current is passed through the copper sulphate solution, you will find that a thin layer of copper metal is deposited on the iron spoon and an equivalent amount of copper is lost by the copper plate.

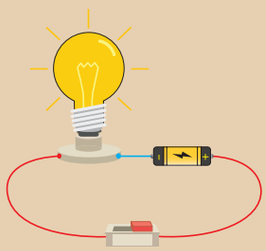


Electro plating is applied in many fields. We use iron in bridges and automobiles to provide strength. However, iron tends to corrode and rust. So, a coating of zinc is deposited on iron to protect it from corrosion and formation of rust. Chromium has a shiny appearance. It does not corrode. It resists scratches. But, chromium is expensive and it may not be economical to make the whole object out of chromium. So, the objects such as car parts, bath taps, kitchen gas burners, bicycle handlebars, wheel rims are made from a cheaper metal and only a coating of chromium is deposited over it.

5.8.2 Heating effect of current

Activity 7

Take a battery, a bulb, a switch and few connecting wires. Make an electric circuit as shown in the figure. Keep the switch in the 'OFF' position. Does the bulb glow? Now move the electric switch to the 'ON' position and let the bulb glow for a minute or so. Touch the bulb now. Do you feel the heat?



When electric current passes through a conductor, there is a considerable 'friction' between the moving electrons and the molecules of the conductor. During this process, electrical energy is transformed to heat energy. This is known as heating effect of electric current. The heat produced depends on the amount of resistance offered by the wire.

Copper wire offers very little resistance and does not get heated up quickly. On the other hand, thin wires of tungsten or nichrome which are used in bulbs offer high resistance and gets heated up quickly. This is

the reason why tungsten wire is used in the filaments of the bulbs and nichrome wire is used as a heating element in household heating appliances. Heating effect of electric current can be seen in many devices. Some of them are given below.

Fuse

Fuse is a strip of alloy wire which is made up of lead and tin with a very low melting point. This can be connected to the circuit. The fuse is usually designed to take specific amount of current. When current passing through the wire exceeds the maximum limit, it gets heated up. Due to low melting point it melts quickly disconnecting the circuit. This prevents damage to the appliances.

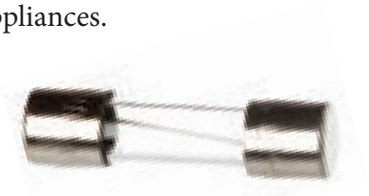


Figure 5.17 Fuse wire

Electric cookers

Electric cookers turn red hot when electric current is passed through the coil. The heat energy produced is absorbed by the cooking pot through conduction.

Electric kettles

The heating element is placed at the bottom of the kettle which contains water. The heat is then absorbed by the liquid and distributed throughout the liquid by convection.

Electric irons

When current flows through the heating element, the heat energy developed is conducted to the heavy metal base, raising its temperature. This energy is then used to press clothes.

Points to Remember

- Opposite charges attract each other and like charges repel each other.
- Charges can be transferred from one region to another region by any of the following ways: Transfer by friction, Transfer by conduction and Transfer by induction.
- Friction between objects results in transfer of electrons between them.
- When a charged body touches another body, charges can be transferred from one body to another.
- Induction is a process of charging an uncharged body by bringing a charged body near to it but not touching it.
- Electroscope is an instrument used to detect and measure electric charges.
- Earthing is the process of connecting the exposed metal parts of an electrical circuit to the ground.
- Lightning arrester is a device used to protect buildings from the effects of lightning.
- A simple circuit consists of four elements: a source of electricity (battery), a path or conductor through which electricity flows (wire), a switch to control the circuit and an electrical resistor (lamp) which is any device that requires electricity to operate.
- The decomposition of molecules of a solution into positive and negative ions on passing an electric current through it is called electrolysis.
- A fuse is a strip of alloy wire which is made of lead and tin with a very low melting point.

A-Z GLOSSARY

Battery	A device that stores and produces electricity from chemical cells.
Circuit	The path through which electric current flows.
Electric charge	Basic property of matter carried by some elementary particles. Electric charge can be positive or negative.

Electric current	Flow of electric charges through a material.
Electron	A tiny particle which revolves around the nucleus of an atom. It has a negative charge of electricity.
Electroscope	A scientific instrument used to detect the presence of electric charges on a metal body.
Friction	The resistance that one surface or object encounters when moving over another.
Fuse	A strip of wire that melts and breaks an electric circuit if the current exceeds a safe level.
Volt	Unit of electrical force or electric pressure.
Voltage	An electromotive force that causes electrons to flow.

E7I4T7

TEXTBOOK EXERCISES

I. Choose the best answer.

1. When an ebonite rod is rubbed with fur, the charge acquired by the fur is
   a) negative b) positive
   c) partly positive and partly negative
   d) None of these

2. The electrification of two different bodies on rubbing is because of the transfer of
   a) neutrons b) protons
   c) electrons d) protons and neutrons

3. Which of the following a simple circuit must have?
   a) Energy source, Battery, Load
   b) Energy source, Wire, Load
   c) Energy source, Wire, Switch
   d) Battery, Wire, Switch

4. An electroscope has been charged by induction with the help of charged glassrod. The charge on the electroscope is
   a) negative b) positive
   c) both positive and negative
   d) None of the above

5. Fuse is
   a) a switch
   b) a wire with low resistance
   c) a wire with high resistance
   d) a protective device for breaking an electric circuit

II. Fill in the blanks.

1. _____takes place by rubbing objects together.
2. The body which has lost electrons becomes _____
3. _____ is a device that protects building from lightning strike.
4. _____ has a thin metallic filament that melts and breaks the connection when the circuit is overheated.
5. Three bulbs are connected end to end from the battery. This connection is called _____

III. State true or false. If false, correct the statement.

1. The charge acquired by an ebonite rod rubbed with a piece of flannel is negative.

2. A charged body induces an opposite charge on an uncharged body when they are brought near.
3. Electroscope is a device used to charge a body by induction.
4. Water can conduct electricity.
5. In parallel circuit, current remains the same in all components.

IV. Match the following.

Two similar charges	acquires a positive charge
Two dissimilar charges	prevents a circuit from overheating
When glass rod is rubbed with silk	repel each other
When ebonite rod is rubbed with fur	attract each other
Fuse	acquires a negative charge

V. Give reason for the following.

1. When a glass rod is rubbed with silk cloth both get charged.
2. When a comb is rubbed with dry hair it attracts small bits of paper.
3. When you touch the metal disc of an electroscope with a charged glass rod the metal leaves get diverged.
4. In an electroscope the connecting rod and the leaves are all metals.
5. One should not use an umbrella while crossing an open field during thunderstorm.

VI. Consider the statements given below and choose the correct option.

1. **Assertion:** People struck by lightning receive a severe electrical shock.
   Reason: Lightning carries very high voltage.
2. **Assertion:** It is safer to stand under a tall tree during lightning.
   Reason: It will make you the target for lightning.

a) Both assertion and reason are true and reason is the correct explanation of assertion.

b) Both assertion and reason are true and reason is not the correct explanation of assertion.

c) Assertion is true but reason is false.

d) Assertion is false but reason is true.

VII. Answer briefly.

1. How charges are produced by friction?
2. What is earthing?
3. What is electric circuit?
4. What is electroplating?
5. Give some uses of electroplating.

VIII. Answer in detail.

1. Explain three ways of charge transfer.
2. What is electroscope? Explain how it works.
3. Explain series and parallel circuit.
4. How lightning takes place?
5. What is electroplating? Explain how it is done.

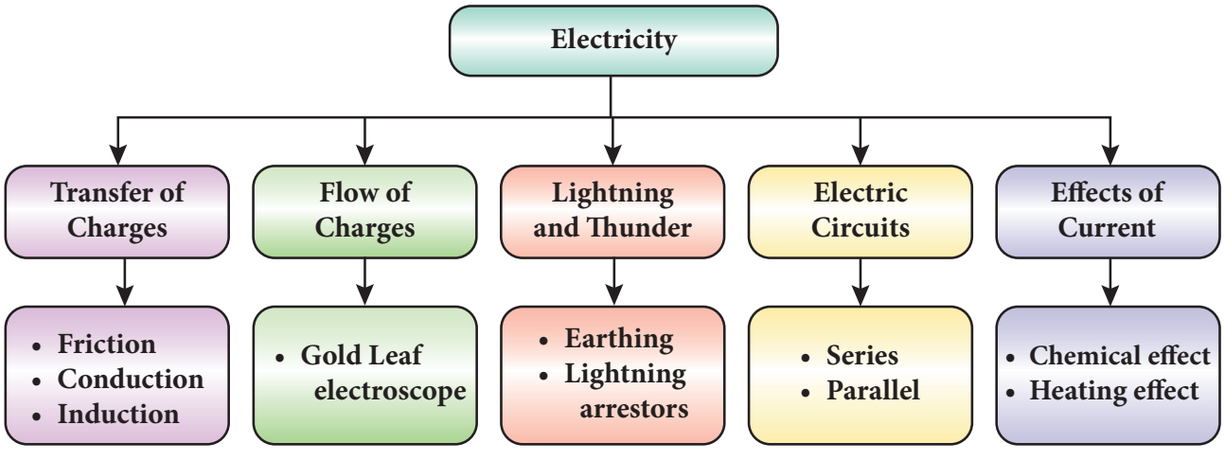
REFERENCE BOOKS

1. Concept of physics - HC Verma
2. A Text-Book on Static Electricity - Hobart Mason
3. Fun With Static Electricity - Joy Cowley
4. Frank New Certificate Physics. McMillan Publishers.

INTERNET RESOURCES

1. http://sciencenetlinks.com/lessons/static-electricity-2/
2. https://www.stem.org.uk/resources/community/collection/13389/static-electricity
3. https://www.physicsclassroom.com/class/estatics

Concept Map



ICT CORNER

Electricity

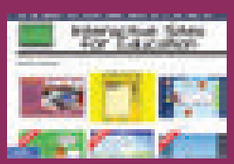
Through this activity you will learn the usage of electricity through Interactive games.

Step 1 Open the Browser and type the URL given below

Step 2 You will see lot of games which is related to Electricity

Step 3 Click the Electricity circuits activity (First activity), you will see the sub topics, like Electricity in home, Introduction to circuits etc...

Step 4 Select the sub topic and play the game. Likewise play all the games.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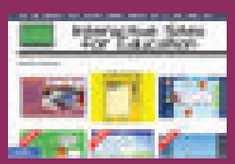
Step2


Step3


Step4

Browse in the link:

http://interactivesites.weebly.com/electricity-and-energy.html

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*Pictures are indicative only

UNIT 6

SOUND

Learning Objectives

After the completion of this lesson, students will be able to:

- understand the production of sound.
- explain the propagation of sound in a medium.
- analyse the properties of sound.
- explain the wave nature of sound.
- know about the mechanism of hearing.
- discuss about noise pollution and the ways to control it.

Introduction

We hear variety of sounds in our daily life. Thundering of clouds, chirping of birds, mewing of cats, rustling of leaves, music on the radio and television and noise of vehicles are some of the sounds that all of us are familiar with. Each sound has particular characteristics. Sound enables us to communicate with each other. Animals also communicate with other members of their species with the help of sound. Some sounds like music are pleasing to us and we like to hear them. But some sounds, for example noise in our surrounding is undesired. In this lesson we will study about the production and propagation of sound, human voice system, hearing, noise pollution and the ways to control it.

6.1 Production of Sound

Sound is produced when an object is set to vibrate. Vibration means a kind of rapid to and fro motion of a particle. This to and fro motion of the particle causes the substances around it to vibrate. Thus sound spreads to the surroundings. The substance through which sound is transmitted is called medium. Sound moves through a medium from the point of generation to the listener. We can understand the production of sound with the help of some activities.

Activity 1

Take the tray of an empty match box and stretch a rubber band around it, along its length. Then, pluck the stretched rubber band with your index finger. What do you observe? Do you hear any sound?

On plucking the rubber band, it starts vibrating. You can hear a feeble humming sound as long as the rubber band is vibrating. The humming sound stops as soon as the rubber

band stops vibrating. This confirms that sound is produced by vibrating particles. You can see this kind of vibrations in stringed musical instruments, such as guitar and sitar also.

Activity 2

Take a metal shallow pan. Hang it at a convenient place in such a way that it does not touch anything. Now, strike it with a stick. Touch the pan gently with your index finger. Do you feel the vibrations? Again, strike the pan with the stick and hold it tightly with your hands, immediately after striking. Do you still hear the sound?

This activity shows that vibrating pan produces sound. In this case vibrations can be felt by touching the pan. But in some cases vibrations are visible.

Activity 3

Take a metal dish, pour some water in it. Strike it at its edge with a spoon. Do you hear any sound? Again strike the dish and touch it. Can you feel the dish vibrating? Look at the surface of water. Do you see any movement on the water surface? Now, hold the dish with your hands. What change do you observe on the surface of the water?

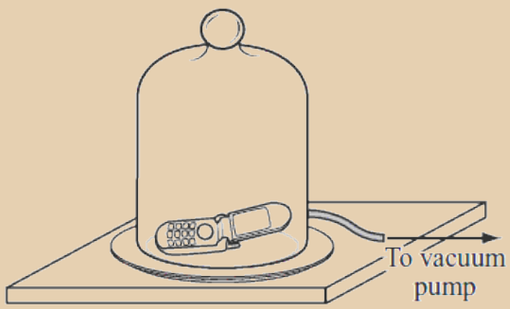
The above activities show that sound is produced when an object is set to vibrate. The sound produced by vibration is propagated from one location to another. When it reaches our ear we hear the sound.

6.2 Propagation of Sound

When you call your friend who is standing at a distance, your friend is able to hear your voice. How your friend is able to hear your voice? He is able to hear because your sound travels from one place to another. As we saw earlier sound is a form of energy and it needs a medium to travel. This can be understood from the activity given below.

Activity 4

Take a bell jar and a mobile phone. Switch on the music in the mobile phone and place it in the jar. Now, pump out the air from the bell jar using a vacuum pump. As more and more air is removed from the jar, the sound from the mobile phone becomes feebler and finally, very faint.



It is clear from this experiment that sound cannot travel in vacuum and it needs a medium like air. Sound travels in water and solids also. The speed of sound is more in solids than in liquids and it is very less in gases.

Thomas Alva Edison, in 1877 invented the phonograph, a device that played the recorded sound.

Activity 5

Take two stones and strike them together and listen to the sound produced by them. Now take the stones underwater and strike them. You will find that the sound produced by the stones underwater is feeble and not very clear.

The speed of sound is the distance travelled by sound in one second. It is denoted by 'v'. It is represented by the expression, $v = n\lambda$, where 'n' is the frequency and 'λ' is the wavelength.

More to know

Wavelength is the distance between two consecutive particles, which are in the same phase of vibration. It is denoted by the Greek letter 'λ'. The unit of wavelength is metre (m).

Frequency is the number of vibrations of a particle in the medium, in one second. It is denoted by 'n'. The unit of frequency is hertz (Hz).

Problem 1

A sound has a frequency of 50 Hz and a wavelength of 10 m. What is the speed of the sound?

Solution

Given, $n = 50$ Hz, $\lambda = 10$m

$v = n\lambda$

$v = 50 \times 10$

$v = 500$ ms^{-1}

Problem 2

A sound has a frequency of 5 Hz and a speed of 25 ms^{-1}. What is the wavelength of the sound?

Solution

Given, $n = 5$ Hz, $v = 25$ ms^{-1}

$v = n\lambda$

$\lambda = v/n = 25/5 = 5$ m

The speed of sound depends on the properties of the medium through which it travels, like temperature, pressure and humidity. In any medium, as the temperature increases the speed of sound also increases. For example, the speed of sound in air is 331 ms^{-1} at 0°C and 344 ms^{-1} at 22°C. The speed of sound at a particular temperature in various medium are listed in Table 6.1.

Table 6.1 Speed of sound in different medium at 25°C

State	Substance	Speed (ms-1)
Solids	Aluminum	6420
	Steel	5960
	Iron	5950
Liquid	Sea Water	1530
	Distilled Water	1498
Gases	Hydrogen	1284
	Oxygen	316

More to know

The amount of water vapour present in the air is known as humidity. It is less during winter and more during summer. The speed of sound increases with increase in humidity. This is because the density of air decreases with increase in humidity.

We saw that sound travels in different medium with different speed. Now let us see how it travels in a medium. When a body vibrates, the particle of the medium in contact with the vibrating body is first displaced from its equilibrium position. It then exerts a force on the adjacent particle. This process continues in the medium till the sound reaches the ear of the person.

In order to understand this let us consider a vibrating tuning fork. When a vibrating tuning fork moves forward, it pushes and

compresses the air in front of it, creating a region of high pressure. This region is called a compression (C), as shown in Figure 6.1. When it moves backward, it creates a region of low pressure called rarefaction (R). These compressions and rarefactions produce the sound wave, which propagates through the medium.

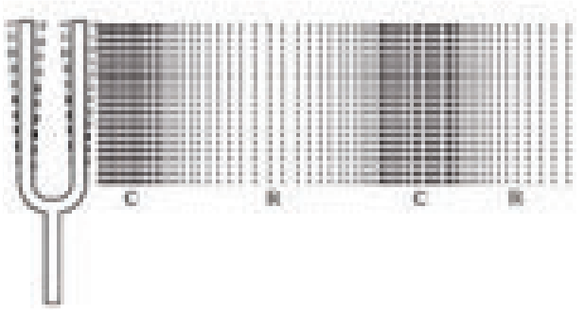


Figure 6.1 Vibrating tuning fork

6.3 Sound Waves

Activity 6

Throw a stone into a pool of still water. It produces waves, which spread rapidly over the surface of water and they travel in all directions. Do water particles move away from the point of disturbance? Check it by placing grains of saw dust over the water. They do not move away. Instead they merely move up and down about their mean position. Similarly, sound travels in the form of a wave.

Sound is a form of energy. It is transferred through the air or any other medium, in the form of mechanical waves. Mechanical wave is a disturbance, which propagates in a medium due to the repeated periodic motion of the particles of the medium, from their mean position. The disturbance which is caused by the vibrations of the particles is passed over to the next particle. It means that the energy is transferred from one particle to another as a wave motion.

6.3.1 Characteristic of wave motion

1. In wave motion, only the energy is transferred not the particles.
2. The velocity of the wave motion is different from the velocity of the vibrating particle.
3. For the propagation of a mechanical wave, the medium must possess the properties of inertia, elasticity, uniform density and minimum friction among the particles.

DO YOU KNOW?

How do astronauts communicate with each other? The astronauts have devices in their helmets which transfer the sound waves from their voices into radio waves and transmit it to the ground (or other astronauts in space). This is exactly the same as how radio at your home works.

6.3.2 Types of mechanical wave

There are two types of mechanical wave. They are

1. Transverse wave
2. Longitudinal wave

Transverse wave

In a transverse wave the particles of the medium vibrate in a direction, which is perpendicular to the direction of propagation of the wave. E.g. Waves in strings, light waves, etc. Transverse waves are produced only in solids and liquids.

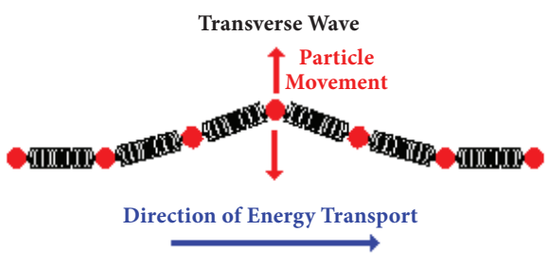


Figure 6.2 Transverse wave

Longitudinal wave

In a longitudinal wave the particles of the medium vibrate in a direction, which is parallel to the direction of propagation of the wave. E.g. Waves in springs, sound waves in a medium. Longitudinal waves are produced in solids, liquids and also in gases.

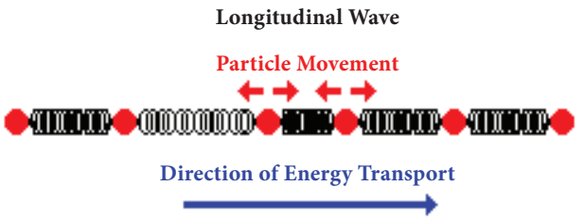


Figure 6.3 Longitudinal wave

The seismic wave formed during earthquake is an example for a longitudinal wave. Waves travelling through the layers of the Earth due to explosions, earthquakes and volcanic explosions are called seismic waves. Using a hydrophone and seismometer one can study these waves and record them. Seismology is the branch of science that deals with the study of seismic waves.

6.4 Properties of Sound

All sounds that we hear are not the same. There are some properties that differentiate one kind of sound from another. We will study about these properties now.

6.4.1 Loudness

It is defined as the characteristic of a sound that enables us to distinguish a weak or feeble sound from a loud sound. The loudness of a sound depends on its amplitude. Higher the amplitude louder will be the sound and vice-versa. When a drum is softly beaten, a weak sound is produced. However, when it is beaten strongly, a loud sound is produced. The unit of loudness of sound is decibel (dB).

More to know

Amplitude is the maximum displacement of a vibrating particle from its mean position. It is denoted by 'A'. The unit of amplitude is 'metre' (m).

6.4.2 Pitch

The pitch is the characteristic of sound that enables us to distinguish between a flat sound and a shrill sound. Higher the frequency of sound, higher will be the pitch. High pitch adds shrillness to a sound. The sound produced by a whistle, a bell, a flute and a violin are high pitch sounds.

Normally, the voice of a female has a higher pitch than a male. That is why a female's voice is shriller than a male's voice. Some examples of low pitch sound are the roar of a lion and the beating of a drum.

6.4.3 Quality or Timbre

The quality or timbre is the characteristic of sound that enables us to distinguish between two sounds that have the same pitch and amplitude. For example in an orchestra, the sounds produced by some musical instruments may have the same pitch and loudness. Yet, you can distinctly identify the sound produced by each instrument.

6.4.4 Audibility and Range

According to the frequency we can classify the sounds into three types. They are:

- Audible sound
- Infrasonic sound
- Ultrasonic sound

Audible sound

Sound with frequency, ranging from 20 Hz to 20000 Hz is called sonic sound or audible sound. Sound with this frequency range alone can be heard by the human beings. Human ears

cannot hear sounds with frequencies below 20 Hz or above 20000 Hz. So, the above range is called as audible range of sound.

Infrasonic sound

A sound with a frequency, below 20 Hz is called as subsonic or infrasonic sound. Humans cannot hear the sound of this frequency, but some animals like dog, dolphin, etc., can hear. Uses of infrasonic sound are:

- It is employed in the earth monitoring system.
- It is also used in the study of the mechanism of human heart.

Ultrasonic sound

A sound with a frequency greater than 20000 Hz is called as ultrasonic sound. Animals such as bats, dogs, dolphins, etc., are able to hear certain ultrasonic sounds as well. Some of the uses of ultrasonic sounds are:

- It is extensively used in medical applications like 'sonogram'.
- It is used in the SONAR system to detect the depth of the sea and to detect enemy submarines.
- It is also employed in dish washers.
- Another important application of ultra sound is the Galton's whistle. This whistle is inaudible to the human ear, but it can be heard by the dogs. It is used to train the dogs for investigation.

A bat can hear the sounds of frequencies higher than 20,000 Hz. Bats produce ultrasonic sound during screaming. These ultrasonic waves help them to locate their way and the prey.

6.5 Musical Instruments

Some sounds are pleasing to the ear and make us happy. The sound that provides a pleasing sensation to the ear is called 'music'. Music is produced by the regular patterns of vibrations. Musical instruments are categorized into four types as given below.

- Wind instruments
- Reed instruments
- Stringed instruments
- Percussion instruments

Wind instruments

In a wind instrument the sound is produced by the vibration of air in a hollow tube. The frequency is varied by changing the length of the vibrating air column. Trumpet, Flute, Shehnai and Saxophone are some well-known wind instruments.

Reed instruments

A reed instrument contains a reed. Air, which is blown through the instrument, causes the reed to vibrate, which in turn produces the specific sound. Examples of reed instruments include Harmonium and Mouth Organ.

Stringed instruments

Stringed instruments make use of a string or wire to produce vibrations and hence the specific sound. These instruments also have hollow boxes that amplify the sound that is produced. The frequency of sound is varied by varying the length of the vibrating wire. Violin, Guitar, Sitar are some of the examples of stringed instruments.

A guitar string has a number of frequencies at which it will naturally vibrate. These natural frequencies are known as the **harmonics** of the guitar string. The natural frequency, at which an object vibrates, depends upon the tension of the string, the linear density of the string and the length of the string.

Percussion instruments

Percussion instruments produce a specific sound when they are struck, scrapped or

Figure 6.4 Musical instruments

clashed together. They are the oldest type of musical instruments. There is an amazing variety of percussion instruments all over the world. Percussion instruments like the drum and tabla consist of a leather membrane, which is stretched across a hollow box called the resonator. When a membrane is hit, it starts vibrating and produces the sound.

6.6 Sound produced by Humans

In human being, the sound is produced in the voice box, called the larynx, which is present in the throat. It is located at the upper end of the windpipe. The larynx has two ligaments called 'vocal cords', stretched across it. The vocal cords have a narrow slit through which air is blown in and out. When a person speaks, the air from the lungs is pushed up through the trachea to the larynx. When this air passes through the slit, the vocal cords begin to vibrate and produce a sound. By varying the thickness of the vocal cords, the length of the air column in the slit can be changed. This produces sounds of different pitches. Males generally have thicker and longer vocal cords that produce a deeper, low pitch sound in comparison with females.

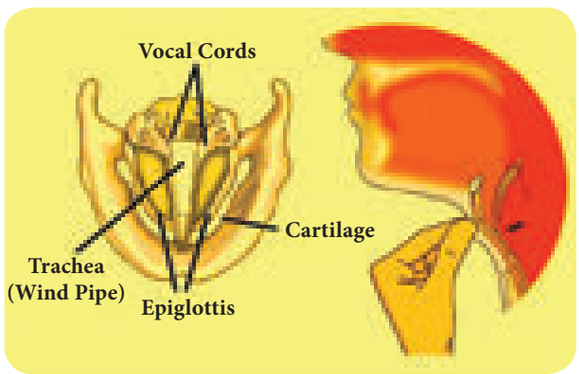


Figure 6.5 Structure of Larynx

6.7 Mechanism of Human Ear

Ear is the important organ for all animals to hear a sound. We are able to hear sound through our ears. Human ear picks up and interprets high frequency vibrations of air. Ears of aquatic animals are designed to pick up high frequency vibrations in water. The outer and visible part of the human ear is called pinna (curved in shape). It is specially designed to gather sound from the environment, which then reaches the ear drum (tympanic membrane) through the ear canal. When the sound wave strikes the drum,

W8A6U3

the ossicles move inward and outward to create the vibrations. These vibrations are then picked up by special types of cells in the inner ear. From the inner ear the vibrations are sent to the brain in the form of signals. The brain perceives these signals as sounds.

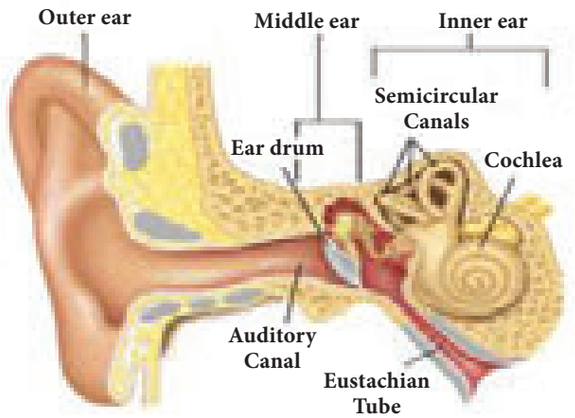


Figure 6.6 Human Ear

6.8 Noise Pollution

Any sound that is unpleasant to the ear is called noise. It is the unwanted, irritating and louder sound. Noise is produced by the irregular and non-periodic vibrations. Noise gives us stress. The disturbance produced in the environment by loud and harsh sounds from various sources is known as noise pollution. Busy roads, airplanes, electrical appliances such as mixer grinder, washing machine and un-tuned radio cause noise pollution. Use of loudspeakers and crackers during the festivals also contributes to the noise pollution. The major source of noise pollution is from the industries. Noise pollution is the bi-product of industrialisation, urbanisation and modern civilisation.

6.8.1 Health hazards due to noise pollution

Noise creates some health hazards. Some of them are listed below.

- Noise may cause irritation, stress, nervousness and headache.

Figure 6.7 Hazards of noise pollution

- Long term exposure to noise may change the sleeping pattern of a person.
- Sustained exposure to noise may affect hearing ability. Sometimes, it leads to loss of hearing.
- Sudden exposure to louder noise may cause heart attack and unconsciousness.
- It causes lack of concentration in one's work. Noise of horns, loud speakers, etc., cause disturbances leading to lack of concentration.
- Noise pollution affects a person's peace of mind. It adds to the existing tensions of modern living. These tensions results in disease like high blood pressure or short-tempered nature.

6.8.2 Controlling noise pollution

We studied about the harmful effects of noise pollution. It becomes necessary for us to reduce it. Noise pollution can be significantly reduced by adopting the following steps.

- Strict guidelines should be set for the use of loudspeakers on social, religious and political occasions.
- All automobiles should have effective silencers.
- People should be encouraged to refrain from excessive honking while driving.
- Industrial machines and home appliances should be properly maintained.

- All communication systems must be operated in low volumes.
- Residential areas should be free from heavy vehicles.
- Green corridor belt should be set up around the industries as per the regulations of the pollution control board.
- People working in noisy factories should wear ear plugs.
- People should be encouraged to plant trees and use absorbing materials like curtains and cushions in their home.

6.8.3 Hearing loss

You may have hearing loss without realising it. The following are the symptoms of hearing loss.

- Ear ache
- A feeling of fullness or fluid in the ear.
- Ringing in your ears

Hearing loss is caused by various reasons. Some of them are listed below.

- Aging
- Ear infections if not treated
- Certain medicines
- Genetic disorders
- A severe blow to the head
- Loud noise

Points to Remember

- Sound is produced by the vibration of the particles of a medium.
- Sound is a form of energy that is transferred as vibrations through the air or any other medium, in the form of waves.
- In a wave motion only the energy is transferred not the particles.
- The distance between two consecutive particles which are in same phase of vibration is called wavelength.
- The time taken by a vibrating particle to complete one vibration is known as time period of the vibration.
- The speed of a wave is the distance travelled by it in one second.
- Higher the frequency of sound, higher will be the pitch.
- The speed of sound increases with increase in humidity.
- Music is produced by the regular patterns of vibrations.
- Sound with the frequency ranging from 20 Hz to 20000 Hz is called sonic sound or audible sound.
- A sound with a frequency below 20 Hz is called as subsonic or infrasonic sound.
- A sound with a frequency greater than 20000 Hz is called as ultrasonic sound.

A-Z GLOSSARY

Amplitude	The measure of a sound wave.
Pitch	How high or low a sound is. It is determined by the frequency of the vibration.
Sonic Boom	A shock wave that consists of compressed sound waves created when something moves faster than the speed of sound.
Sound Wave	Moving pattern of high and low pressure or vibrations.
Speed of Sound	How fast sound moves through an object.
Vibration	Back and forth motion.
Wavelength	The length between the compressions in a sound wave.

TEXTBOOK EXERCISES

B5C5Y8

I. Choose the best answer.

1. Sound waves travel very fast in
   a) air b) metals
   c) vacuum d) liquids
2. Which of the following are the characteristics of vibrations?
   i. Frequency ii. Time period
   iii. Pitch iv. Loudness
   a) i and ii b) ii and iii
   c) iii and iv d) i and iv
3. The amplitude of the sound wave decides its
   a) speed b) pitch
   c) loudness d) frequency
4. What kind of musical instrument is a sitar?
   a) String instrument
   b) Percussion instrument
   c) Wind instrument
   d) None of these
5. Find the odd one out.
   a) Harmonium b) Flute
   c) Nadaswaram d) Violin
6. Noise is produced by
   a) vibrations with high frequency.
   b) regular vibrations.
   c) regular and periodic vibrations.
   d) irregular and non-periodic vibrations.
7. The range of audible frequency for the human ear is
   a) 2 Hz to 2000 Hz
   b) 20 Hz to 2000 Hz
   c) 20 Hz to 20000 Hz
   d) 200 Hz to 20000 Hz
8. If the amplitude and frequency of a sound wave are increased, which of the following is true?
   a) Loudness increases and pitch is higher.
   b) Loudness increases and pitch is unchanged.
   c) Loudness increases and pitch is lower.
   d) Loudness decreases and pitch is lower.
9. Which of the following may be caused by noise?
   a) Irratition b) Stress
   c) Nervousness d) All the above

II. Fill in the blanks.

1. Sound is produced by _____.
2. The vibrations of a simple pendulum are also known as _____.
3. Sound travels in the form of _____.
4. High frequency sounds that cannot be heard by you are called_____.
5. Pitch of a sound depends on the _____ vibration.
6. If the thickness of a vibrating string is increased, its pitch _____.

III. Match the following.

Ultrasonics	Frequency below 20Hz
Speed of sound in air	Needs material medium
Infrasonics	330ms^{-1}
Sound propagation	Frequency more than 20000 Hz

IV. Consider the statements given below and choose the correct option.

1. **Assertion:** When lightning strikes, the sound is heard a little after the flash is seen.

   Reason: The velocity of light is greater than that of the sound.

2. **Assertion:** Two persons on the surface of moon cannot talk to each other.

   Reason: There is no atmosphere on moon.

A. Both assertion and reason are true and reason is the correct explanation of assertion.

B. Both assertion and reason are true but reason is not the correct explanation of assertion.

C. Assertion is true but reason is false.

D. Assertion is false but reason is true.

E. Both Assertion and reason are false.

V. Answer briefly.

1. What is vibration?
2. Give an example to show that light travels faster than sound?
3. To increase loudness of sound by four times, how much should the amplitude of vibration be changed?
4. What is an ultrasonic sound?
5. Give two differences between music and noise.
6. What are the hazards of noise pollution?
7. Mention few measures to be taken to reduce the effect of noise pollution.
8. Define the following terms.
   a. Amplitude b. Loudness
9. How does planting trees help in reducing noise pollution?

VI. Answer in detail.

1. Describe an experiment to show that sound cannot travel through vaccum.
2. What are the properties of sound?
3. What steps should be taken to reduce the effect of noise pollution?
4. Describe the structure and function of the human ear?

VII. Problems.

1. Ruthvik and Ruha hear a gunshot 2 second after it is fired. How far away from the gun they are standing? (Speed of sound in air is equal to $330 ms^{-1}$)
2. A sound wave travels 2000 m in 8 s. What is the velocity of the sound?
3. A wave with a frequency of 500 Hz is traveling at a speed of 200 ms^{-1}. What is the wavelength?

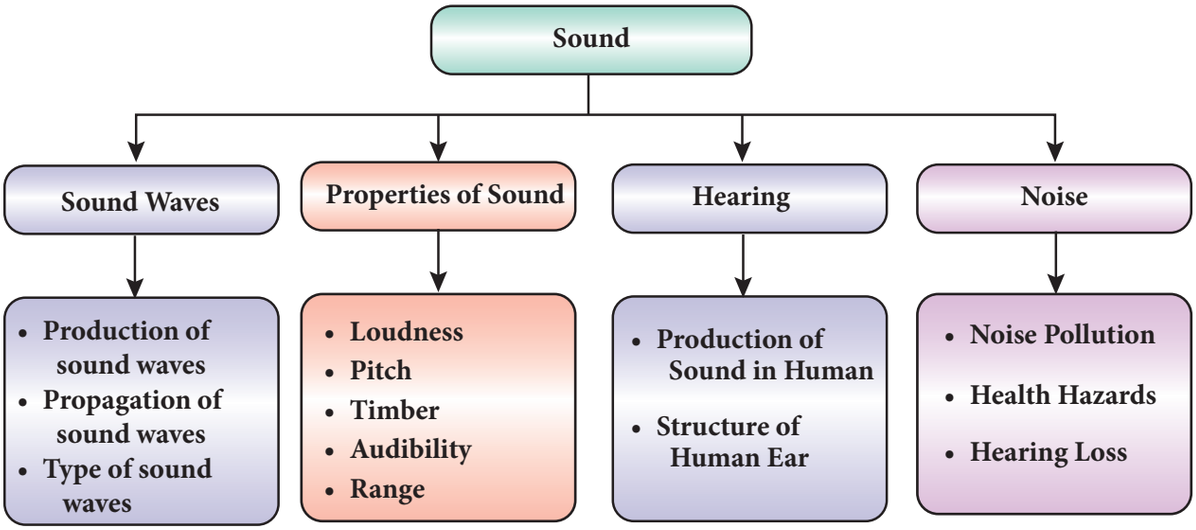
REFERENCE BOOKS

1. The everyday physics of hearing and vision by Bejamin de Mayo
2. Vibration and Waves by Anthony French

INTERNET RESOURCES

1. www.pbslearningmedia.org
2. www.scholastic.com

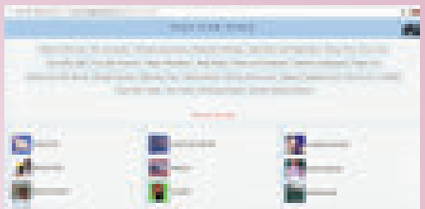
Concept Map



ICT CORNER

Sound

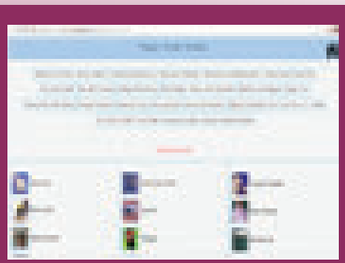
Make simple science toys from trash and enjoy the sounds so produced.



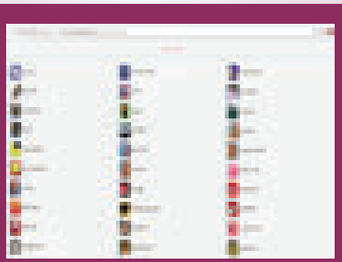
Step 1 Open the browser and type the URL or scan the QR code given below.

Step 2 Toys from Trash page will open. Simple science toys will appear under the heading 'Simple Sounds'.

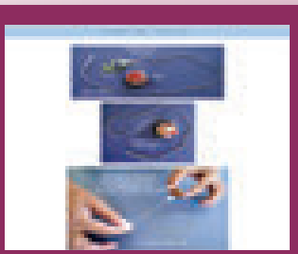
Step 3 Click on the Icons to learn the step by step procedure for making simple sounds toys. Enjoy making and playing with various sound producing toys.



Step 1



Step 2



Step 3

Web URL:

http://www.arvindguptatoys.com/simple-sounds.php

*Pictures are indicatives only.

*If browser requires, allow Flash Player or Java Script to load the page

B359_8_SCIENCE_EM

UNIT 7

MAGNETISM

Learning Objectives

H8V9A4

After the completion of this lesson, students will be able to:

- know about magnet and its types.
- distinguish between natural and artificial magnets.
- define magnetic field and compare uniform and non-uniform magnetic fields.
- summarize the properties of magnet.
- understand the concept of Earth's magnetism.
- list out the uses of magnets.

Introduction

Magnets are objects of stone, metal or other material which have the property of attracting metals like iron, cobalt and nickel. The attracting property of a magnet is called magnetism and it is either natural or induced. The branch of physics which deals with the property of a magnet is also called magnetism. The earliest evidence for magnets are found in a region of Asia Minor called Magnesia. It is believed that the Chinese had known the property of magnet even before 200 B.C. They used a magnetic compass for navigation in 1200 A.D. Use of magnets in compasses facilitated long-distance sailing. After the discovery of magnets the world progressed into a new direction. Today magnets play an important role in our lives. Magnets are used in refrigerators, computers, car engines, elevators and many other devices. In this lesson we will study about the types, properties and uses of magnets.

7.1 Classification of Magnets

Magnets are classified into two types. They are natural magnets and artificial magnets.

Natural Magnets

Magnets found in the nature are called natural magnets. They are permanent magnets i.e., they will never lose their magnetic power. These magnets are found in different places of the earth in the sandy deposits. Lodestone called magnetite (Iron oxide) which is the ore of iron is the strongest natural magnet. Minerals like Pyrrhotite (Iron Sulphide), Ferrite and Coulumbite are also natural magnets.

Figure 7.1 Natural magnet

DO YOU KNOW?

There are three types of iron ores. They are: Hematite (69% of Iron), Magnetite (72.4% of Iron) and Siderite (48.2% of Iron). Magnetite is an oxide ore of iron with the formula Fe_3O_4. Among these ores, magnetite has more magnetic property.

Artificial Magnets

Magnets that are made by people in the laboratory or factory are called artificial magnets. These are also known as man-made magnets, which are stronger than the natural magnets. Artificial magnets can be made in various shapes and dimensions. Bar magnets, U-shaped magnets, horseshoe magnets, cylindrical magnets, disc magnets, ring magnets and electromagnets are some examples of artificial magnets. Artificial magnets are usually made up of iron, nickel, cobalt, steel, etc. Alloy of the metals Neodynium and Samarium are also used to make artificial magnets.

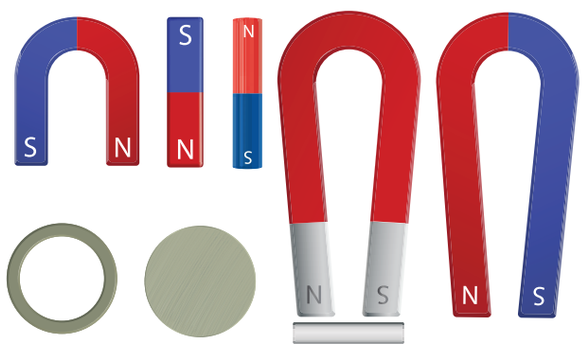


Figure 7.2 Artificial magnets

Table 7.1 Difference between natural and artificial magnets

Natural Magnets	Artificial Magnets
These are found in nature and have irregular shapes and dimensions.	These are man-made magnets. They can be made in different shapes and dimensions.
The strength of a natural magnet is well determined and difficult to change.	Artificial magnets can be made with required and specific strength.
These are long lasting magnets.	Their properties are time bound.
They have a less usage.	They have a vast usage in day to day life.

Know Your Scientist

William Gilbert laid the foundation for magnetism and suggested that the Earth has a giant bar magnet. William Gilbert was born on 24th May 1544. He was the first man who performed the systematic research on the properties of the lodestone (magnetic iron ore) and published his findings in the influential 'De Magnete' (The Magnet).

7.2 Magnetic Properties

The properties of a magnet can be explained under the following headings.

- Attractive property
- Reflective property
- Directive property

7.2.1 Attractive Property

A magnet always attracts materials like iron, cobalt and nickel. To understand the attractive property of a magnet let us do an experiment.

Activity 1

Take some iron filings in a paper and place a magnet near them. Do you see the iron filings being attracted by the magnet? In which part of the magnet they are attracted?

You can observe here that the iron filings are attracted near the ends of the magnet. These ends are called poles of a magnet. This shows that the attractive property of a magnet is more at the poles. One pole of the magnet

is called the North Pole and the other pole is called the South Pole. Magnetic poles always exist in pairs.

What happens when a bar magnet is broken into two pieces? Each broken piece behaves like a separate bar magnet. When a magnet is split vertically, the length of the magnet is altered and each piece acts as a magnet. When a magnet is split horizontally, the length of the new pieces of magnet remains unaltered and there is no change in their polarity. In both cases the strength of the magnet is reduced.

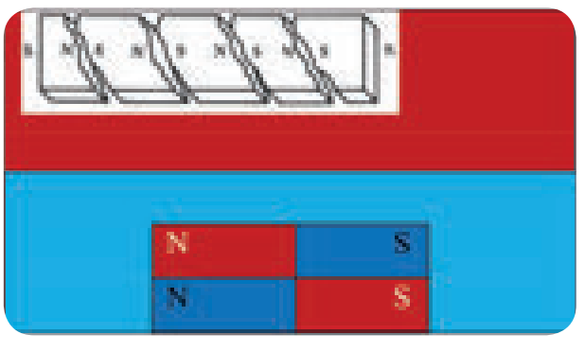
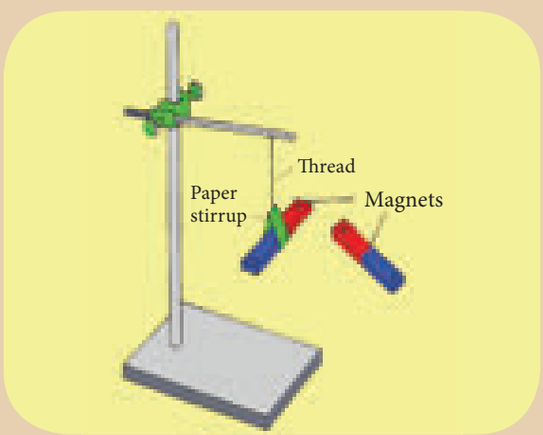


Figure 7.3 Magnetic poles exist in pair

7.2.2 Repulsive Property

Activity 2

Take a bar magnet and suspend it from a support. Hold another bar magnet in your hand. Bring the north pole of this magnet close to the north pole of the suspended magnet. What do you see? The north pole of the suspended magnet will move away.

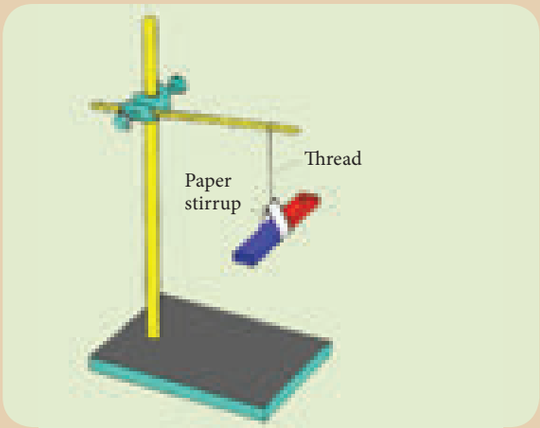


This activity explains another property of a magnet that like poles repel each other i.e., a north pole repels another north pole and a south pole repels another south pole. If you bring the south pole of the magnet close to the north pole of the suspended magnet you can see that the south pole of the suspended magnet is immediately attracted. Thus, we can conclude that unlike poles of a magnet attract each other. i.e., the north pole and the south pole of a magnet attract each other.

7.2.3 Directive Property

Activity 3

Suspend a bar magnet from a rigid support using a thread. Ensure that there are no magnetic substances placed near it. Gently disturb the suspended magnet. Wait for a moment, let it oscillate. In a short time it will come to rest. You can see that the north pole of the magnet is directed towards the geographic north. Repeat the procedure a number of times. You will observe that the magnet is oriented in the same direction.



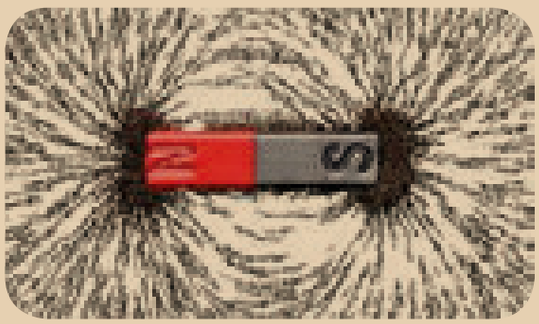
This experiment shows that a freely suspended bar magnet always aligns itself in the geographic north-south direction. The property of a magnet, by which it aligns itself along the geographic north-south direction, when it is freely suspended, is known as the directive property of a magnet. The north pole of the

magnet points towards the geographic north direction and the south pole of the magnet points towards the geographic south direction.

7.3 Magnetic Field

Activity 4

Spread some iron filings collected from the sand uniformly on a sheet of white paper placed on a table. Place a bar magnet below the white sheet. Gently tap the table. What do you see? You can see the pattern as shown in the figure.



You can observe from this experiment that the iron filings are arranged in the form of curved patterns around the magnet. The space around the bar magnet where the arrangement of iron filings exists, represents the field of influence of the bar magnet. It is called the magnetic field. Magnetic field is defined as the space around a magnet in which its magnetic effect or influence is observed. It is measured by the unit *tesla* or *gauss* (1 tesla =10,000 gauss).

7.3.1 Tracing the magnetic field

We can trace the magnetic field with the help of a compass needle. A white sheet of paper is fastened on the drawing board using the board pins or cello tape. A small plotting compass needle is placed near the edge of the paper and the board is rotated until the edge of the paper is parallel to the magnetic needle. The compass needle is then placed at the centre of the paper and the ends of the needle, i.e., the new positions of the north and south pole are marked when the needle comes to rest. These points are joined and a straight line is obtained. This line represents the magnetic meridian. Cardinal directions N-E-S-W are drawn near the corner of the paper.

The bar magnet is placed on the line at the centre of the paper with its north pole facing the geographic north. The outline of the bar magnet is drawn. The plotting compass is placed near the North Pole of the bar magnet and the end of the needle (north pole) is marked. Now the compass is moved to a new position, such that its south pole occupies the position previously occupied by its north pole. In this way it is proceded step by step till the compass is placed near the south pole of the magnet. Deflecting points are marked. A curved line is then drawn by joining the plotted points marked around the magnet. This represents the magnetic line of force. In the same way several magnetic lines of force are drawn around the magnet as shown in the Figure 7.4. These curved lines around the bar magnet represent the magnetic field of the magnet. The direction of the lines is shown by the arrow heads.

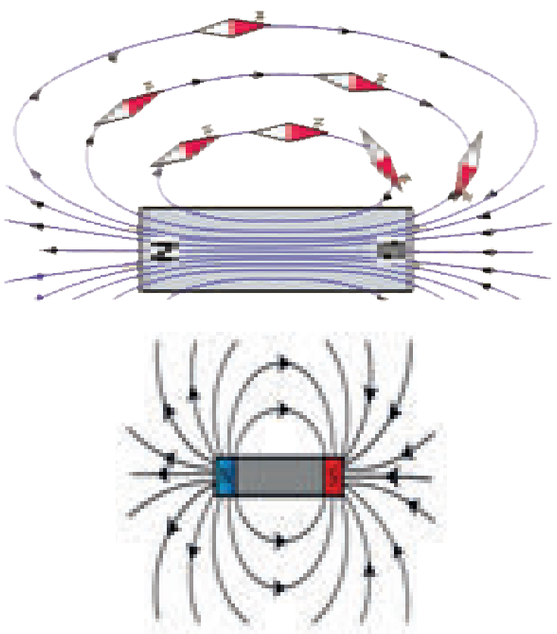


Figure 7.4 Magnetic Field

We can observe here that the compass needle gets deflected to a large extent, when it is closer to the magnet. When the distance is large, the deflection of the needle is gradually decreased. At one particular position there is no deflection because there is no magnetic force at this position. This shows that each magnet exhibits its magnetic influence around a specific region.

DO YOU KNOW?

A compass needle, also known as plotting compass or magnetic needle, consists of a tiny pivoted magnet in the form of a pointer, which can rotate freely in the horizontal plane. The ends of the compass needle point approximately towards the geographic north and south direction.

7.4 Magnetic Materials

Activity 5

Spread some iron pins, stapler pins, iron nails, small pieces of paper, a scale, an eraser and a plastic cloth hanger on a wooden table. Place a magnet nearby these materials. What do you observe? List out which of these things are attracted by the magnet? Which objects are not attracted? Tabulate your observations.

Materials which are attracted by magnets are called magnetic materials and those materials which are not attracted by magnets are called non-magnetic materials. There are a number of materials that can be attracted by magnets. These can be magnetised to create permanent magnets. Magnetic materials can be categorised as magnetically hard or magnetically soft materials. Magnetically soft materials are easily magnetised. Magnetically hard materials also can be magnetised but they require a strong magnetic field to be magnetised. It is because materials have different atomic structure and they behave differently when they are placed in a magnetic field. Based on their behaviour in a magnetic field they can be classified as below.

- Diamagnetic materials
- Paramagnetic materials
- Ferromagnetic materials

7.4.1 Diamagnetic materials

Diamagnetic materials have the following characteristics.

- When suspended in an external uniform magnetic field they will align themselves **perpendicular** to the direction of the magnetic field.
- They have a tendency to move away from the stronger part to the weaker part when suspended in a non-uniform magnetic field.
- They get magnetised in a direction opposite to the magnetic field.
- Examples for diamagnetic substances are bismuth, copper, mercury, gold, water, alcohol, air and hydrogen.
- Magnetic character of these substances is not affected by the external temperature.

7.4.2 Paramagnetic materials

The following are the characteristics of paramagnetic materials.

- When suspended in an external uniform magnetic field they will align themselves **parallel** to the direction of the magnetic field.
- They have a tendency to move from the weaker part to the stronger part when suspended in a non-uniform magnetic field.
- They get magnetised in the direction of the field.

- Examples for paramagnetic substances are aluminium, platinum, chromium, oxygen, manganese, solutions of salts of nickel and iron.
- Magnetic character of these substances is affected by the external temperature.

7.4.3 Ferromagnetic materials

The characteristics of ferromagnetic materials are given below.

- When suspended in an external uniform magnetic field they will align themselves **parallel** to the direction of the magnetic field.
- It has a tendency to move quickly from the weaker part to the stronger part when suspended in a non-uniform magnetic field.
- They get strongly magnetised in the direction of the field.
- Examples for ferromagnetic substances are iron, cobalt, nickel, steel and their alloys.
- Magnetic character of these substances is affected by the external temperature. When they are heated they become para magnetic.

More to know

The temperature, at which the ferromagnetic material becomes paramagnetic is called the curie temperature.

7.5 Artificial Magnets

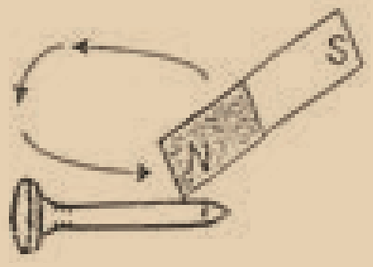
Artificial magnets are produced from magnetic materials. These are generally made by magnetizing iron or steel alloys electrically. These magnets are also produced by striking a magnetic material with magnetite or with other artificial magnets. Depending on their ability to retain their magnetic property, artificial magnets are classified as permanent magnets or temporary magnets.

7.5.1 Temporary Magnets

Temporary magnets are produced with the help of an external magnetic field. They lose their magnetic property as soon as the external magnetic field is removed. They are made from soft iron. Soft iron behaves as a magnet under the influence of an external magnetic field produced in a coil of wire carrying a current. But, it loses the magnetic properties as soon as the current is stopped in the circuit. Magnets used in electric bells and cranes are the examples of temporary magnets.

Activity 6

Spread some steel pins on a wooden board and bring an iron nail near them. Are they attracted? Now, make one of the magnetic poles of the bar magnet touch one end of the iron nail. Slide it along its length in one direction slowly till the other end is reached. Repeat the process 20 to 30 times as shown in the diagram. The magnet has to be moved in one direction only. Avoid the swiping of the magnet back and forth. Now, bring the iron nail near the steel pins. What do you notice? The steel pins stick to the iron nail because nail has become a temporary magnet.



DO YOU KNOW?

Magnetisation is a process in which a substance is made a permanent or temporary magnet by exposing it to an external magnetic field. This is one of the methods to produce artificial magnets.

7.5.2 Permanent Magnets

Permanent magnets are artificial magnets that retain their magnetic property even in the absence of an external magnetic field. These magnets are produced from substances like

hardened steel and some alloys. The most commonly used permanent magnets are made of ALNICO (An alloy of aluminium, nickel and cobalt). Magnets used in refrigerators, speakers, fridge and magnetic compass are some familiar examples of a permanent magnet. Neodymium magnets are the strongest and the most powerful magnets on the Earth.

DO YOU KNOW?

Alnico cow magnet is used to attract sharp iron wire and other iron objects that may be ingested by animals while grazing thereby causing damage to their digestive tract.

The magnetic properties of a magnet will be removed from it by the following ways.

- Placing the magnet idle for a long time.
- Continuous hammering of the magnetic substance.
- Dropping the magnet from a height.
- Heating a magnet to a high temperature.
- Passing a variable current in a coil that encloses the magnet.
- Improper storage of the magnet.

7.6 Earth's Magnetism

Z8W2M1

Earth has been assumed or imagined by the scientists as a huge magnetic dipole. However, the position of the Earth's magnetic poles is not well defined in the Earth. The south pole of the imaginary magnet inside the Earth is located near the geographic north pole and the north pole of the earth's magnet is located near the geographic south pole. The line joining these magnetic poles is called the magnetic axis.

The magnetic axis intersects the geographic north pole at a point called the north geomagnetic pole or northern magnetic pole. It intersects the geographic south pole at a point called the south geomagnetic pole or southern magnetic pole. The magnetic axis and the geographical axis (axis of rotation) do not coincide with each other. The magnetic axis of the Earth is inclined at an angle of about 10° to 15° with the geographical axis.

DO YOU KNOW?

The most powerful magnet in the universe is actually a neutron star called magnetar (magnetic neutron star) located in the Milky Way Galaxy. The diameter of the magnetar is 20 kilometer and its mass is 2 to 3 times that of the Sun. Its magnetic field is so enormous and lethal that it is capable of absorbing all the iron atoms from the bloodstream (hemoglobin) of a living body even if it is positioned at a distance of 1000 km from it.

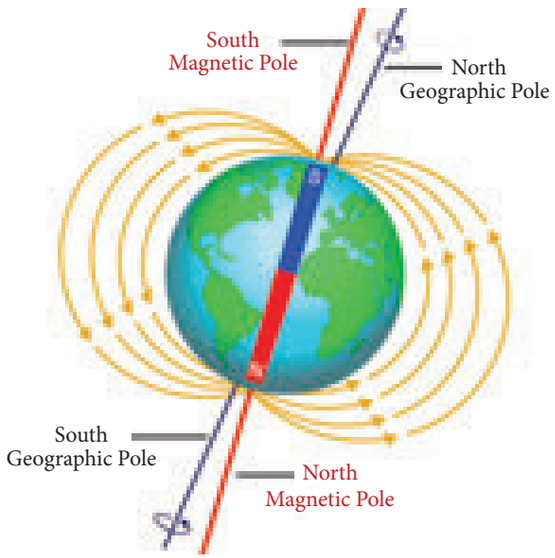


Figure 7.5 Earth as a magnet

The exact cause of the Earth's magnetism is not known even today. However, some important factors, which may be the cause of the Earth's magnetism, are as follows.

- Masses of magnetic substances in the Earth
- Radiations from the Sun
- Action of the Moon

However, it is believed that the Earth's magnetic field is due to the molten charged

metallic fluid inside the Earth's surface with a core of radius of about 3500 km compared to the Earth's radius of 6400 km.

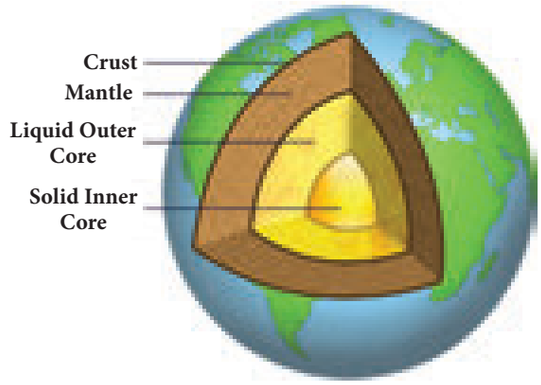


Figure 7.6 Core of the Earth

DO YOU KNOW?

Pigeons have extraordinary navigational abilities. It enables them to find their way back home even if you take them to a place where they have never been before. The presence of magnetite in their beaks enables them to sense the magnetic field of the Earth. Such a magnetic sense is called **magneto-reception.**

7.6.1 Earth's Magnetic Field

A freely suspended magnetic needle at a point on the Earth comes to rest approximately along the geographical north - south direction. This shows that the Earth behaves like a huge magnetic dipole with its magnetic poles located near its geographical poles. The north pole of a magnetic needle approximately points towards the geographic north (NG). Thus, it is appropriate to say that the magnetic north pole of the needle is attracted by the magnetic south pole of the Earth (Sm), which is located at the geographic north (NG). Also, the magnetic south pole of the needle is attracted by the magnetic north pole of the Earth (Nm), which is located at the geographic south (SG). The magnitude of the magnetic field strength at the Earth's surface ranges from 25 to 65 micro tesla.

DO YOU KNOW?

Earth's magnet is 20 times more powerful than a fridge magnet.

7.7 Uses of Magnets

We come into contact with magnets offen in our daily life. They are used in wide range of devices. Some of the uses of magnets are given below.

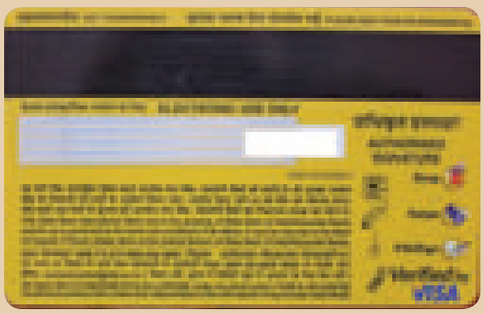
- In ancient times the magnet in the form of 'direction stone' were used by seamen to find the directions during a voyage.
- Nowadays, magnets are used to generate electricity in dynamos.
- Electromagnets are used in our day to day life.
- They are used in electric bells and electric motors.
- They are used in loudspeakers and microphones.
- An extremely powerful electromagnet is used in the fast moving Maglev train to remain floating above the tracks.
- In industries, magnetic conveyor belts are used to sort out magnetic substances from scraps mixed with non-magnetic substances.
- Magnets are used in computer in its storing devices such as hard disks.

DO YOU KNOW?

Maglev train (Magnetic levitation train) has no wheels. It floats above its tracks due to strong magnetic forces applied by computer controlled electromagnets. It is the fastest train in the world. The speed attained by this train is around 500 km/hr.

DO YOU KNOW?

The strip on the back of a credit card/debit card is a magnetic strip, often called a magstripe. The magstripe is made up of tiny iron-based magnetic particles in a thin plastic film. Each particle is really a very tiny bar magnet about 20 millionth of an inch long.



- In banks, the magnets enable the computers to read the MICR numbers printed on a cheque.
- The tip of the screw drivers are made slightly magnetic so that the screws remain attached to the tip.
- At hospitals, MRI (Magnetic Resonance Imaging) is used to scan the specified internal organ. An extremely from electromagnet is used in it.

Figure 7.7 MRI scanning machine

Points to Remember

- Magnets are classified into two types. They are: natural magnets and artificial magnets.
- Magnets attract things made of magnetic substances such as iron.
- The force of attraction of a magnet is maximum at the poles.
- A freely suspended magnet always comes to rest along the geographic north-south direction.
- Like poles of magnets repel while unlike poles attract one another.
- Materials which are attracted by magnets are called magnetic materials and those objects which are not attracted by magnets are called non-magnetic materials.
- Based on their behaviour in a magnetic field magnets can be classified as diamagnetic, paramagnetic and ferromagnetic materials.
- Depending on their ability to retain their magnetic property, artificial magnets are classified as permanent or temporary magnets.
- The south pole of the imaginary magnet inside the Earth is located near the geographic north pole and the north pole is located near the geographic south pole.
- In ancient times the magnet in the form of 'direction stone' helped seamen to find the directions during a voyage.
- Magnets, especially electromagnets are used in day to day life.
- Nowadays, magnets are used to generate electricity in dynamos.
- Magnets are used in computers in the storing devices such as hard disks. They are used in debit and credit cards also.

A-Z GLOSSARY

ALNICO	An alloy of aluminium, nickel and cobalt.
Compass needle	A needle (or plotting compass) which consists of a tiny pivoted magnet, usually in the form of a pointer, which can turn freely in a horizontal plane.

Magnet	A piece of iron or other material, which can attract things containing iron.
Magnetic axis	The line joining the magnetic poles.
Magnetic field	The space around the magnet, in which the magnetic force is experienced within a particular region.
Magnetism	The branch of physics which deals with the property of a magnet.
Magnetisation	A process in which a substance is made a permanent or temporary magnet by exposing it to an external magnetic field.
Magnetite	A rock which has magnetic properties.

TEXTBOOK EXERCISES

F6R6W2

I. Choose the best answer.

1. A magnet attracts _____.
   a) wooden materials b) any metal
   c) copper d) iron and steel
2. One of the following is an example for a permanent magnet.
   a) Electromagnet b) Mumetal
   c) Soft iron d) Neodymium
3. The south pole of a bar magnet and the north pole of a U-shaped magnet will _____.
   a) attract each other
   b) repel each other
   c) neither attract nor repel each other
   d) None of the above
4. The shape of the Earth's magnetic field resembles that of an imaginary _____.
   a) U-shaped magnet
   b) straight conductor carrying current
   c) solenoid coil d) bar magnet
5. MRI stands for _____.
   a) Magnetic Resonance Imaging
   b) Magnetic Running Image
   c) Magnetic Radio Imaging
   d) Magnetic Radar Imaging
6. A compass is used for _____
   a) plotting magnetic lines
   b) detection of magnetic field
   c) navigation d) All of these

II. Fill in the blanks.

1. The magnetic strength is _____ at the poles.
2. A magnet has _____ magnetic poles.
3. Magnets are used in _____ for generating electricity.
4. _____ are used to lift heavy iron pieces.
5. A freely suspended bar magnet is always pointing along the _____north-south direction.

III. Match the following.

Magnetite	Magnetic lines
A tiny pivoted magnet	Natural magnet
Cobalt	Compass box
Closed curves	Ferromagnetic material
Bismuth	Diamagnetic material

IV. Consider the statements given below and choose the correct option.

1. **Assertion:** Iron filings are concentrated more at the magnetic poles.
   Reason: The magnets are so sharp.

2. **Assertion:** The Earth's magnetic field is due to iron present in its core.

   Reason: At a high temperature a magnet loses its magnetic property or magnetism.

a. Both assertion and reason are true and reason is the correct explanation of assertion.

b. Both assertion and reason are true, but reason is not the correct explanation of assertion.

c. Assertion is true, but reason is false.

d. Assertion is false, but reason is true.

V. Answer briefly.

1. Define magnetic field.
2. What is artificial magnet? Give examples.
3. Distinguish between natural and artificial magnets?
4. Earth acts as a huge bar magnet. Why? Give reasons.
5. How can you identify non-magnetic materials? Give an example of a non-magnetic material.

VI. Answer in detail.

1. List out the uses of magnets.
2. How will you convert a 'nail' into a temporary magnet?
3. Write a note on Earth's magnetism.

VII. Higher Order Thinking Questions.

1. Though Earth is acting as a huge bar magnet it is not attracting other ferromagnetic materials. Why? Give reasons.
2. Why it is not advisable to slide a magnet on an iron bar back and forth during magnetising it?
3. Thamizh Dharaga and Sangamithirai were playing with a bar magnet. They put the magnet down and it broke into four pieces. How many poles will be there?

REFERENCE BOOKS

1. Electricity and Magnetism - Brijlal S. Subramanian - S. Chand publications
2. ICSE Physics - Lakmir Singh and Manjit Kaur - S. Chand publications
2. Physics concepts and connections - Art Hobson. Edition: Pearson Education

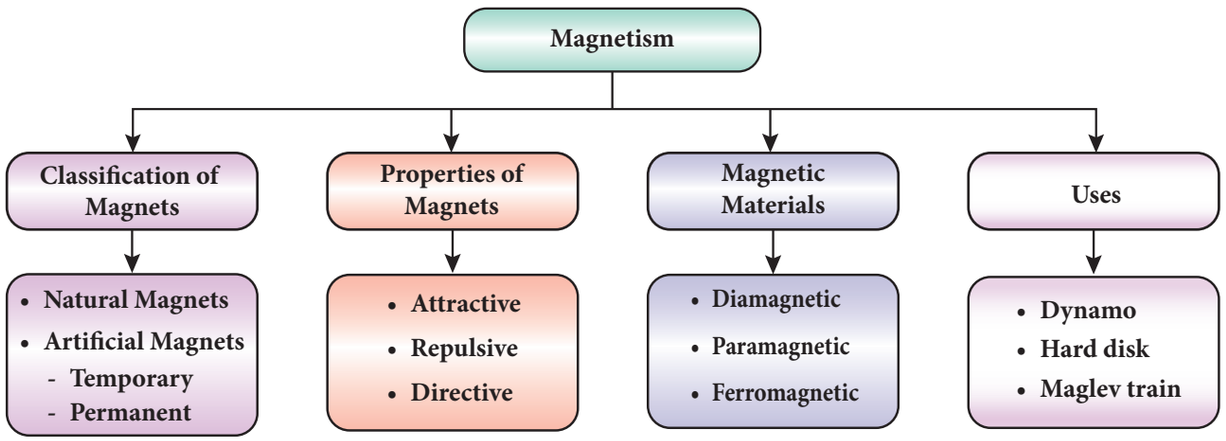
INTERNET RESOURCES

https://www.livescience.com/38059-magnetism.html

https://en.wikipedia.org/wiki/Magnetar

https://www.investopedia.com/terms/m/magnetic-stripe-card.asp

Concept Map



UNIT 8

UNIVERSE AND SPACE SCIENCE

Learning Objectives

F8U9A8

After the completion of this lesson, students will be able to:

- know about the parts of rockets and the types of rocket fuel.
- understand the principle behind launching of rockets.
- list out the achievement of Indian space programmes, Chandrayan and Mangalyan.
- know about NASA and the contributions of Indians in NASA.

Introduction

Have you ever watched the clear sky in the night? We will be delighted when we see countless number of stars and the beautiful Moon. The science, which deals with the study of stars, planets and their motions, their positions and compositions, is known as astronomy. The stars, the planets, the Moon and many other objects like asteroids and comets in the sky are called celestial objects. The Sun and the celestial bodies which revolve around it, form the solar system. A collection of billions of stars, held together by mutual attraction, is called 'Galaxy'. Our Sun belongs to a galaxy called 'Milky Way'. Billions of such galaxies form the universe. Hence, the solar system, the stars and the galaxies are the constituents of the universe. In the recent years many countries are showing interest to explore the space and they are sending manned and unmanned rockets to the Moon and other planets. Our country also has launched a number of rockets into the space and achieved a lot in space research. In this lesson we will study about launching of rockets, types of rocket fuels, Indian space research programmes and NASA.

8.1 Rockets

The universe is a great mystery to all of us. Our mind always tries to know about the space around us. Understanding the space will be helpful to us in many ways. Space research provides information to understand the environment of the earth and the changing climate and weather on the earth. Exploring the space will help us to answer many of the challenges we are facing these days. Discovery of rockets has opened a small portion of the universe to us.

Rockets help us to launch space probes to explore the planets in the solar system. They also help us to launch space-based telescopes to explore the universe. More than all rockets

DO YOU KNOW?

Rockets were invented in China, more than 800 years ago. The first rockets were a cardboard tube packed with gunpowder. They were called fire arrows. In 1232 AD, the Chinese used these 'fire arrows' to defeat the invading Mongol army. The knowledge of making rockets soon spread to the Middle East and Europe, where they were used as weapons.

enable us to put satellites, which are useful to us in a number of ways. Our country has effective rocket technology and has applied it successfully to provide so many space services globally.

8.1.1 Parts of Rockets

A rocket is a space vehicle with a very powerful engine designed to carry people or equipment beyond Earth and out into space. There are four major parts or systems in a rocket. They are:

- Structural system
- Payload system
- Guidance system
- Propulsion system

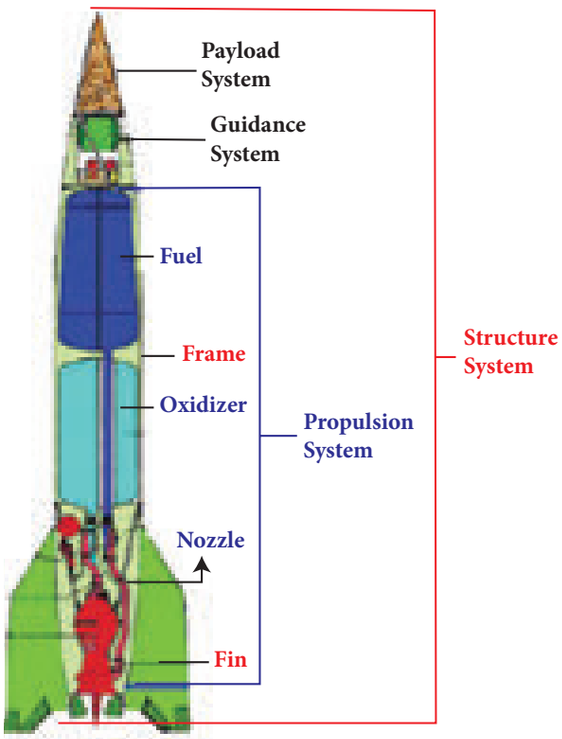


Figure 8.1 Parts of a Rocket

Structural system (Frame)

The structural system is the frame that covers the rocket. It is made up of very strong but light weight materials like titanium or aluminum. Fins are attached to some rockets at the bottom of the frame to provide stability during the flight.

Payload system

Payload is the object that the satellite is carrying into the orbit. Payload depends on the rocket's mission. The rockets are modified to launch satellites with a wide range of missions like communications, weather monitoring, spying, planetary exploration, and as observatories. Special rockets are also developed to launch people into the Earth's orbit and onto the surface of the Moon.

Guidance system

Guidance system guides the rocket in its path. It may include sensors, on-board computers, radars, and communication equipments.

Propulsion system

It takes up most of the space in a rocket. It consists of fuel (propellant) tanks, pumps and a combustion chamber. There are two main types of propulsion systems. They are: liquid propulsion system and solid propulsion system.

DO YOU KNOW?

Polar Satellite Launch Vehicle (PSLV) and Geosynchronous Satellite Launch Vehicle (GSLV) rockets are India's popular rockets.

Activity 1

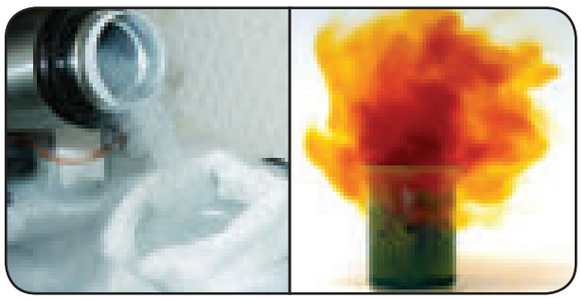
Make a model of a rocket using the low cost materials available to you. Also prepare an album of the rockets launched by India.

8.1.2 Types of Propellants

A propellant is a chemical substance that can undergo combustion to produce pressurized gases whose energy is utilized to move a rocket against the gravitational force of attraction. It is a mixture, which contains a fuel that burns and an oxidizer, which supplies the oxygen necessary for the burning (combustion) of the fuel. The propellants may be in the form of a solid or liquid.

a. Liquid propellants

In liquid propellants, fuel and oxidisers are combined in a combustion chamber where they burn and come out from the base of the rocket with a great force. Liquid hydrogen, hydrazine and ethyl alcohol are the liquid fuels. Some of the oxidizers are oxygen, ozone, hydrogen peroxide and fuming nitric acid.

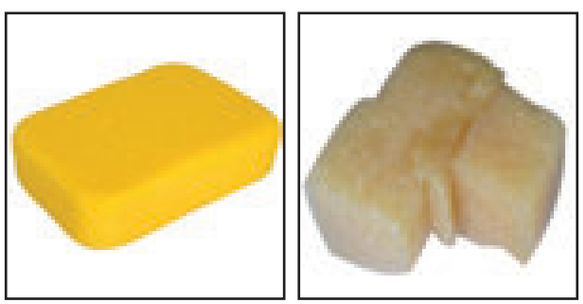


Liquid Hydrogen Fuming Nitric Acid

Figure 8.2 Liquid Propellants

b. Solid propellants

In solid rocket propellants, fuel and oxidiser compounds are already combined. When they are ignited they burn and produce heat energy. Combustion of solid propellants cannot be stopped once it is ignited. Solid fuels used in rockets are polyurethanes and poly butadienes. Nitrate and chlorate salts are used as oxidizers.



Polyurethanes Poly butadienes

Figure 8.3 Solid propellants

c. Cryogenic propellants

In this type of fuel, the fuel or oxidizer or both are liquefied gases and they are stored at a very low temperature. These fuels do not need any ignition system. They react on mixing and start their own flame.

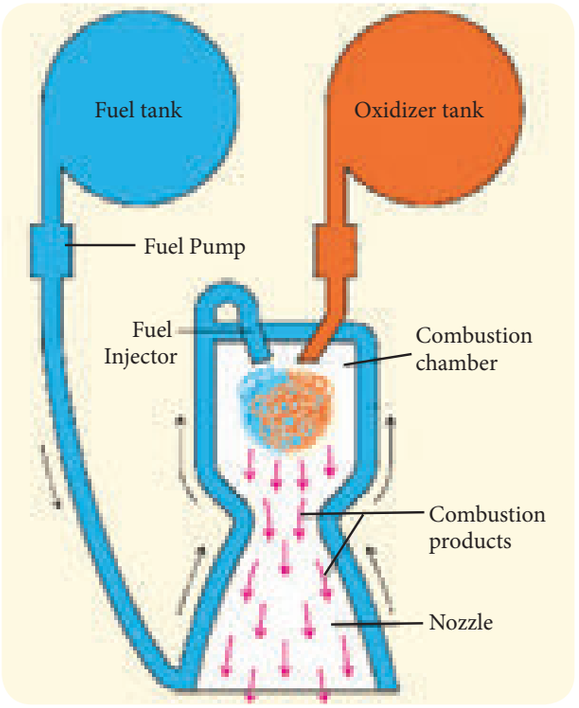


Figure 8.4 Cryogenic Fuels

8.1.3 Launching of Satellite

Activity 2

Take a balloon and blow air into it. Now let the air inside the balloon to come out. What do you observe? You can see the balloon moving in a direction opposite to the direction of the air. Rocket also moves almost similar to this.

Before being launched into the space, rockets will be held down by the clamps on the launching pad. Manned or unmanned satellites will be placed at the top of the rocket. When the fuel in the rocket is burnt, it will produce an upward thrust. There will be a point at which the upward thrust will be greater than the weight of the satellite. At that point the clamp will be removed by remote control and the rocket will move upwards. According to Newton's third law, for every action there is an equal and opposite reaction. As the gas is released downward, the rocket will move upward.

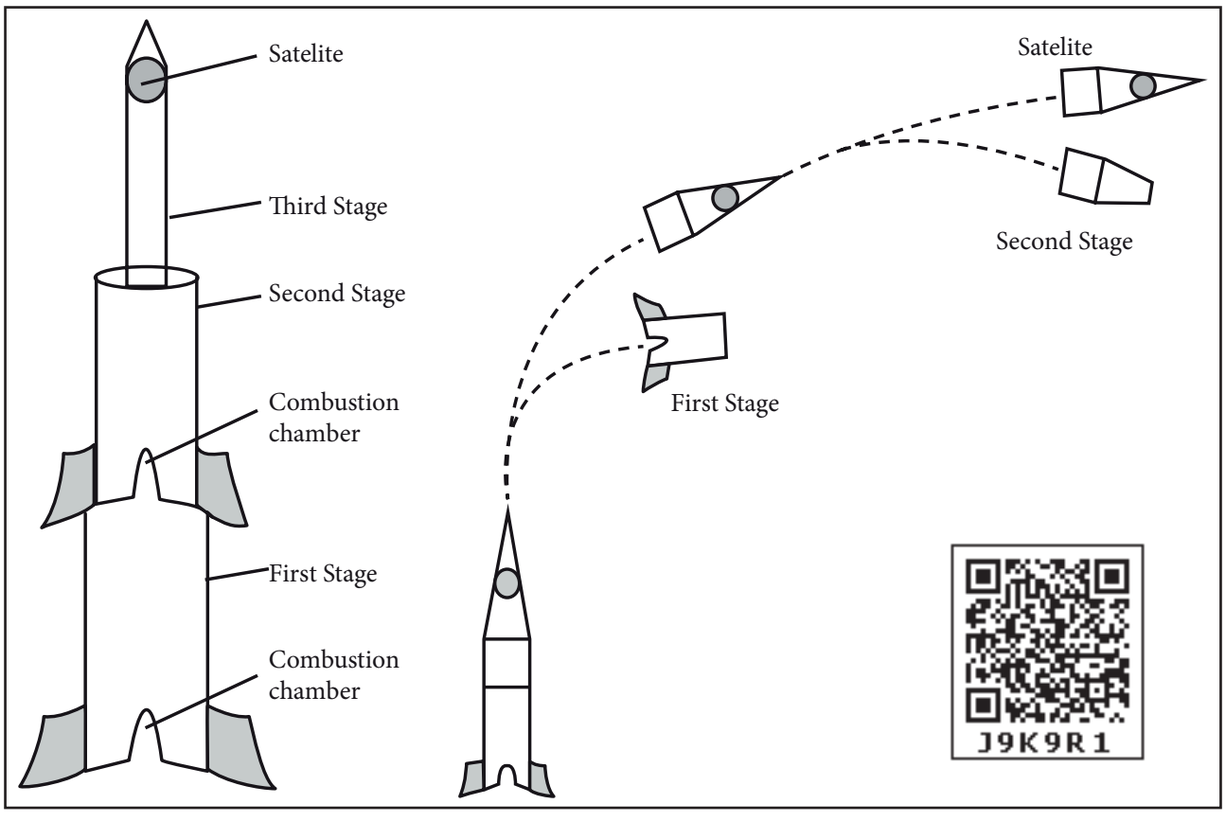


Figure 8.5 Launching of Rocket

To place a satellite in a particular orbit, a satellite must be raised to the desired height and given the correct speed and direction by the launching rocket. If this high velocity is given to the rocket at the surface of the Earth, the rocket will be burnt due to air friction. Moreover, such high velocities cannot be developed by a single rocket. So, multistage rockets are used. To penetrate the dense lower part of the atmosphere, initially the rocket rises vertically and then it is tilted by a guidance system.

8.2 India's Space Programmes

Soon after independence, India initiated space research activities. In 1969, Indian Space Research Organisation (ISRO) was formed with the objective of developing space technology and its application for different needs of the nation. India is focusing on satellites for communication and remote sensing, space transportation systems and application programmes. The first ever satellite Aryabhata was launched in 1975. Since then India has achieved a lot in space programmes equal to that of the developed nations.

Activity 3

With the help of your teacher gather information about the achievements of India in space research. Prepare an album about the satellite programmes of India.

DO YOU KNOW?

Rakesh Sharma, an Indian pilot from Punjab was selected as a 'Cosmonaut' in a joint space program between India and Soviet Russia and become the first Indian to enter into the space on 2nd April, 1984.

8.2.1 Chandrayaan - 1

Our country launched a satellite Chandrayaan-1 (meaning Moon vehicle) on 22nd October 2008 to study about the Moon. It was launched from Sathish Dhawan Space Center in Sriharikota, Andhra Pradesh with the help of PSLV (Polar Satellite Launch Vehicle) rocket. It was put into the lunar orbit on 8th November 2008.

The spacecraft was orbiting around the Moon at a height of 100 km from the lunar surface. It collected the chemical, the mineralogical and the geological information about the Moon. This mission was a major boost for the Indian space programs and helped to develop its own technology to explore the Moon. Chandrayaan-1 was operated for 312 days and achieved 95% of its objectives. The scientists lost their communication with the space craft on 28th August 2009. On the successful completion of all the major objectives, the mission was concluded.

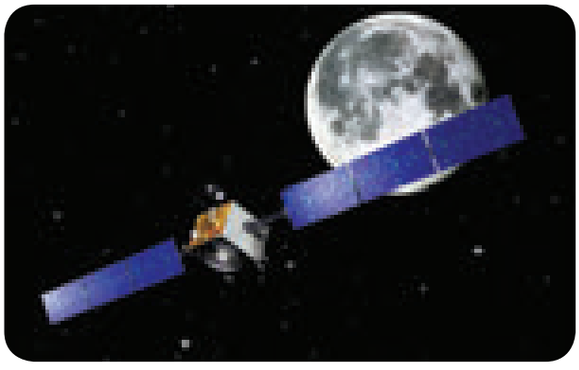


Figure 8.6 Chandrayaan - 1

a. Objectives of Chandrayaan-1

The following are the objectives of Chandrayaan – 1 mission.

- To find the possibility of water on the Moon.
- To find the elements of matter on the Moon.
- To search for the existence of Helium-3.
- To make a 3-dimensional atlas of the Moon.
- To study about the evolution of the solar system.

Kalam Sat is the world's smallest satellite weighing only 64 gram. It was built by a team of high school students, led by Rifath Sharook, an 18 year old school student from 'Pallapatti' near Karur, Tamil Nadu. It was launched into the space on 22nd June 2017 by NASA.

b. Achievements of Chandrayaan-1

The following are the achievements of Chandrayaan-1 mission.

- The discovery of presence of water molecules in the lunar soil.
- Chandrayaan-1 confirmed that the Moon was completely molten once.
- Chandrayaan-1 has recorded images of the landing site of the US space-craft Apollo-15 and Apollo-11.

Know your Scientist

Dr. Mylsamy Annadurai was born on 2nd July 1958, at Kodhavadi, a small village near Pollachi in Coimbatore district. He pursued his B.E. degree course at Government College of Technology, Coimbatore. In 1982, he pursued his higher education and acquired an M.E. degree at PSG College of Technology, Coimbatore. In the same year he joined the ISRO as a scientist. And later, he got his doctorate degree from Anna University of Technology, Coimbatore. Annadurai is a leading technologist in the field of satellite system. He has served as the Project Director of Chandrayaan-1. He has also made significant contributions to the cost effective design of Chandrayaan.

- It has provided high-resolution spectral data on the mineralogy of the Moon.
- The existence of aluminium, magnesium and silicon were picked up by the X-ray camera.
- More than 40,000 images have been transmitted by the Chandrayaan-1 camera in 75 days.
- The acquired images of peaks and craters show that the Moon mostly consists of craters.
- Chandrayaan-1 beamed back its first images of the Earth in its entirety.
- Chandrayaan-1 has discovered large caves on the lunar surface that can act as human shelter on the Moon.

8.2.2 Mangalyaan (Mars vehicle)

After the successful launch of Chandrayaan-1, ISRO planned an unmanned mission to Mars (Mars Orbiter Mission) and launched a space probe (space vehicle) on 5th November 2013 to orbit Mars orbit. This probe was launched by the PSLV Rocket from Sriharikota, Andra pradesh. Mars Orbiter Mission is India's first interplanetary mission. By launching Mangalyaan, ISRO became the fourth space agency to reach Mars.

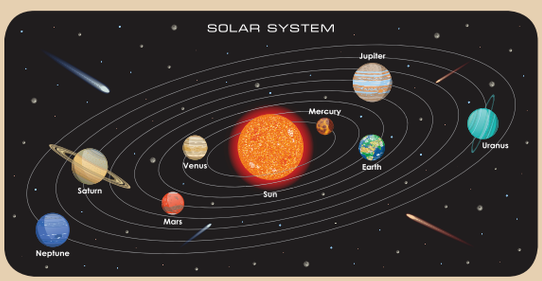
Mangalyaan probe traveled for about a month in Earth's orbit, and then it was moved to the orbit of Mars by a series of projections. It was successfully placed in the Mars-orbit on 24th September 2014.

Figure 8.7 Mangalyaan

Mars Orbiter Mission (MOM) successfully completed a period of 3 years in the Martian orbit and continues to work as expected. ISRO has released the scientific data received from the Mangalyaan in the past two years (up to September 2016).

More to know

Mars is the fourth planet from the Sun. It is the second smallest planet in the solar system. Mars is called as the Red Planet because of its reddish colour. Iron Oxide present in its surface and also in its dusty atmosphere gives the reddish colour to that planet. Mars rotates about its own axis once in 24 hours 37 minutes. Mars revolves around the Sun once in 687 days. The rotational period and seasonal cycles of Mars are similar to that of the Earth. Astronomers are more curious in the exploration of Mars. So, they have sent many unmanned spacecrafts to study the planet's surface, climate, and geology.



Activity 4

Gather information about the planets in the solar system. Can we reach all the planets in the solar system? Discuss in the class room.

a. Objectives of Mangalyaan

The following are the objectives of Mangalyaan mission.

- To develop the technology required for interplanetary mission.
- To explore the surface of Mars.

- To study the constituents of the atmosphere of Mars.
- To provide information about the future possibility of life and past existence of life on the planet.

Figure 8.8 Images from Mars Orbiter Mission

DO YOU KNOW?

India became the first Asian country to reach Mars and the first nation in the world to achieve this in the first attempt. Soviet Space Program, NASA, and European Space Agency are the three other agencies that reached Mars before ISRO.

8.2.3 Chandrayaan - 2

ISRO has currently launched a follow on mission to Chandrayaan-1 named as Chandrayaan-2, on 22nd July 2019. Chandrayaan-2 mission is highly complex mission compared to previous missions of ISRO. It brought together an Orbiter, Lander and Rover. It aims to explore South Pole of the Moon because the surface area of the South Pole remines in shadow much larger than that of North Pole.

Orbiter

It revolves around the moon and it is capable of communicating with Indian Deep Space Network (IDSN) at Bylalu as well as Vikram Lander.

Lander

It is named as Vikram in the memory of Dr.Vikram A. Sarabhai, the father of Indian space program.

Rover

It is a six wheeled robotic vehicle named as 'Pragyan' (Sanskrit word) that means wisdom. Chandrayaan-2 was successfully inserted into the lunar orbit on 20th August 2019. In the final tage of the mission, just 2.1 km above the lunar surface, Lander 'Vikram' lost its communication with the ground station on 7th September 2019. But the Orbiter continues its work successfully.

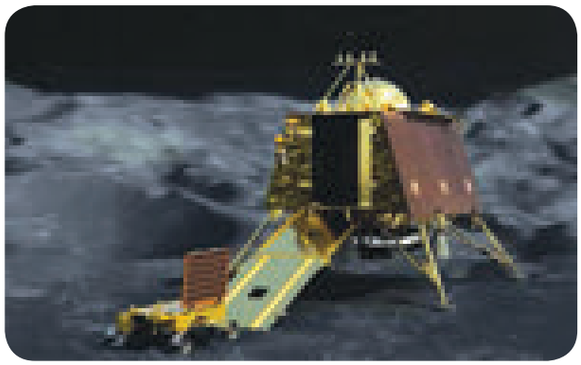


Figure 8.9 Vikram Lander

Know your Scientist

Dr. Kailasa Vadivoo Sivan is the chairperson of the Indian Space Research Organization (ISRO). He was born in Sarakkalvilai, in Kanyakumari district of Tamil Nadu. Sivan graduated with a bachelor's degree in Aeronautical Engineering from Madras Institute of Technology in 1980. Then he got his master's degree in Aerospace Engineering from Indian Institute of Science, Bangalore in 1982, and started working in ISRO. He completed his doctoral degree in Aerospace Engineering from Indian Institute of Technology, Bombay in 2006. He was appointed as Chairman of ISRO from 10th January 2018. Sivan is popularly known as the 'Rocket Man' for his significant contribution to the development of cryogenic engines for India's space programs. The ability of 'ISRO' to send 104 satellites in a single mission is a great example of his expertise.

More to know

The Moon is the only natural satellite of the Earth. It is at a mean distance of about 3,84,400 km from the Earth. Its diameter is 3,474 km. It has no atmosphere of its own. It doesn't have its own light, but it reflects the sunlight. The time period of rotation of the Moon about its own axis is equal to the time period of revolution around the Earth. That's why we are always seeing its one side alone.

8.3 NASA (National Aeronautics and Space Administration)

NASA is the most popular space agency whose headquarters is located at Washington, USA. It was established on 1st October 1958. It has 10 field centers, which provide a major role in the execution of NASA's work. NASA is supporting International Space Station which is an international collaborative work on space research. It has landed rovers on Mars, analysed the atmosphere of Jupiter, explored Saturn and Mercury.

The Mercury, Gemini and Apollo programs helped NASA learn more about flying in space. NASA's robotic space probes have visited every planet in the solar system. Satellites launched by NASA have revealed a wealth of data about Earth, resulting in valuable information such as a better understanding of weather patterns. NASA technology has contributed to make many items used in everyday life, from smoke detectors to medical tests.

8.3.1 Apollo Mission

Apollo Missions are the most popular missions of NASA. These missions made American Astronauts to land on the Moon. It consists of totally 17 missions. Among them Apollo -8 and Apollo-11 are more remarkable. Apollo-8 was the first manned mission to go to the Moon. It orbited around the Moon and came back to the Earth. Apollo-11 was the first 'Man Landing Mission' to the moon. It landed on the Moon on 20th July 1969. Neil Armstrong was the first man to walk on the surface of the Moon.

Figure 8.10 Apollo Mission by NASA

The members present in the crew during the Man Landing Mission were Neil Armstrong, Buzz Aldrin and Michael Collins.

8.3.2 NASA's work with ISRO

NASA made an agreement to work with ISRO to launch the NISAR Satellite (NASA-ISRO Synthetic Aperture Radar) and Mars Exploration Missions.

8.3.3 Work of Indians at NASA

People of Indian origin in America are working in NASA and they have made remarkable contribution to NASA.

Kalpana Chawla

Kalpana Chawla was born on 17th March 1962 in Karnal, Punjab. In 1988, she joined the NASA. She was selected to take part in the Colombia Shuttle Mission in 1997 and she became the first Indian women astronaut to go to space. On her second mission on the Colombia Shuttle, she lost her life, when the shuttle broke down.

Kalpana Chawla travelled over 10.4 million miles in 252 orbits of the earth, logging more than 372 hours in space.

Activity 5

Visit a library and gather more information about the achievements of Kalpana Chawla. Discuss why Kalpana Chawla is an inspiration to all of us.

Sunitha Williams

Sunitha Williams was born on 19th September 1965 in USA. She started her career as an astronaut in August 1998. She made two trips to the International Space Station. She set a record of the longest space walking time by a female astronaut in 2012, with a total space walk of 50 hour and 40 minute (7 space walks). She is one of the crew of NASA's Manned Mars Mission.

Points to Remember

- The solar system, the stars and the galaxies are the constituents of the universe.
- A rocket is a vehicle, which propels itself by ejecting a part of its mass.
- The PSLV (Polar Satellite Launch Vehicle) and GSLV (Geosynchronous Satellite Launch Vehicle) rockets are India's popular rockets.
- A propellant is a chemical substance that can undergo combustion to produce pressurized gases whose energy is utilized to move a rocket against the gravitational force of attraction.
- The propellants may be in the form of a solid or liquid.
- In cryogenic propellant the fuel or oxidizer or both are liquefied gases and they are stored at a very low temperature.
- Our country launched Chandrayaan-1 (Satellite to the Moon) on 22nd October 2008 to study about the Moon. The word Chandrayaan means 'Moon vehicle'.
- Mars is the fourth planet from the Sun. It is the second smallest planet in the solar system.
- After the successful launch of Chandrayaan-1, ISRO planned an unmanned mission to Mars (Mars Orbiter Mission) and launched a space probe (Space vehicle) on 5th November 2013 to orbit 'Mars'.
- Mars Orbiter Mission is India's first interplanetary mission.
- NASA (National Aeronautics and Space Administration) is the most popular space agency whose headquarters is located at Washington, USA.
- Apollo Missions are the most popular missions of NASA. These missions made American Astronauts to land on the Moon.
- Apollo-8 was the first manned mission to go to the Moon.
- Apollo-11 was the first 'Man Landing Mission' to the moon.

GLOSSARY

Cryogenic	Study of very low temperature.
Galaxy	System of millions of stars.
Geological	Study of earth's physical structure and substance.
Mineralogy	Scientific study of minerals.

Payload	Satellites kept in the launching rockets.
Propellant	Fuel or explosive substance.
Space probe	Vehicle sent into space to study the planets.
Universe	All existing matter and space.

TEXTBOOK EXERCISES

I8S4L5

I. Choose the best answer.

1. Which of the following is a celestial body?
   a) Sun b) Moon
   c) Stars d) All the above
2. Mangalyaan was sent to _____
   a) Moon b) Mars
   c) Venus d) Mercury
3. Chandrayaan - 1 was launched on
   a) 22nd October 2008
   b) 8th November 2008
   c) 22nd July 2019
   d) 22nd October 2019
4. _____ is called as Red planet.
   a) Mercury b) Venus
   c) Earth d) Mars
5. Which of the following is the working principle of Rockets?
   a) Newton's first law
   b) Newton's second law
   c) Newton's third law
   d) All the above
6. Cryogenic fuels are stored at
   a) room temperature
   b) low temperature
   c) very low temperature
   d) very high temperature
7. _____ was the first manned mission of NASA to go to the moon.
   a) Apollo-5 b) Apollo-8
   c) Apollo-10 d) Apollo-11

II. Fill in the blanks.

1. The study about stars and planets are known as _____.
2. Our sun belongs to _____ Galaxy.
3. Mars revolves around the Sun once in _____ days.
4. _____ is India's first interplanetary mission.
5. _____ was the first man to walk on the surface of the Moon.

III. Say true or false. If false, correct the statement.

1. The Sun and the celestial bodies form Solar system.
2. Chandrayaan-1 was launched from Sriharikota.
3. Mars is the smallest planet in the Solar system.
4. PSLV and GSLV are India's popular satellites.
5. The propellant of a rocket is only in the form of solids.

IV. Match the following.

Chandrayaan	Fuel
Mangalyaan	Moon
Cryogenic	First manned mission to the moon
Apollo - 8	First man landing mission to the moon
Apollo - 11	Mars

V. Answer briefly.

1. What are celestial objects?
2. Define galaxy.
3. What are the objectives of Chandrayaan -1?
4. List out the objectives of Mangalyaan.
5. What are Cryogenic Fuels?
6. Name the Indians worked at NASA.

VI. Answer in detail.

1. What are the achievements of Chandrayaan - 1?
2. Explain the parts of a rocket.
3. Write a note on Apollo missions.

VII. Higher Order Thinking Questions.

1. We always see one side of the Moon. Why?

REFERENCE BOOKS

1. Big Bang - By Simon Singh.
2. What are the stars? - By G. Srinivas.
3. An introduction to Astronomy - By Baidyanath Basu.

INTERNET RESOURCES

1. https://www.isro.gov.in/Spacecraft/chandrayaan-1
2. https://www.isro.gov.in/chandrayaan2-home-0
3. https://www.isro.gov.in/pslv-c25-mars-orbiter-mission
4. https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-was-apollo-program-58.html

Concept Map