GEOGRAPHY

TEST – 4 Part – 1

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8th std
Unit1.MEASUREMENT

Introduction

Physics is the study of nature and natural phenomena. Physics is considered as the base of all science subjects. Physics 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. Measurement is the process of finding an unknown physical quantity by using a standard quantity.

We need three things for a perfect measurement. They are (i) an instrument, (ii) a standard quantity and (iii) an acceptable unit.

In this activity, let the length of the book be 15 cm, the length is the physical quantity, ruler is the 'instrument', 15 is the 'magnitude' and 'cm' is the unit. This process is called "Measurement"Here, all the students will not get the same value. Thus, one can infer that there may be an error while taking the measurement. This lesson helps us to get a better understanding of measurements.

System of Units

People in various part of the world are using different systems of units for measurement. Some common systems of units are :

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 (Metre 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 an metric system. It is a British system of units.

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 organize other's experimental results. So, the scientists 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, the scientists recognized 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').

The 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)

SI Base Units

Quantity	Unit	Symbol
Length	Metre	M
Mass	Kilogram	Kg
Time	Second	S
Temperature	Kelvin	K
Electric Current	Ampere	mol
Luminous Intensity	Candela	cd

You have already studied about Length, Mass and Time in the lower classes. So, now you are going to study about the other base quantities such as temperature, current, amount of substance and luminous intensity.

Temperature

Identify, which of these objects are hot or cold? (Fig 1.1)

You can see that some objects are cold, and some are hot. You also know that, some objects are hotter than others while some of them are colder than others.

How do you decide, which is hotter and which is colder? So, 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 given to a substance will increase its temperature. Heat removed from a substance will lower its temperature.

Definition

Temperature is a measure of the average kinetic energy of the particles in a system.

Th e SI unit of Temperature is kelvin. 'Th ermometers' are used to measure temperature directly.

Usually, thermometers are calibrated with some standard scales. Celsius, Fahrenheit, Kelvin are the most commonly used scales to measure Temperature. In these thermometers, melting point of pure ice (0°C) is taken as Lower Fixed Point (LFP) and Boiling point of water (100°C) is taken as Upper Fixed Point (UFP).

Table: Various Scales to measure Temperature

Types of Scale	**Lower Fixed Point (LFP)**	**Upper Fixed Point (UFP)**	**No. of divisions in thermometer**
Celsius	0^0C	100^oC	100
Fathrenheit	32^oF	212^oF	180
Kelvin	273K	373K	100

Conversion of Scales of Temperatures

The general formula for the conversion of scales of temperature is:

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

Fig:1.2- Various Thermometers

Application of various thermometric scales

1. Physicians use ' clinical thermometers'. It is graduated in ' Fahrenheit Scale'
2. Scientists are using thermometers with kelvin scale.
3. Common temperature measurements are made in celsius scale. (Example: Weather reports are given in celsius scale.)

Electric Current (I)

Flow of electric charges, in a particular direction is known as 'electric current'.

Th e magnitude of an electric current is the amount of electric charges fl owing through a conductor in one second.

Total capitalised value of the business = $\frac{Averageprofit}{Normalofreturn}$ x 100

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

SI unit of Electric Current is 'ampere' and it is denoted as A. Unit of charge is coulomb.

One ampere is defined as one 'coulomb' of charge moving in a conductor in one second. Ammeter is a device used to measure 'electric current'.

Amount of substance

Can you count the number of copper coins in the picture? (Fig 1.4) Can you count the number of copper atoms in a coin? (Fig 1.4)

It is very difficult to count the number of atoms because the atoms are not visible. Th ere is an indirect method to count the number of atoms or molecules in a substance in multiples of mole. Let us see in detail.

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

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

Th e SI unit of amount of substance is mole and it is denoted as 'mol'.

Mole is defined as the amount of substance, which contains 6.023 x 1023 entities.

Luminous Intensity

Have you seen these scenes on the television? (Fig 1.5)

What is the umpire doing? Is he taking a 'selfie'? (Fig 1.5)

No, he is checking the intensity of light, as perceived by the human eye, by using an instrument called 'Photometer'.

Definition

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 a 'photometer' (Fig 1.6) (Luminous Intensity Meter) which gives the luminous intensity in terms of candela directly.

Plane angle

It is the angle between the intersection of two straight lines or intersection of two planes. (Fig 1.7)

The SI unit of Plane Angle is 'radian' and is denoted as 'rad'.

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 1.8)

π radian = 180°

1 radian = $\frac{180}{\pi}$

Solid Angle

It 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'.

Definition

Steradian is the solid angle at the centre of a sphere subtended by a portion whose surface area is equal to the square of its radius of the sphere. (Fig 1.9)

Do You Know?
Until 1995, Plane Angle and Solid Angle were classified under supplementary quantities. In 1995, they were shifted to derived quantities.

Table: 1.3 Difference between Plane Angle and Solid Angle

Plane Angle	Solid Angle
Angle between the intersection of	Angle between the intersection of three or more

two lines or planes	planes at a common point
It is two dimensional	It is three dimensional
Unit is radian	Unit is steradian

Clocks

Clocks are used to measure time intervals. So, many clocks were used from the ancient time. Scientists modified the clock's mechanism to obtain accuracy.

Types of clocks based on display:

1. Analog clocks; 2. Digital clocks

1. Analog clocks

It looks like a classic clock. It has three hands to show the time. (Fig 1.11)

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.

2. Digital clocks

A digital clock displays the time directly. It shows the time in numerals or other symbols. It may have a 12 hours or 24 hours display. (Fig 1.12)

Recent clocks are showing Date, Day, Month, Year, Temperature etc.
Digital clocks are often called as Electronic Clocks.

Types of clocks based on working mechanism

1. Quartz Clock:

These clocks are activated by 'electronic oscillations', which are controlled by a 'quartz crystal'. (Fig 1.13)

The frequency of a vibrating crystal is very precise. So, the quartz clock is more accurate than the mechanical clock.

These clocks have an accuracy of one second in every 109 seconds.

2. Atomic Clock:

These clocks are making use of periodic vibrations occurring within the atom. (Fig 1.14)

These clocks have an accuracy of one second in every 1013 seconds.

Atomic clocks are used in Global Positioning System (GPS), Global Navigation Satellite System (GLONASS) and International time distribution services.

Do You Know?

GMT) is the mean solar time at the Royal Observator y, 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

Accuracy in Measurements

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’.
The difference between the real value and the observed value is called an error.

Accuracy

Accuracy is the closeness of a measured value to the actual value or true value. (Fig 1.15)

Precision

Precision is the closeness of two or more measurements to each other. (Fig 1.15)

Approximation

We are not following any standard values for preparing a dish. We are following an approximation method for choosing ingredients.

While we prepare a dish, the ingredients are taken approximately.

Approximation is the process of finding a number, which is 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.

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.

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.

Numerical Problems:
1. Convert 80° C into kelvin.
Solution:

K = C + 273
K = 80 + 273
K = 353 kelvin

2. Convert 300 K into celsius.
Solution:
C = K - 273
C = 300 - 273
C = 27 celsius.

3. When 2 coulomb of charge, flows through a circuit for 10 seconds, calculate the current?
Solution:
Given: Charge Q = 2 C; time t = 10 s
I = Q t or I = 2 10
I = 0.2 A

4. Convert 60° into radian.
1° = π 180

$60° = \frac{\pi}{180} 60$

3

$= \pi$ 3radian

5.Convert π 4 into degrees.

π radian = 180°

π 4 radian = $\frac{180}{4}$ = 45°

6. Round off the number 1.864 to two decimal places
Step: 1. Identify the last digit to be kept. 6 is the last digit to be kept.
Step: 2.The following digit, i.e. 8 is less than 5. So, retain it as one. The answer is 1.86

Unit2. Forces and Pressure

Introduction

Every day you can observe bodies around you. When you are coming to school, you can notice that some of them are moving, some of them are at rest. What pushes or pulls them? What brings the moving bodies to rest? What is the effect of these pulls or pushes?

All the above questions can be answered by saying just one word, which is "Force".

FORCE

Observe the following actions in day to day life:

Opening up a pen, opening a door, kicking a football, striking a carrom coin, making of chapattis etc., all these actions need a force.

Force is an 'action of push or pull', which makes the bodies to move or brings the moving bodies to rest. It even changes the shape and size of certain bodies.

The group of students who pull the rope with a greater force will definitely win. The winners are applying a greater amount of force. Hence, the rope moves in the direction of the greater force.

Definition of force

Force is that which changes or tends to change: i) the state of rest or ii) the state of uniform motion of a body or iii) the direction of a moving body or iv) the shape of a body.

Pushes and pulls are forms of forces. The direction of a force is in the direction in which a push or a pull is applied. Thus, force is a vector quantity, which has magnitude and direction. It is measured with a unit called "newton (N)".

Factors on which a force depends

You have studied the effects of force so far. Now, you are going to study the factors on which the effect of a force actually depends.

When you play any game, the greater the force you apply on a body, greater will be its effect on it. Just observe the strokes of the bat by a batsman. If he wants to hit the cricket ball to the boundary, the striking force on the ball must be greater.

Now, the question before you is does it depend on the area of impact?

Inference: It is a wonderful sight to see that the balloon will not burst. How is this possible?
Reason: If you prick the 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 a large number of pins prick a body, each pin exerts very little pressure on the balloon, as the applied force gets distributed over a larger surface of the body. So, the balloon will not burst.

We conclude that the effect of a force depends on the magnitude of the force and the area over which it acts.

Thrust

It is aforce acting perpendicularly on any given surface area of a body. It is measured by the unit newton.

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 one square meter of a body. Unit of pressure is pascal (Pa) or N m–2.

Pressure = $\frac{Thrust(or)Force}{Area}$, P = F A. The SI unit of pressure is pascal (named after the French scientist Blaise Pascal). 1 pascal = 1 N m^{-2}

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

SOLVED PROBLEM:

Calculate the pressure exerted by the foot of an elephant using the following data. Average weight of an elephant is 4000 N. Surface area of the sole of its foot is 0.1m2 .

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.

Pressure= $\frac{Force}{Area} = \frac{1000}{0.1}$

= 10000 $\frac{N}{m2}$ = 10^4 N m^{-2}

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

Increasing pressure:

The effect of pressure can be increased by increasing the thrust or by decreasing the area of the surface of the body experiencing the thrust.

Examples:

The axe, nail, knife, injection needle, bullet etc., all these are having sharp fine edges so as to exert a larger pressure on a smaller area of the body; in order to get the maximum effect from them.

It is very difficult 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.

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 a lower pressure on the shoulders by providing a larger area of contact with the shoulder.
3. It is difficult to drive an automobile, which has flattened tyres.

PRESSURE EXERTED BY AIR - ATMOSPHERIC PRESSURE

You all know very well that air fills the space all around us. This envelope of air is called as atmosphere. It extends up to 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.

Atmospheric pressure 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' (1atm).

1atmospheric peressure =1at = pressureexerted by the mercury column of height 76 cm in the barometer = 1.01×10^5 N $m^{-2.}$
In the SI system 1 atm = 1,00,000pascal (approximately).
SI unit of atmospheric pressure is Nm^{-2} or pascal.
To realise the effect of atmospheric pressure:

FORCES IN LIQUIDS

Buoyant force of a liquid

An upward force is exerted by water on a floating or a partly submerged body. This upward force is called buoyant force. The phenomenon is known as "buoyancy". This force is not only exerted by liquids, but also by gases. Liquids and gases together are called fluids.

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.

A body floats if the buoyant force > its weight; A body sinks if its weight > buoyant force.

Pressure exerted by liquids

Liquids do not have a definite shape. The force acting on unit area of the surface, on which the liquid is placed, is called the static pressure of the liquid. Liquids exert a pressure not only on the base of their container/vessel, but also on its side walls. The pressure exerted by a liquid depends upon the depth of the point of observation considered in it.

An instrument used to measure the difference in the liquid pressure is called a "manometer". You can measure the pressure of fluids enclosed in a definite container using the manometer.

a) Pressure exerted by a liquid on the base of a container depends upon the height of the liquid column:

You have already studied that the atmospheric pressure is measured in terms of the height of the mercury column in a barometer.

b) Liquids exert the same pressure in all directions at a given depth:

c) Liquid pressure varies with the depth:

Home Assignments

1. Ask your family doctor how blood pressure is to be measured?
2. Read the life history of Blasie Pascal.

Pascal's law:

The pressure applied at any point of a liquid at rest, in a closed system, will be distributed equally through all regions of the liquid.

Application of Pascal's law:

Some of the following examples highlight their working according to Pascal's law.

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

All the above questions have an answer, i.e., "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. Thus, the amount of force acting per
unit length, on the surface of a liquid is called surface tension. It has the unit N m^1.

Application of surface tension:

- 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" (you will study this topic in the forth-coming classes), which is caused by the surface tension of water.
- For a given volume, the surface area of a sphere is the minimum. This is the reason for the liquid drops to acquire a spherical shape.
- Water strider insect slides on the water surface easily due to the surface tension of water.
- During a heavy storm, sailors pour soap powder or oil into the sea near their ship to decrease the surface tension of sea water. This process reduces the impact of the violent water current against the all of ship.

VISCOUS FORCE OR VISCOSITY

Definition:

When a liquid is flowing, there is a frictional force between the successive layers of the liquid. This force 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.

Viscosity force is measured by the unit called poise in CGS and kg m^{-1} s^{-1} or N s m^{-2} in SI.

Friction

Reason: Ram's brother falls down due to the lackof friction between his feet and the banana peels.

You have studied that forces are classified into two types: contact force and non-contact force. Now, you are going to study one of the contact forces, i.e., friction.

It is easy to hold a tumbler due to the friction between the surfaces of your palm and the tumbler. But, when oil is applied to your palm, the contact force between your fingers and the tumbler is reduced. So, the friction is reduced. Hence, it is difficult to hold it with an oily hand.

Origin of friction

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.

Effects of friction:

Friction can produce the following effects:

a) Friction opposes motion.

b) Friction causes wear and tear of the surfaces in contact.

c) Friction produces heat.

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. (E.g.: all the objects rigidly placed to be at rest on the Earth, a knot in a thread.)

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

Sliding friction: When a body slides over the surface of another body, the friction acting between the surfaces in contact is called sliding friction.

Rolling 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.

Reason: When you push the book, the pencils roll in the direction of the applied force. They prevent the contact of the bookwith the rough surface. Rolling pencils offer the least amount of friction. So, it is easy to displace the book in comparison with sliding it on the table.

This method is often used in moving heavy wood from one place to another.

Factors affecting friction

a) Nature of a surface:

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.

Advantages of friction

Friction is a necessity in most of our day to day activities. It is desirable in most situations of our daily life.

- We can hold any object in our hand due to friction.
- We can walk on the road because of friction. The footwear and the ground help us to walk without slipping.
- Writing easily with a pen on paper is 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 in the wall because of friction.

Though it is giving a negative effect, in most of our day to day life friction helps us to make our life easy. So, it is called as "necessary evil".

Disadvantages of friction

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

Increasing and decreasing friction

a) Area of contact:

Friction can be increased by increasing the area of the surfaces in contact. Have you seen the sole of a shoe, which has grooves? It is done to provide the shoes a better grip with the floor, so that you can walk safely. Treaded tyres (tyres with slots and projections) are used to increase the friction.

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.

E.g.: Sumo players, Kabbadi players rub their hand with mud, to get a better grip. Football shoes are having soles with many projections, for providing a stronger grip with the ground.

b) Using lubricants:

A substance, which reduces the frictional force, is called a lubricant. E.g.: 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, the rolling friction is smaller than sliding friction, sliding is replaced by rolling with the usage of ball bearings. You can see lead shots in the bearing of a cycle hub.

Unit3. Light

Introduction

Lofty mountains covered with greenish vegetation, magnificent trees reaching up to 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.

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. In this lesson, you will study about other types of mirrors like the spherical mirrors and parabolic mirrors and their applications in our daily life. 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.

Types of Mirrors

We use mirrors in our daily life for various purposes. We use them for decoration. In vehicles, they are used as rear view mirrors. They are also used in scientific apparatus, like telescope. 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. You would have studied about plane mirrors in your lower classes. In this section, you will study about spherical and parabolic mirrors.

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.

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.

Concave mirrors

A spherical mirror, in which the reflection of light occurs at its concave surface, is called a concave mirror. These mirrors magnify theobject 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' to warn the drivers. This is because inside the mirrors, vehicles will appear to be coming at a long distance.

Parabolic mirrors

A parabolic mirror is one type of curved mirror, which is in the shape of a parabola. 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 this 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 energy such as light, heat, sound 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.

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 IbnSahl. The first parabolic mirrors were constructed by Heinrich Hertz, a German physicist, in the form of reflector antennae in the year 1888.

TERMS RELATED TO SPHERICAL MIRRORS

In order to understand the image formation in spherical mirrors, you 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 your next class).

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.

That is, focal length= $\frac{Radiusofcurvature}{2}$

PROBLEM 1

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

Solution:

Radius of curvature =20cm

Focal length (f0 = $\frac{Radiusofcurvature}{2}$

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

PROBLEM 2

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

Solution:

Focal length = 7 cm

Radius of curvature (R) = 2 × focal length = 2 × 7 = 14 cm

IMAGES FORMED BY SPHERICAL MIRRORS

Images formed by spherical mirrors are of two types: i) real image and ii) 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 is 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.

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,	Virtual and erect

		point sized	
Between infinity the pole (P)	Between P and F	Diminished	Virtual erect

Table 3.2 Image formed by a concave mirror

POSITION OF THE OBJECT	POSITIOIN 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

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.

Application of curved Mirrors
Concave mirrors

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 and throat as they provide a shadow-free illumination of the organ.
5. They are also used in reflecting telescopes. Figure 3.3 Concave mirrors

Convex mirrors

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.

Not all the objects can produce the same effect as produced by the plane mirror. A ray oflight, 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: i) incident ray and ii) 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 law 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.
- The angle of incidence and the angle of reflection are always equal.

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

TYPES OF REFLECTION

You have learnt that not all bodies can reflect light rays. Th e amount of reflection depends on the nature of the reflecting surface of a body. Based on the nature of the surface, reflection can be classified into two types namely, i) regular reflection and ii) irregular reflection.

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.

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 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 'diff used reflection'. Example: Reflection of light from a wall.

MULTIPLE REFLECTIONS

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 a body kept in between two plane mirrors, which were inclined to each other, you could see many images. Th is is because, the 'image' formed by one mirror acts as an 'object' for the other mirror. Th e 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. Th us, we have three images of a single body. Th is is known as multiple reflection. Th is type of reflections can be seen in show rooms and saloons.

Th e 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 $= \frac{360}{0}$ -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°

Number of images formed =

$$\frac{360^0}{\theta} - \frac{360^o}{90^o} - 1 = -1 = 4 - 1 = 3$$

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 with each other. It can be designed from inexpensive materials and the colourful image patterns formed by this will be pleasing to you. This instrument is used as a toy for children.

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. Th e distance between the mirrors also varies depending on the purpose of using the 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.

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 and a part of it is absorbed and most of the light passes through it. Th rough 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. Th is 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.

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.

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 andwhen the speed of light is less, the bending is more.

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').

$$\mu = \frac{Speedoflighinair(c)}{Speedoflight \operatorname{int} hemedium(v)}$$

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.

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.

$$\mu_2 \frac{Absoluterefactiveindexofthe\sec ondmedium}{Absoluterefactiveindexofthefivemedum}$$

$$_1\mu_2 = \frac{\frac{c}{v_2}}{\frac{c}{v_1}} \qquad \text{or} \qquad _1\mu_2 = \frac{v_1}{v_2}$$

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

PROBLEM 4

Speed of light in air is 3 × 108 m s-1 and the speed of light in a medium is 2 ×108 ms-1. Find the refractive index of the medium with respect to air.

Solution:

Refractive index (μ)= $\frac{Speedoflightinair(c)}{Speedoflight\ \mathrm{int}\ hemedum(v)}$

$$\mu = \frac{3X10^8}{2X10^8} = 1.5$$

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:

$$_w\mu_g = \frac{\text{Refractive index of glass}}{\text{Refractive index of water}} = \frac{\frac{3}{2}}{\frac{4}{3}} = \frac{9}{8} = 1.125$$

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:

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.

In the above 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 the Newton's disc experiment, which you studied in VII standard.

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.

8TH Standard Term II
1. Heat

Introduction

All the substances in our surrounding are made up of atoms and molecules. These atomsand 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 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 this in this lesson. You will also study about transfer of heat and measurement of heat change know about the working of thermos flask.

Effect 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

1.1.1 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.

You would have noticed some space being left in railway tracks. Why? It is because railway tracks which are made up of iron metal expand during summer. When there is a gap, there will not be any damage in the track due to expansion of the metal rod

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 supplied increases the kinetic energy of the molecules. temperature of the water increases. This shows that heat energy causes increase in temperature.

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)

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

1.2 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

Conduction
Activity 4

Take hot water in a cup and put a silver spoon in it. Leave the spoon inside the water for some time. Now touch the 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 ofatoms or molecules.

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.

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. Thusthe 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.

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

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

form of heat transfer. Radiation is defined as the way of heat transfer from one place to another in the form of electromagnetic waves.

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.

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.

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 in detail in Standard IX.

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.

The amount of energy in food items is measured by the unit kilo calorie. 1 kilo calorie = 4200 J (Approximately).

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

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

Therefore, C' = Q / ΔT

The unit of heat capacity is cal / °C. In SI

system, it is measured in JK-1.

1.3.4 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 of capacity

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

Therefore, $C = Q / m . \Delta T$

The SI unit of specific heat capacity is J Kg-1 K -1.

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.

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

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.

t**hermostat**

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.

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 possibilities of getting a bad taste.

The vacuum flask was invented by Scottish scientist Sir James Dewar in 1892. In his honour it is called 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.

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.

Chapter 2 -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 effect of electric current.

Atoms

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 indifferent 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.

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.

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 havepositive elementary charge (+e) and electrons have negative elementarycharge (-e). Since protons and electrons are equal in number, an atom is electrically neutral.

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 three ways.

- Transfer by Friction

- Transfer by Conduction
- Transfer by Induction

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 electronsb 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.

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 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.

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.

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.

If a negatively 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.

2.3.2 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 give the reason?

When the ebonite rod is rubbed with woollen cloth, electrons from the woolen 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 on 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.

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

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 charges. 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.

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 is zero. When the rod is removed from the ground, the positive charge continues 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.

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 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.

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

2.5.1 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.

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 the 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.

Lighting andThunder

Getting a shock from a doorknob after rubbing your foot on a carpet floor, results from discharge. Discharge occurs when electronson 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 becomepositively 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.

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 much faster than the speed of sound.

During lightning and thunder, we should avoid standing in ground and 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.

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 leaksout from the insulation.

Lightning Arresters

Lightning arrestor is a device used to protect buildings from the effects of lightning. Lightning conductor consists of a metallic lightning rod 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.

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.

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.

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.

In this series circuit, charges (electrons)from the battery have only one path to travel.Here battery, key and two bulbs are connectedin series. Charges flow from the battery to eachbulb, one at a time, in the order they are wired tothe circuit. If one bulb in the circuit is unscrewed,the current flow to another bulb would beinterrupted. We put serial lights during festivals.If the lights are in a series circuit, one burnedout bulb will keep all the lights off. If the numberof bulbs in a circuit with a battery increases, thelight will be dimmer because many resistors areacting on the same power from the battery.

We saw that in series circuit same current travels through every resistance and the voltagewill be different across each resistance. Let us consider three bulbs connected in series. Let I be the current through the circuit and V1, V2, V3 be the voltage across each bulb. The supply voltage V is the total of the individual voltage drops across the resistances.

$$V = V1 + V2 + V3$$

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.

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 parallelcircuit 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 I1, I2, I3 be the current across each bulb. The current I from the battery is the total of the individual current flowing through the resistances.

$$I = I1 + I2 + I3$$

Difference between series and parallel circuits

Series circuits	**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 Voltage 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 compound breaks down, the whole circuit will burn out.	Other Components will function even if one component breaks down.

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.

Chemical Effect of Current

We saw 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.

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 ofresistance 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 ofthem 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.

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.

SOUND

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.

Production of Sound

Sound is produced when an object is set tovibrate. Vibration means a kind of rapid to and fromotion of an object. This to and fro motion of thebody 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.

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 bodies. You can see this kind of vibrations in stringed musical instruments, such as guitar and sitar also.

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.

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.

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.

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

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.

The speed of sound is the distance travelled by it in on We 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.

Problem 1

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

Solution

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

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 media are listed in Table.

State	Substance	Speed (ms-1)
Speed (ms-1)	Aluminum	6420
	Steel	5960
	Iron	5950
Liquid	Sea Water	1530
	Distilled Water	1498
Gases	Aluminum	6420
	Steel	965
	Iron	346
	Iron	316

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. 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.

Sound Waves

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.

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.

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.

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.

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.

Properties of Sound

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

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 viceversa. 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).

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.

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.

Audibility and Range

According to the frequency we can classify the sound 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. These sounds can be heard by the human beings only. 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 given below.

- It is employed in the Earth monitoring system.
- It is also used in the study of the mechanism of the 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 given below.

- 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.

Musical Instruments

Some sounds are pleasing to the ear and make you 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 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.

Sound produced by Humans

In a 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.

Mechanism of Human Ear

The ear is the important organ for all animals to hear a sound. We are able to hear sound through our ears. The 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, 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.

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 you 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.

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.
- 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 a 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.

Controlling noise pollution

We studied about the harmful effects of noise pollution. Hence, 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.

Hearing Loss

You may have hearing loss without realizing 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

MAGNETISM

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.

Classification of Magnets

Magnets are classified into two types. They are: i. Natural magnets ii. 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.

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

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.

Magnetic Properties

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

- Attractive property
- Reflective property
- Directive property

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.
You can observe here that the iron fi lings 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.

Repulsive Property

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.

Directive Property

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

Magnetic Field

You can observe from this experiment that the iron fi lings are arranged in the form of curved patterns around the magnet. The space around the bar magnet where the arrangement of iron fi lings 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).

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., thenew 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 as A. 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 as B, C, D, E, F, G, H and I. 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 severalmagnetic lines of force are drawn around the magnet as shown in the Figure 2.4. These curved lines around the bar magnet represent the magnetic field of the magnet. The direction of the lines is shown by the arrows heads.

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 its specific region.

Magnetic Materials

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
- Paramagnetic
- Ferromagnetic

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.

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.

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 paramagnetic

Artificial Magnets

Artificial magnets are produced from magnetic materials. These are generally made by magnitising iron or steel alloys electrically. These magnets are also produced by stroking 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.

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.

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 refrigerator, bar magnet, speaker magnet, fridge magnet and magnetic compass are some familiar examples of a permanent magnet. Neodymium magnets are the strongest and the most powerful magnets on the Earth

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.

Earth's Magnetism

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 ata 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.

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.

Core of the Earth

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.

Earth's Magnetic Field

A freely suspended magnetic needle ata 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.

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' helped seamen to find the directions during a voyage.
- Nowadays, magnets are used to generate electricity in dynamos.
- Magnets, especially 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.

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.

The strip on the back of a credit card/debit card is a magnetic strip, often called a magnetic strip. The magnetic strip 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, extremely strong electro magnets are used in the MRI (Magnetic Resonance Imaging) to scan the specified internal organ.

UNIVERSE AND SPACE SCIENCE

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 revolving 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.

Rockets

The universe is a great mystery to all of us. Our minds always try 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 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.

> 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.

More than all rockets 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.

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

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.

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

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.

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

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.

Launching of Satellite

Before being launched into the space, rockets will be held down by the clamps on the launching pad initially. 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.

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.

India's Space Programmes

Within few years after the 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.

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.

a. Objectives of Chandrayaan-1

The following were 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 RifathSharook, 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.MylsamyAnnadurai 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, Chandrayaan-2 and Mangalyaan. 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.

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.

Mars Orbiter Mission 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 MOM 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.

a. Objectives of Mangalyaan

The following are the objectives of Chandrayaan – 2 mission.

- To develop the technology required for interplanetary mission.
- To explore the surface of Mars.
- To study the constituents of the Martian atmosphere.
- To provide information about the future possibility of life and past existence of life on the planet.

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.

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 6 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 stage 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.

Know your Scientist

Dr.Kailasavadivoo 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.

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 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.

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.

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

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.

Work of Indians at NASA

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

KalpanaChawla

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

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.

8th Term I
UNIT-9. MATTER

Introduction

- In the universe all manifestations, phenomena and evolution of life are caused by matter and energy. The various objects which exist around us are made of some kind of matter. We perceive some of these objects through our senses like sight, touch, hearing, taste and smelling. A glass tumbler can be seen, agarbatti burning can be recognized by its smell whereas wind blowing can be felt. All kinds of matter possess mass and occupy space, of course some are heavy and others are light. Thus, matter can be defined as anything, which occupies space or volume and mass and can be perceived by our senses.

As we know already matter exists in

Solids: Substances like wood, stone, sand, iron etc.
Liquids: Substances like water, milk, fruit juice, etc
Gases: Substances like oxygen, nitrogen, carbon dioxide, steam, etc.,

How the matter is composed?

- Matter in any physical state is composed of smaller particles such as atom, molecules orions. Molecules are also made up of atoms of same or different kinds. Hence, atoms are the building blocks of matter.

1. **Atom:** An atom is the smallest particle of an element, which exhibits all the properties of that element. It may or may not exist independently but takes part in every chemical reaction. We have learned about the basics of atoms in Class VII, atomic structure chapter.

2. **Molecules:** Atoms of the same element or different elements combine to form a molecule. A molecule is the smallest particle of a pure substance (element or compound), which can exist independently and retain the physical and chemical properties of the substance.
3. **Ions:** Atoms or group of atoms having a charge (positive or negative) are called ions.

Why symbols?

- A symbol is an image, object, etc., that stands for some meaning. For instance, a dove is a symbol of peace. Similarly, we denote mathematical operations by symbols. For example (+) denotes addition; (–) denotes subtraction, etc. In the same way in chemistry each element is denoted by a symbol. Writing out the name of an element every time would become too troublesome. So, the name of an element is represented by shortened form called as symbol.

Symbol of elements

- Let us learn the brief history of symbols of elements.

Greek symbols

- The symbols in form of the geometrical shapes were those used by the ancient
- Greeks to represent the four basic elements around us such as earth, air, fire and water.

Alchemist symbol

- In the days of alchemists, the different materials that they used were represented by the above-mentioned symbols while they try to change less valuable metal into gold. The process was called alchemy and the men who did this work were known as alchemists.

Dalton symbols

- In 1808, John Dalton, English scientist tried to name the various elements based on these pictorial symbols. These symbols are difficult to draw and hence they are not used. It is only of historical importance.

Pictorial symbols

Daltons 1808AD(CE) symbols and formulae.		
Hydrogen	Soda	Ammonia
Nitrogen	Pot ash	Olefiant
Carbon	Oxygen	Carbonic oxide
Sulphur	Copper	Carbonoic acid
Phosphorus	Lead	Sulphuric Acid
Alumina	Water	

Berzelius symbols

- In 1813, Jon Jakob Berzelius devised a system using letters of alphabet rather than signs.,. The modified version of Berzelius system follows under the heading 'System for Determining Symbols of the Elements'

Present System for Determining Symbols of the Elements

1. The symbols of the most common elements, mainly non-metals, use the first letter of their English name.

Element	Symbol	Element	Symbol
Boron	B	Oxygen	O
Carbon	C	Phosphorus	P
Fluorine	F	Sulphur	S
Hydrogen	I	Uranium	

2. If the name of the element has the same initial letter as another element, then symbol uses the first and second letters of their Element name. First letter in upper case and the second letter is in lower case.

Element	**Symbol**	**Element**	**Symbol**
Aluminium	Al	Gallium	Ga
Barium	Ba	Helium	He
Beryllium	Be	Lithium	Li
Bismuth	Br	Neon	Ne
Bromine	Br	Silicon	Si
Cobalt	Co	Argon	Ar

3. If the first two letters of the names of elements are the same, then the symbol consists of first letter and second or third letter of English name that they do not have in common.

Element	**Symbol**	**Element**	**Symbol**
Argon	Ar	Calcium	Ca
Arsenic	As	Cadmium	Cd
Chorine	Cl	Mangnesium	Mg
Chromium	Cr	Manganese	Mn
Bromine	Br	Silicon	Si
Cobalt	Co		

4. Some symbols are used on the basis of their old names or Latin name of an element. There are eleven elements.

Name of element	Latin Name	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe

Name of element	**Latin Name**	**Symbol**
Copper	Cupurum	Cu
Silver	Argentum	Ag
Gold	Aurum	Au
Mercury	Hydrargyrum	Hg
Lead	Plumbum	Pb
Tin	Stannum	Sn
Anitmony	Stibium	Sb
Tungsten	Wolfram	W

5. Some elements are named using name of country/scientist/colour/mythological character/planet.

Name	Symbol	Name Derived from
Americium	Am	America (country)
Europium	Eu	Europe (country)
Nobelium	No	Alfred Nobel (scientist)
Iodine	I	Violet (colour, Greek)
Mercury	Hg	God Mercury (mythologic character)
Pultonium	Pu	Pluto (planet0
Neptunium	Np	Neptune (Planet)
Uranium	U	Uranus (plnet)

Do you know how to write a symbol for a given element?

While writing a symbol for an element, we should adhere to the following method.

1. If the element has a single English letter as a symbol, it should be written in capital letter.

2. For elements having two letter symbols, the first letter should be in capital followed by small letter

What is the significance of the symbol of an element?

Symbol of an element signifies

- Name of the element
- One atom of the element For example,
- The symbol O stands for the element of Oxygen
- One atom of oxygen

METALS AND NON-METALS

- The progress of man towards civilization is linked with the discovery of several metals and non-metals. Even today, the index of prosperity of a country depends upon the amount of metals and non-metals it producesand uses. The wealth of a country is measured by the amount of gold in its reserve.

- These days, metals and non-metals are used for making tools, machines, cars, utensils, etc. Some of the common metals used are iron, copper, silver, gold, lead, zinc, aluminium, magnesium, nickel, chromium and mercury etc. Similarly, the common non-metals used are nitrogen, oxygen, hydrogen, carbon, sulphur, phosphorus and chlorine etc.

- An element can be identified as metal or non-metal by comparing its properties with the general properties of metals and non- metals. In doing so, we find that some elements neither fit with the metals or with non-metals. Such elements are called semi-metals or metalloids.

- Elements are classified into metals, non-metals, and metalloids based on their properties

METALS

- Iron,copper,gold,silver, etc. that we use in our daily life are metals. Can you add some more examples that you come across in day to day activities.

Physical properties of metals

1. Physical state: Metals are solid under normal conditions of temperature and pressure. Mercury is liquid at room temperature. Elements cesium (Cs), rubidium (Rb), Francium (Fr) and Gallium (Ga) become liquid at or just above room temperature. 2.

2.Hardness: Most metals are hard. Th e exception here is sodium and potassium, which is soft enough to be cut by a knife. Osmium is so hard that it can scratch glass. 3.

3.Lustre: All metals are shiny. Th e typical shine of metals is called metallic lustre. All metals have a typical metallic lustre. An exception is calcium.

4. Density: Metals generally have high density. Sodium and potassium have exceptionally low density.

5. Melting point and boiling point: Metals in general have high melting point and boiling point. Sodium,potassium,mercury and gallium are exceptions.

6. Tensile strength: Metals have the capacity to withstand strain without breaking. Th is property is called tensile strength. It is the property that owes the use of iron for the construction of railway tracks. Zinc, arsenic and antimony are exceptions.

7. Malleability: Metals can be hammered into very thin sheets. Th is tendency of metals is called malleability. Aluminummakes use of this property to transform into silvery foils.

8. Ductility: Metals can be drawn into thin wires. Th is property of metals is called ductility. Example: copper wires.

9. Conductivity: Metals are good conductors of heat and electricity. Silver and copper are very good conductors of electricity. However, bismuth and tungsten are poor conductors.

10. Sonorous: On being hit, metals produce a typical sound. Hence, they are said to be sonorous. Th is property is being made used in making temple bells.

NON-METALS

- Elements that generally do not shine, neither too hard nor too soft, are non-metals. All gases are non-metals. Some non-metals are Sulphur, Carbon, Oxygen etc..

1. **Physical state:** Non-metals occur as solids, liquids or gases at normal temperature; for example sulphur, phosphorus occurs in solid state while bromine occurs in liquid state. Gases like oxygen, nitrogen, etc., occur in the gaseous state.

2. Hardness: Non-metals are generally not hard except diamond.(a form of carbon)

3. **LUSTRE**: Non-metals have a dull ap p e a r a n c e ; Graphite and iodine are exceptions as they are shiny and lustrous.

4. Density: Non- Metals are generally soft and have low densities. The exception here is diamond (a form of carbon) which is the hardest naturally occurring substance

5. Melting point and boiling point: Non-metals have low melting point and boiling point. However, carbon, silicon and boron are exceptions.

6. Tensile strength: Non-metals do not have tensile strength. However, carbon fibre (a form of carbon) is as tensile as steel.

7. Malleability: Non-metals are non-malleable. If hammered, they form a powdery mass. Actually non-metals in solid state are brittle in nature.

8. Ductility: Non-metals are not ductile. Carbon fibre is highly ductile.

9. Conductivity: Non-Metals are generally bad conductor of electricity. Graphite (a form of carbon) is exception.

10. Sonorous: Non-Metals do not produce sound(non-sonorous) when hit.

A Compartive Study of Metals and Non-Metals

Property	**Metal**	**Non Metal**
Physical state at room Temperature	Usually Soild (Occasionaly liquid)	Solid, liquid or gas
Malleablity	Good	Poor-usually soft or brittle
Ductility	Good	Poor-usually soft or brittle
Melting point	Usually high	Usually low
Boiling point	Usually high	Usually low
Density	Usually high	Usually low
Coductivity (Thermal and electrical)	Good	Very poor

Uses of Metals and Non-Metals
Metal

1. Iron is used for making bridges,engine parts, iron-sheet and bars.

2. Copper is used for making electrical wires, coins and statue.

3. Silver and gold are used for making jewels,in decorative purposes and photography.

4. Mercury is used in thermometers and barometers because of its high density and uniform expansion at different temperature.

5. Aluminium is used in electrical wires, cables and in aerospace industries.

6. Lead is used in automobile batteries, X-ray machines.

Non-Metals

1. Diamond (a form of carbon) is used for making jewels, cutting and grinding equipments. Graphite is used in making pencil lead.

2. Sulphur is used in the manufacturing of gun powder and vulcanization of rubber

3. Phosphorus is used in matches, rat poison etc.

4. Nitrogen is used for manufacturing ammonia.

5. Chlorine is used as a bleaching agent and in sterilizing water.

6. Hydrogen is used as a rocket fuel and hydrogen flame is used for cutting and welding purposes, as well as a reducing agent

Metalloids

- The elements which exhibit the properties of metals as well as non-metals are called metalloids. Examples: boron, silicon, arsenic, germanium, antimony, tellurium and polonium.

Physical properties of metalloids

Metalloids are all solid at room temperature.

1. They can form alloys with other metals

2. Some metalloids, such as silicon and germanium, can act as electrical conductors under the specific conditions, thus they are called semiconductors.

3. Silicon for example appears lustrous, but is not malleable nor ductile (it is brittle - a characteristic of some non metals). It is a much poorer conductor of heat and electricity than the metals

4. The physical properties of metalloids tend to be metallic, but their chemical properties tend to be non-metallic.

Uses of metalloids

1. Silicon is used in electronic devices .
2. Boron is used in fireworks and as a fuel for ignition in rocket.

Compound

- A compound is a pure substance which is formed due to the chemical combination of two or more elements in a fixed ratio by mass. The properties of a compound are different from those of its constituents.

- Water, carbon di oxide, sodium chloride etc. are few examples of compounds. A molecule of water is composed of an oxygen atom and two hydrogen atoms in the ratio 1:2 by volume or 8:1 by mass.

Classsification compound

- Based on the origin of chemical constituents, compounds are classified as inorganic compounds and organic compounds.

a. Inorganic compounds

- Compounds obtained from non living sources such as rock, minerals etc., are called inorganic compounds. Example: chalk, baking powder etc.,

b.Organic compounds

- Compounds obtained from living sources such as plants, animals etc., are called organic compound. Example: Protein, carbohydrates, etc.,

- Both inorganic and organic compounds exists in all three states of matter ie., solids, liquids and gases.

- Let us learn some important compounds in solids, liquids and gaseous state.

Compounds in solid

- Some important compounds that exist in solid state are tabulated as follows

Compound	**Consititutent Elements**
Silica (sand)	Silicon, oxygen

Potassium hydrox-ide (caustic potash)	Potassium, Hydrogen, Oxygen
Sodium hydroxide (Caustic soda)	Sodium, Oxygen, Hydrogen
Copper sulphate	Copper, Sulphur, Oxygen
Zine carbonate (calamine)	Zine, carbon, Oxygen

Compounds in liquid

- Some important compounds that exist in liquid state are tabulated as follows

Compound	**Consititutent Elements**
Water	Hydrogen, Oxygen
Hydro chloric Acid	Hydrogen, Chlorine
Nitric Acid	Hydrogen, Nitrogen, Oxygen
Sulphuric Acid	Hydrogen, Sulphur, Oxygen
Acetic acid (Vineger)	Carbon, Hydrogen, Oxygen

Compounds in gas

- Some important compounds that exist in gaseous state are tabulated as follows

Compound	Constitiuent Elements
Carbon dioxide, carbon monoxide	Carbon, Oxygen
Sulphur dioxide	Sulphur, Oxygen
Methane	Carbon, Hydrogen
Nitrogen dioxide	Nitrogen, Oxygen
Ammonia	Nitrogen, Hydrogen

Uses of Compounds

- Let us tabulate some compounds and their constituents that we use in our daily life.

COMMON NAME	**CHEMICAL NAME**	**CONSTITUENTS**	**USES**
Water	Hydrogen Oxide	Hydrogen and Oxygen	For drinking and as solvent
Table slat	Sodium chloride	Sodium and chlorine	Essential component of our daily diet, preservative for meat and fish.
Sugar	Surcrose	Carbon, hydrogen and oxygen	Preparation of sweets, coffees and fruit juices.
Baking soda	Sodium bicarbonate	Sodium, hydrogen, carbon and oxygen	Fire extinguisher, preparation of baking powder and

			preparation of cakes and bread.
Washing soda	Sodium carbonate	Sodium, carbon and oxygen	As cleaning agent in soap and softening of hardwater.
Bleaching powder	Calcium Oxy chloride	Calcium, oxygen and chlorine	As bleaching agent, disinfectant and sterillisation of dringking water
Quick lime	Calcium oxide	Calcium and oxygen	Manufacture of cement and glass
Slaked lime	Calcium carbonate	Calcium, carbon and oxygen	Preparation of chalk pieces.

Unit.5 Changes Around Us

Introduction

Adithya, a standard VIII student once visited QutubMinar, Delhi and wondered about the 1500 years old rust resistant iron-pillar. He was thinking about why the iron pillar has not rusted for more than 1500 years. One day he noticed milk turned into curd and he wondered how it is happening.

As you studied earlier in standard VII changes like folding a paper, drying wet clothes, bending of iron rod are some examples for physical changes. On the other hand, changes like burning of paper, digestion of food, turning of milk into curd and decaying of vegetables are some of the examples for chemical changes.

Now, shall we do an activity?

Dear students, can you define a chemical change? Yes, you can. A chemical change is a permanent, irreversible change and produces a new substance.

Chemical changes are otherwise called as chemical reactions, because one or more substances(Reactants)undergo a reaction to form one or more new substances(Products).

Reactant(s) $\rightarrow$ Product(s)

In a society people live in different conditions not under same conditions. Likewise, all chemical reaction will not occur at all conditions. For every chemical reaction to take place, certain specific condition is required.

Do you know what are the conditions required for a chemical reaction to take place?

Chemical reactions can be done through;

1. Physical contact 2. Solution of reactants
3. Electricity 4. Heat
5. Light 6.catalyst

Let us discuss the conditions that are necessary to carryout a chemical reaction with one or two examples.

CHEMICAL REACTIONS BASED ON PHYSICAL CONTACT

Dear children, could you remember some of the day to day activities like burning of matchstick on rubbing, iron materials turning into reddish brown. Why and how these changes happen?

Students, these changes are due to chemical reactions by contact in physical state. Combination of reactants in their naturally occurring states (solids, liquids, gases) is referred as phycial contact.

1) When dry wood comes into contact with fire, it burns with the help of oxygen to form carbon dioxide, which is given out as smoke.

2) When a matchstick is rubbed on the sides of a matchbox, a chemical reaction takes place to form heat, light and smoke.

3) When quick lime (calcium oxide) comes in contact with water, it forms slaked lime (calcium hydroxide).

From above reactions, we can conclude that certain chemical reactions take place only when the reactants are brought in contact with each other in their physical states.

CHEMICAL REACTIONS BASED ON SOLUTION OF REACTANTS

Do you like coffee? How coffee is prepared? As your mother does, when milk is mixed with coffee decoction the colour of milk and decoction changes due to chemical reaction. Your mother adds enough sugar to make it tasty.

Like this when we mix two substances(Reactants)in solution form, the chemical reaction takes place to form new substances(Products). For example take small amount of solid silver nitrate and sodium chloride in a test tube. Do you observe any change? No, the reactants in solid state have no recations. Now you dissolve the same reactants in water in separate test tubes. Mix both the solutions. What do you observe? Silver nitrate solution reacts with sodium chloride solution to form a white precipitate of silver chloride and sodium nitrate solution. Fom the above reaction, we infer that some chemical reactions proceed only in solution form not in solid form.

CHEMICAL REACTION BASED ON ELECTRICITY

Can we live without electricity? Absolutelynot. Electricity is very essential for our living. We use electricity for cooking, lighting, grinding, watching TV, charging mobiles, laptops, computers, water heaters etc. Do you know electricity can be used to carry out chemical reactions? Yes, by using electricity many chemical reactions are done which are industrially very important. As you know, water is made of hydrogen and oxygen molecules. When electricity is passed through water containing small amounts of sulphuric acid, hydrogen and oxygen gases are liberated. Similarly, a concentrated solution of sodium chloride called BRINE is electrolysed to produce chlorine and hydrogen gases along with sodium hydroxide. This is a very important reaction to produce chlorine industrially.

From the above two reactions, we infer that some chemical reactions proceed only by the passage of electricity. Hence, such reactions are called as electrochemical reaction or electrolysis.

Do you Know?

The term electrolysis was introduced by Michael Faraday in the 19th century. Electrolysis is a combination of electron + lysis. Electron is related to electricity and lysis means decomposition.

CHEMICAL REACTIONS BASED ON HEAT

As you know food is very important for our survival and also many other living beings. Have you closely watched your mother cooks food for you? She boils rice, cooks vegetables, and prepares kuzhambu and rasametc by heating them over stove. When enough heating is given some chemical reactions take place to convert the raw food (uncooked) items into cooked ones.

You can perform this reaction in your laboratory. Take small amount of lead nitrate in a dry test tube and heat it gently over a flame. Observe the changes closely. You will hear cracking sound and an evolution of reddish brown coloured gas (nitrogen dioxide). In industries limestone rocks are heated to get quicklime (calcium oxide). Hence, some of the chemical reactions can be achieved by the supply of heat only. These reactions are called **thermo chemical reactions or thermolysis.**

CHEMICAL REACTIONS BASED ON LIGHT

What will happen if there is no sunlight? All the human activities will be affected and there will be no food for us to survive. Isn't it?

Sunlight is important not only for us but also for plants as welll. As you know photosynthesis is a process in which light energy from the sun is used by the plants to prepare starch from carbondioxide and water. The sunlight in uses the chemical reactions beweencarondioxide and water,which finally ends up in the production of starch (photo means light and synthesis means production). These chemical reactions in used by light are called as photochemical reactions.

Do you Know?

Photolysis In Atmosphere: The ultraviolet rays from the sun break Ozone (O_3) molecules in the stratosphere into oxygen and atomic oxygen. This atomic oxygen again combines with molecular oxygen to form Ozone.

CHEMICAL REACTION BASED ON CATALYST:

Do you like cakes and buns? Yes, you do. Have you ever questioned about why idly batter prepared by your mother turns into sour taste after few hours? The answer for your question is fermentation. It is a chemical reaction in which a substance is decomposed with the help of yeast or bacteria to give simpler products.In the case of yeasts, the enzymes released by the yeast makes the reaction faster. Like this, in industries some chemical substances are used to alter the speed of a chemical reaction. These substances are called catalysts. For example, metallic iron is used as a catalyst in the manufacture of ammonia using Haber process. This ammonia is the basic material for the production of urea, an important fertilizer in agriculture. In Vanaspati ghee (dalda) preparation finely divided nickel is used as a catalyst.

Thus, speed of the certain reactions is influenced by the catalysts and such reactions are called **catalytic reactions.**

EFFECTS OF CHEMICAL REACTIONS

We know that every chemical reaction requires a specific condition to occur. When chemical reactions take place there will be production of heat, light,sound,pressure etc. Let us discuss these effects elaborately.

Biological Effects

a) Spoilage of food and vegetables:

Food spoilage may be defined as any change that causes food unfit for human consumption. The chemical reactions catalyzed by the enzymes result in the degradation of food quality such as development of bad tastes and odor, deterioration and loss of nutrients.

e.g.1. Rotten eggs develop a bad smell due to formation of hydrogen sulphide gas

e.g.2. Decaying of vegetables and fruits due to microbes

b) Rancidity of fi shes and meat:

Fishes and meat containing high levels of polyunsaturated fatty acids that undergo oxidation causes bad odour when exposed to air or light. Th is process is called Rancidity.

c) Apples and fruits turn brown when cut:

Apples and some fruits turn brown due to chemical reaction with oxygen in air. Th is chemical reaction is called browning. Th e cells of apples, fruits and other vegetables contain an enzyme called polyphenol oxidase or tyrosinase that when in contact with oxygen catalyses a biochemical reaction of plants' phenolic compounds to brown pigments known as melanins.

Environmental Effects

a) Environment is the place around you that comprises both living and non living things. Our environment provides air to breathe, water to drink and the land to produce food. Due to human activities like industries, increasing number of automobiles etc our environment is badly affected now-a-days. So, there is an unwanted change in physical, chemical and biological properties of the environment .Th is is termed as pollution. Th e substances which cause these changes are called pollutants. Generally there are three types of pollutions viz air, water and land pollution. Due to increasing human activities lot of chemical substances are produced artificially which harm all the living and non living thingsWe can tabulate the types of chemical substances and their effects.

SI.no	Type of pollution	Chemical substances responsible for the pollution	Effects
1.	Air pollution	Carbon di oxide, Carbon monoxide, oxide of Sulphur oxides of nitrogen Chlorofluorocarbons methanetc	Acid rain Global warming, respiratory problems etc.
2.	Water pollution	Waste water containing chemical substances (e.g dyeing industries) detergents, oil spillage etc	Decrease in quality of water skin diseases etc

3.	Land pollution	Fertilizers like urea, various pesticides herbicides etc.	Spoilage of land cancer, respiratory diseases etc.

b) What happens to the steel benches and tables during rainy season? They turn into reddish brown. Isn't it?

Do you know why? This is because the iron metal comes into contact with water and oxygen, it undergoes a chemical reaction called RUSTING.

c) Tarnishing of metal articles:

Shiny metal surfaces and other articles lose their shining appearance due to chemical reactions on the surface. For example, silver articles become black on exposure to atmospheric air. Similarly, brass vessels which contain copper as one of constituents develop a greenish layer on exposure to air for a long time. This is due to a chemical reaction between copper and moist air to form basic copper carbonate and copper hydroxide.

Production of heat, light, sound and pressure

a) Production of heat:

Have you ever rubbed your palms in winter season to keep yourself warm? Have you noticed the heat produced when you use cycle pump? Chemical reactions also produce heat energy. Such reactions are called **EXOTHERMIC REACTIONS.** For example when you add water to quicklime (Calcium oxide), lot of heat is released to produce slaked lime (Calcium hydroxide).Thus we conclude that some chemical reactions produce heat energy.

b) Production of light:

What happens when you ignite a candle? You get light as a result of burning. Some chemical reactions like these produce light. For example when a piece of magnesium ribbon is burnt in a flame, bright light is produced with heat. Even the fireworks during festival times produce different coloured lights which are all due to chemical reactions. Similarly when we ignite methane gas, it produce heat and light.
So, we can say that light is produced during the chemical reactions .

c) Production of sound:

We produce sound when we speak. When you hit metals like iron, copper etc sound is heard. Some chemical reactions do produce sound when they take place. What happens when you fire cracker during Deepavali? The chemical substances kept in the crackers undergo some chemical reactions to produce sound.

So, sound will be produced in certain chemical reactions.

You heard a POP SOUND. Isn't it? When a metal like zinc or magnesium reacts with diluted acids hydrogen gas is produced. Since hydrogen gas is highly flammable it reacts with oxygen in air to produce POP sound.

d) Production of pressure:

What happens when you compress hard a balloon having full of air? Will it burst or not?

Yes, it will burst. This is due to sudden release of air from the balloon as a result of increased pressure on compression. Like this some chemical reactions produce gases which build up the pressure when the reaction takes place in a closed container. If the pressure level goes beyond the limit, we get the explosion. Explosives, fireworks work on this basis. When they are ignited they explode due to pressure generated by gases from the chemical reactions. Thus you hear a huge sound.
So, we conclude that pressure can be generated by certain chemical reactions.

Evolution of Gas, Change in Colour and Change in State
In addition to above effects certain other effects may also take place as a result of chemical reactions.

a) Evolution of gas:
What happens when you open a soda bottle? You can see air bubbles coming out of soda water. Similarly gas evolution may take place as a result of chemical reactions. For example when dilute hydrochloric acid is added to a solution of sodium carbonate or sodium bicarbonate carbon dioxide gas is evolved.

b) Change in colour:
What happens when you play under hot sun for a long time? Your skin becomes dark. Right?

Like this certain chemical changes produce change in colour. For example when you place a iron nail in a solution of copper sulphate, the blue colour of copper sulphate slowly changes into green due to chemical reaction between iron copper sulphate solution.

c) Change in state:
Take a small ice cube and place it on a plate. What happens after some time? Ice melts into water. Isn't it? Here solid ice cubes change into liquid water. Like this in certain chemical reaction change of state is observed. For example when you burn a piece of camphor, smoke comes out as result of chemical reaction between solid camphor and oxygen. Here, there is a change of state from solid to gas.

8th SCIENCE
Unit 11 Air

Introduction

Air is a mixture of gases that surrounds our planet earth. It is essential for the survival of all the living things. Air contains 78.09% nitrogen, 20.95% oxygen, 0.93% argon, 0.04% carbon dioxide and small amount of other gases. We breath in oxygen and breath out carbon dioxide. Plants in turn use carbondioxde for photosynthesis and release oxygen into the atmosphere. Since men have been cutting down trees for their needs, the amount of carbon dioxide in the atmosphere is increasing. This is responsible for the raising of atmospheric temperature. Industries and vehicles release gases like carbon monoxide and sulpher dioxide into the atmosphere. This has resulted in effects like global warming and acid rain which affect us in many ways. In total, the quality of air is gone in the modern days. In this lesson we are going to study about the effects like green house effect, global warming and acid rain. We will also study about occurrence and properties of the gases oxygen, nitrogen and carbon dioxide.

Oxygen

All living things in the world need oxygen. We cannot imagine the world without oxygen. Swedish chemist C.W. Scheele first discovered oxygen in 1772. He called the gas fire air or vital life because it was found to support the process of burning. It was independently discovered by the British scientist Joseph Priestley in 1774. Lavoisier named oxygen. The name oxygen comes from the Greek word 'oxygenes' which means 'acid producer'. It is called so because early chemists thought that oxygen is necessary for all acids.

Occurrence of Oxygen

Oxygen is the most abundant element on the earth by mass and the third most abundant element after Hydrogen and Helium in the universe. It occurs both in free state and combined state. It is present in free state as dioxygen molecule (O2) in the atmosphere. Most of this has been produced by the process photosynthesis in which the chlorophyll present in the leaves of plants uses solar energy to produce glucose.

Oxygen in free state		**Oxygen in combined state**	
Source	Percentage	Source	Percentage
Atmospheric air	21 %	Plants and animals	60 – 70 %
Water	88 – 90 %	Minerals in the form of silicates, carbonates and oxides	45 – 50 %

$6CO_2 + 6H_2O$ + Energy from the Sun $C_6H_{12}O_6 + 6O_2$.

In combined state it is present in the earth's crust as silicates and metal oxides. It is also found in the water on the surface of the earth. Tri oxygen molecule (O_3) known as ozone is present in the upper layers of the atmosphere.

Physical properties of Oxygen

.Oxygen is a colourless, odourless and tasteless gas.
.It is a poor conductor of heat and electricity
.Oxygen dissolves readily in cold water.

Oxygen is about two times more soluble in water than nitrogen. If it had the same solubility asnitrogen, then less oxygen would be present in seas, lakes and rivers that will make life much more difficult for living organisms.

.It is denser than air.
.It can be made into liquid (liquified) at high pressure and low temperature.
.It supports combustion.

Chemical properties of Oxygen

1. Combustibility

Oxygen is a non-combustible gas as it does not burn on its own. It supports the combustion of other substances.

If oxygen has the capacity to burn itself, striking a match stick will be enough to burn all the oxygen in our planet's atmosphere.

2. Reaction with metals

Oxygen reacts with metals like sodium, potassium, magnesium, aluminium, iron etc., to form their corresponding metal oxides which are generally basic in nature. But the metals differ in their reactivity towards oxygen.

Metal + Oxygen Metal oxide

Example

$4Na + O_2$ $2Na_2O$

Sodium Oxygen Sodium oxide.

Activity 1
Heat a strip of magnesium ribbon in the flame till it catches fire and introduce it into the jar containing oxygen. It burns with a dazzling bright light and white ash of magnesium oxide is formed.

Table 3.2 Reactivity of Oxygen with metals

Metal	Condition	Product formed
K	Room temperature	Potassium Oxide (K_2O)
Mg Heating	Heatingslightly	Magnesium Oxide(MgO)
Ca	Heating slightly	Calcium Oxide (CaO)
Fe Cu Ag	High temperature	Iron Oxide (Fe_3O_4) Cupric Oxide (CuO) Silver Oxide (Ag_2O)
Au Pt	Even at high temperature	No action

3. Reaction with non metals

Oxygen reacts with various non-metals like hydrogen, nitrogen, carbon, sulphur, phosphorus etc., to give corresponding non metallic oxides which are generally acidic in nature.

Non-metal + Oxygen Non-metallic oxide

Example
$C + O_2$ CO_2
Carbon Oxygen Carbon dioxide

Table 3.3 Reactivity of Oxygen with non metals

Non metal	Products formed
C	Carbon dioxide (CO_2)
N	Nitric oxide (NO)
S	Sulphur dioxide (SO_2)
P	Phosphorus trioxide (P_2O_3) or Phosphorus pentoxide (P_2O_5)

Activity 2
Heat a small piece of phosphorous and introduce it into the oxygen jar. Phosphorous burns withsuffocating smell and gives phosphorous pentaoxide (white fumes).

4. Reaction with Hydrocarbons

Hydrocarbons (compound containing C and H) react with oxygen to form carbon dioxide and water vapour. E.g. Wood, Petrol, Diesel, LPG, etc. When they burn in oxygen, they produce heat and light energy. Hence they serve as fuel.

Hydrocarbon + O_2 CO_2 + Water + Heat + Light
vapour energy

5. Rusting

The process of conversion of iron into its hydrated form of oxide in the presence of air and moisture (humid atmosphere) is called rusting. Rust is hydrated ferric oxide.

$4Fe + 3O_2$ $2Fe_2O_3$ Fe_2O_3+ X H_2O Fe_2O_3• X H_2O
(rust)

(X = Number of water molecules which isvariable)

Uses of Oxygen

.It is used as oxy-acetylene light for cutting and welding metals.
.It is used to remove carbon impurities from steel.
.Plants and animals use oxygen from the air for respiration.
.It is used to oxidize rocket fuel.
.It is used for artificial respiration by scuba divers, mountaineers, astronauts, patients etc.
.Mixed with powdered charcoal it is used as explosives.
.It is used in the synthesis of methanol and ammonia.

Nitrogen

Nitrogen is one of the most important elements. Animals and plants need nitrogen for their growth. All living organisms (including us) contain nitrogen. It is an essential element present in proteins and nucleic acids which are the 'building blocks' of all living things. It was first isolated from the air by Swedish chemist Carl Wilhelm Scheele in 1772. The name 'nitrogen' is derived from the Greek words 'nitron' and 'gene' meaning 'I produce nitre'. Nitre is potassium nitrate compound of nitrogen. Antoine Lavoisier suggested the name azote, from the Greek word meaning 'no life

Occurrence of Nitrogen

Nitrogen is the fourth most abundant element in the human body by mass. It accounts for about three percent of the mass of the human body. It is thought to be the seventh most abundant element in the universe by mass. Titan, the largest moon of Saturn, has an atmosphere made up of 98% Nitrogen. Nitrogen occurs both in free state and combined state. Nitrogen exists in freestate in the atmospheric air as dinitrogen (N_2).It is present in volcanic gases and gases evolved by burning of coal. Nitrogen is present in combined state in the form of minerals like nitre (KNO_3) and chile salt petre ($NaNO_3$). It is present in organic matters such as protein ,enzymes, nucleic acid etc.

Physical properties of Nitrogen

.It is a colourless, tasteless and odourless gas.
.It is slightly lighter than air.
.It is slightly soluble in water.

.Nitrogen becomes a liquid at low temperature and looks like water.
.When it freezes, it becomes a white solid.
.It is neutral to litmus like oxygen.

Chemical properties of Nitrogen

1. Chemical reactivity

Nitrogen is inactive at ordinary conditions. It combines with many elements at high temperature and pressure or in the presence of catalyst.

2. Combustibility

Nitrogen is neither combustible nor a supporter of combustion. So nitrogen in the air moderates the rate of combustion.

3. Reaction with metals

Nitrogen reacts with metals like lithium, calcium, magnesium etc., at high temperature to form their corresponding metal nitrides.

Metal + Nitrogen Metal nitride

Example
$3Ca + N_2$ Ca_3N_2
Calcium Nitrogen Calcium nitride.

4. Reaction with non metals
Nitrogen reacts with non-metals like hydrogen, oxygen etc., at high temperature to form their corresponding nitrogen compounds.

Non-metal + Nitrogen Nitrogen compound

Example
$3H_2 + N_2$ $2NH_3$
Hydrogen Nitrogen Ammonia

Uses of Nitrogen

.Liquid nitrogen is used as a refrigerant.
.It provides an inert atmosphere for conducting certain chemical reactions.
.It is used to prepare ammonia (by Haber's process) which is then converted into fertilizers and nitric acid.
.It is used for inflating tyres of vehicles.
.It is used for filling the space above mercury in high temperature thermometer to reduce the evaporation of mercury.

.Many explosives such as TNT (Trinitrotoluene), nitroglycerin, and gun powder contain nitrogen.
.It is used for the preservation of fresh foods, manufacturing of stainless steel, reducing fire hazards, and as part of the gas in incandescent light bulbs.

Now a days nitrogen is used as a substitute for compressed air in tyres. Have you noticedit? Why do people prefer nitrogen instead of compressed air in tyres?

Nitrogen fixation

Nitrogen gets circulated in the air, soil and living things as the element itself or in the form of its compounds. Just as there is a circulation of carbon in nature so also there is a circulation of nitrogen. It is essential for the proper growth of all plants. The plants cannot make use of the elemental nitrogen from the air as such. The plants require soluble compounds of nitrogen. Thus, plants depend on other processes to supply them with nitrates. Any process that converts nitrogen in the air into a useful nitrogen compound is called nitrogen fixation. Fixation of nitrogen is carried out both naturally and by man.

Carbon dioxide

Carbon dioxide is a chemical compound in which one carbon and two oxygen atomsare bonded together. It is a gas at room temperature. It is represented by the formula CO2. It is found in the earth's atmosphere and it sends back the solar energy which is reflected by the surface of the earth, to make it possible for living organisms to survive. When carbon dioxide accumulates more in the atmosphere itproduces harmful effects.

Occurrence of Carbon dioxide

Carbon dioxide is present in air to the extent of about 0.03% in volume. It is evolved by the plants and animals during respiration and is produced during fermentation reactions. Much of the naturally occurring CO2 is emitted from the magma through volcanoes. CO2 may also originate from the bio degradation of oil and gases. Human CO2 emissions upset the natural balance of the carbon cycle. Man-made CO2 in the atmosphere has increased global temperatures which is warming the planet. While CO2 derived from fossil-fuel is a very small component of the global carbon cycle, the extra CO2 is cumulative because the natural carbon exchange cannot absorb all the additional CO2.

Physical properties of Carbon dioxide

.Carbon dioxide is a colourless and odourless gas.
.It is heavier than air.
.It does not support combustion.
.It is fairly soluble in water and turns blue litmus slightly red. So it is acidic in nature.
.It can easily be liquified under high pressure and can also be solidified. This solid form of CO2 is called dry ice which undergoes sublimation.

The process of conversion of solid into vapour without reaching liquid state is called sublimation.

Chemical properties of Carbon dioxide

1. Combustibility

It is non-combustible and not a supporter of combustion.

2. Reaction with metals

Lighter metals like sodium, potassium and calcium, combine with CO_2 to form corresponding carbonates whereas magnesium gives its oxide and carbon.

Example
$4Na + 3CO_2$ $2Na_2CO_3 + C$
Sodium Sodium carbonate
$2Mg + CO_2$ $2MgO + C$
Magnesium Magnesium oxide

3. Reaction with sodium hydroxide (Alkali)

Sodium hydroxide (base) is neutralized by carbon dioxide (acidic) to form sodium carbonate (salt) and water.

Base + Acid Salt + Water
$2NaOH + CO_2$ $Na_2CO_3 + H_2O$
Sodium carbonate.

4. Reaction with Lime water

(Calcium hydroxide)
When a limited amount of CO_2 is passed through lime water, it turns milky due to the formation of insoluble calcium carbonate.

$Ca(OH)_2 + CO_2$ $CaCO_3 + H_2O$
Calcium carbonate

When an excess amount of CO_2 is passed through lime water, it first turns milky and the milkyness disappears due to the formation of soluble calcium hydrogen carbonate, $Ca(HCO_3)_2$.

Venus' atmosphere consists of roughly 96-97% carbon dioxide. Because of the amount of carbon dioxide present, the surface of Venus continually retains heat and as such, the surface temperature of Venus is roughly 462°C, making it the hottest planet in our solar system.

Uses of Carbon dioxide

.CO_2 is used to prepare soft drinks or aerated drinks.
.It is used in fire extinguishers
.It is used in manufacturing sodium carbonate by Solvay process.
.Solid carbon dioxide, called as dry ice is used as a refrigerant. The gas is so cold that moisture in the air condenses on it, creating a dense fog which is used in stage shows and movie effects.
.It is used along with ammonia in the manufacture of fertilizers like urea.
.CO_2 can be used in the preservation of food grains, fruits etc.

Aerated water is nothing but carbon dioxide dissolved in water under pressure. This is also called 'soda water'.

Green House Effect and Global Warming

The solar radiation is absorbed by the surface of land and ocean. In turn, they release infra red radiation
or heat into the atmosphere. Certain gaseous molecules present in the atmosphere absorb the infra redrays and reradiate the heat in all directions. Hence, these gases maintain the temperature of earth's surface. The gases which absorb these radiations are called green house gases and this effect is called green house effect.

The green house gases are CO_2, N_2O, CH_4, CFC (Chlorofluoro carbon) etc. The increase in the levels of these gases results in the gradual increase of temperature of the earth's surface.This increased green house effect is caused due to increase in the air pollutants and it results in the average increase of temperature of the atmosphere. This is called as Global warming.

Effects of Global warming

The following are the effects of global warming.
.Melting of ice cap and glaciers.
.Increase in frequency of floods, soil erosion and unseasonal rains.
.Loss of biodiversity due to the extinction of coral reefs and other key species.
.Spreading of waterborne and insectbornediseases.

Preventive measures

In order to save the earth and its resources we need to take certain measures. Some of the measures are given below.
.Reduction in the use of fossil fuels.
.Controlling deforestation.
.Restricting the use of CFCs.
.Planting more trees.

.Reducing, reusing and recycling resources.

Acid rain

Rain water is actually the purest form of water. However, pollutants such as oxides of nitrogen and sulphur in the air released by factories, burning fossil fuels, eruption of volcanoes etc., dissolve in rain water and form nitric acid and sulphuric acid which adds up to the acidity of rain water. Hence, it results in acid rain.

Acid rain has pH less than 5.6 whereas pH of pure rain water is around 5.6 due to dissolution of atmospheric CO2 in it.

Effects of Acid rain

Acid rain affects us in many ways. Some of the consequences are given below.
.It irritates eyes and skin of human beings.
.It inhibits germination and growth of seedlings.
.It changes the fertility of the soil, destroys plants and aquatic life.
.It causes corrosion of many buildings, bridges, etc.

Preventive measures

Acid rain and its effects can be controlled by the following ways.
.Minimizing the usage of fossil fuel such as petrol, diesel etc.,
.Using CNG (Compressed Natural Gas).
.Using non-conventional source of energy.
.Proper disposal of the industrial wastes.

8th term II
Unit – 4 ATOMIC STRUCTURE

Introduction

Every substance in our surrounding is made up of unique elements. There are 118 elements identified worldwide so far. Out of these elements, 92 elements occur in the nature and the remaining elements are synthesised in the laboratories. Copper, Iron, Gold and Silver are some of the elements found in the nature. Elements like Technetium, Promethium, Neptunium and Plutonium are synthesised in the labaratories. Each element is made up of similar, minute particles called atoms. For example, the element gold is made up of similar atoms which determine its characteristics. The word atom is derived from the Greek word atomas. Tomas means smallest divisible particle and atomas means smallest indivisible particle. Ancient philosophers like Democritus have spoken about atoms. Even our Tamil poet Avvaiyar has mentioned about atoms in her poem while describing Thirukkural (mZ i tj ;J i sj ;J Vo; f l i yg;Gf l ;bf ; FWf j ; j hpj ; Fws).

But, none of them have scientific base. The first scientific theory about atom was given by John Dalton. Followed by him, J.J.Thomson and Rutherford have given their theory about atom. In this lesson, we will study how atomic theories evolved at different times. We will also study about valency, molecular formula, rules for naming chemical compounds and balancing chemical equations.

Dalton's Atomic Theory

John Dalton provided a basic theory about the nature of matter. He proposed a model of atom known as Dalton's atomic theory in 1808 based on his experiments. The main postulates of Dalton's atomic theory are:

- All the matters are made up of extremely small particles called atoms (Greek philosopher Democritus used the same name for the smallest indivisible particles).
- Atoms of the same element are identical in all respects (size, shape, mass and properties).
- Atoms of different elements have different sizes and masses and possess different properties.
- Atoms can neither be created nor be destroyed. i.e., atom is indestructible.
- Atoms of different elements may combine with each other in a fixed simple ratio to form molecules or compounds.
- An atom is the smallest particle of matter that takes part in a chemical reaction.

John Dalton, son of a poor weaver, began his career as a village school teacher at the age of 12. He became the principal of the school seven years later. In 1793, he moved to Manchester to teach Physics, Chemistry and Mathematics in a college. He proposed his atomic theory in 1803. He carefully recorded each day, the temperature, pressure and amount of rainfall from his youth till the end. He was a meticulous meteorologist.

Advantages of Dalton's Atomic Theory

- Dalton's theory explains most of the properties of gases and liquids.
- This explains the laws of chemical combination and the law of conservation of mass.
- This theory helps to recognize the molecular differences of elements and compounds.

Limitations of Dalton's Atomic Theory

- Atom is no longer considered as the smallest indivisible particle.
- Atoms of the same element have different masses (Isotopes).
- Atoms of the different elements may have same masses (Isobars).
- Substances made up of same kind of atoms may have different properties (Ex. Coal, Graphite and Diamond are made up of carbon atoms but they differ in their properties).

Fundamental Particles

In 1878, Sir William Crookes, while conducting an experiment using a discharge tube, found certain visible rays travelling between two metal electrodes. These rays are known as Crookes' Rays or Cathode Rays. The discharge tube used in the experiment is now referred as Crookes tube or more popularly as Cathode Ray Tube (CRT).

Cathode Ray Tube is a long glass tube filled with gas and sealed at both the ends. It consists of two metal plates (which act as electrodes) connected with high voltage. The electrode which is connected to the negative terminal of the battery is called the cathode (negative electrode). The electrode connected to the positive terminal is called the anode (positive electrode). There is a side tube which is connected to a pump. The pump is used to lower the pressure inside the discharge tube.

Electricity, when passes through air, removes the electrons from the gaseous atoms and produces ions. This is called electrical discharge.

Discovery of Electrons

When a high electric voltage of 10,000 volts or more is applied to the electrode of a discharge tube containing air or any gas at atmospheric pressure, no electricity flows through the air. However, when the high voltage of 10,000 volts is applied to the electrodes of discharge tube containing air or any gas at a very low pressure of about 0.001 mm of mercury, a greenish glow is observed on the walls of the discharge tube behind anode. This observations clearly show some invisible ray coming from the cathode. Hence, these rays are called cathode rays. Later, they were named as electrons.

The fact that air is a poor conductor of electricity is a blessing in disguise for us. Imagine what would happen if air had been a good conductor of electricity. All of us would have got electrocuted, when a minor spark was produced by accident.

Properties of Cathode rays

- Cathode rays travel in straight line from cathode towards anode.
- Cathode rays are made up of material particles which have mass and kinetic energy.
- Cathode rays are deflected by both electric and magnetic fields. They are negatively charged particles.
- The nature of the cathode rays does not depend on the nature of the gas filled inside the tube or the cathode used.

In television tube cathode rays are deflected by magnetic fields. A beam of cathode rays is directed toward a coated screen on the front of the tube, where by varying the magnet field generated by electromagnetic coils, the beam traces a luminescent image.

Discovery of Protons

The presence of positively charged particles in the atom has been precisely predicted by Goldstein based on the conception that the atom being electrically neutral in nature, should necessarily possess positively charged particles to balance the negatively charged electrons. Goldstein repeated the cathode ray experiment by using a perforated cathode. On applying a high voltage under low pressure, he observed a faint red glow on the wall behind the cathode. Since these rays originated from the anode, they were called anode rays or canal rays or positive rays. Anode rays were found as a stream of positively charged particles.

When invisible radiation falls on materials like zinc sulphide, they emit a visible light (or glow). These materials are called fluorescent materials.

Properties of Anode rays

- Anode rays travel in straight lines.
- Anode rays are made up of material particles.
- Anode rays are deflected by electric and magnetic fields. Since, they are deflected towards the negatively charged plate, they consist of positively charged particles.
- The properties of anode rays depend upon the nature of the gas taken inside in the discharge tube.
- The mass of the particle is the same as the atomic mass of the gas taken inside the discharge tube.

When hydrogen gas was taken in a discharge tube, the positively charged particles obtained from the hydrogen gas were called protons. Each of these protons are produced when one electron is removed from one hydrogen atom. Thus, a proton can be defined as an hydrogen ion (H+).
$H \rightarrow H^{+} + e$

Discovery of Neutrons

At the time of J.J.Thomson, only two fundamental particles (proton and electron) were known. In the year 1932, James Chadwick discovered another fundamental particle, called neutron. But, the proper position of these particles in an atom was not clear till Rutherford described the structure of atom. You will study about Rutherford's atom model in your higher classes.

Properties of Neutrons

- Neutron is a neutral particle, that is, it carries no charge.
- It has mass equal to that of a proton, that is 1.6×10^{-24} grams.

Particle	Mass	Relative charge
Electron (e)	9.1×10^{-28} grams	–1
Proton (p)	1.6×10^{-24} grams	+1
Neutron (n)	1.6×10^{-24} grams	0

Thomson's Atom Model

J.J. Thomson, an English scientist, proposed the famous atom model in the year 1904, just after the discovery of electrons. Thomson proposed that the shape of an atom resembles a sphere having a radius of the order of 10-10 m. The positively charged particles are uniformly distributed with electrons arranged in such a manner that the atom is electrically neutral. Thomson's atom model was also called as the plum pudding model or the watermelon model. The embedded electrons resembled the seed of watermelon while the watermelon's red mass represented the positive charge distribution. The plum pudding atomic theory assumed that the mass of an atom is uniformly distributed all over the atom.

Limitations of Thomson's Atom model

Thomson's atom model could successfully explain the electrical neutrality of atom. However, it failed to explain the following.

1. Thomson's model failed to explain how the positively charged sphere is shielded from the negatively charged electrons without getting neutralised.
2. This theory explains only about the protons and electrons and failed to explain the presence of neutral particle neutron.

Valency

In order to understand valency of elements clearly, we need to learn a little about Rutherford's atom model here. According to Rutherford, an atom consists of subatomic particles namely, proton, electron and neutrons. Protons and neutrons are found at the centre of an atom, called nucleus. Electrons are revolving around the nucleus in a circular path, called orbits or shells. An atom has a number of orbits and each orbit has electrons. The electrons revolving in the outermost orbit are called valence electrons.

The arrangement of electrons in the orbits is known as electronic configuration. Atoms of all the elements will tend to have a stable electronic configuration, that is, they will tend to have either two electrons (known as duplet) or eight electrons (known as octet) in their outermost orbit. For example, helium has two electrons in the outermost orbit and so it is chemically inert. Similarly, neon is chemically inert because, it has eight electrons in the outermost orbit.

The valence electrons in an atom readily participate in a chemical reaction and so the chemical properties of an element are determined by these electrons. When molecules are formed, atoms combine together in a fixed proportion because each atom has different combining capacity. This combining capacity of an atom is called valency. Valency is defined as the number of electrons lost, gained or shared by an atom in a chemical combination so that it becomes chemically inert.

Types of Valency

As we saw earlier, an atom will either gain or lose electrons in order to attain the stable electronic configuration. In order to understand valency in a better way, it can be explained in two ways depending on whether an atom gains or losses electrons.

Atoms of all metals will have 1 to 3 electrons in their outermost orbit. By loosing these electrons they will have stable electronic configuration. So, they lose them to other atoms in a chemical reaction and become positively charged. Such atoms which donate electrons are said to have positive valency. For example, sodium atom (Atomic number: 11) has one electron in its outermost orbit and in order to have stability it loses one electron and becomes positively charged. Thus, sodium has positive valency.

All non-metals will have 4 to 7 electrons in the outermost orbit of their atoms. In order to attain stable electronic configuration, they need few electrons. They accept these electrons from other atoms in a chemical reaction and become negatively charged. These atoms which accept electrons are said to have negative valency. For example, chlorine atom (Atomic number: 17) has seven electrons in its outermost orbit. By gaining one electron it attains stable electronic configuration. Thus, chlorine has negative valency.

Valency with respect to atoms

Valency of an element is also determined with respect to other atoms. Generally, valency of an atom is determined with respect to hydrogen, oxygen and chlorine.

Valency with respect to Hydrogen

Since hydrogen atom loses one elctron in its outermost orbit, its valency is taken as one and it is selected as the standard. Valencies of the other elements are expressed in terms of hydrogen. Thus, valency of an element can also be defined as the number of hydrogen atoms which combine with one atom of it. In hydrogen chloride molecule, one hydrogen atom combines with one chlorine atom. Thus, the valency of chlorine is one. Similarly, in water molecule, two hydrogen atoms combine with one oxygen atom. So, valency of oxygen is two.

Since some of the elements do not combine with hydrogen, the valency of the element is also defined in terms of other elements like chlorine or oxygen. This is because almost all the elements combine with chlorine and oxygen.

Molecule	Element	Valency
Hydrogen chloride (HCl)	Chlorine	1
Water (H_2O)	Oxygen	2
Ammonia (NH_3)	Nitrogen	3
Methane (CH_4)	Carbon	4

Valency with respect to Chlorine

Since valency of chlorine is one, the number of chlorine atoms with which one atom of an element can combine is called valency. In sodium chloride (NaCl) molecule, one chlorine atom combines with one sodium atom. So, the valency of sodium is one. But, in magnesium chloride (MgCl2) valency of magnesium is two because it combines with two chlorine atoms.

Valency with respect to oxygen

In another way, valency can be defined as double the number of oxygen atoms with which one atom of an element can combine because valency of oxygen is two. For example, in magnesium oxide (MgO) valency of magnesium is two.

Variable Valency

Atoms of some elements combine with atoms of other elements and form more than one product. Thus, they are said to have different combining capacity. These atoms have more than one valency. Some cations exhibit more than one valency. For example, copper combines with oxygen and forms two products namely cuprous oxide (Cu_2O) and cupric oxide (CuO). In Cu_2O, valency of copper is one and in CuO valency of copper is two. For lower valency a suffix –ous is attached at the end of the name of the metal. For higher valency a suffix –ic is attached at the end of the name of the metal. Sometimes Roman numeral such as I, II, III, IV etc. indicated in parenthesis followed by the name of the metal can also be used.

Element	Cation	Names
Copper	Cu^{+}	Cuprous (or) Copper (I)
	Cu^{2+}	Cupric (or) Copper (II)
Iron	Fe^{2+}	Ferrous (or) Iron (II)
	Fe^{3+}	Ferric (or) Iron (III)
Mercury	Hg^{+}	Mercurous (or) Mercury (I)
	Hg^{2+}	Mercuric (or) Mercury (II)
Tin	Sn^{2+}	Stannous (or) Tin (II)
	Sn^{4+}	Stannic (or) Tin (IV)

Ions

In an atom, the number of protons is equal to the number of electrons and so the atom is electrically neutral. But, during chemical reactions unstable atoms try to attain stable electronic configuration (duplet or octet) either by gaining or losing one or more electrons. When an atom gains an electron it has more number of electrons and thus it carries negative charge. At the same time when an atom loses an electron it has more number of protons and thus it carries positive charge. These atoms which carry positive or negative charges are called ions. The number of electrons gained or lost by an atom is shown as a superscript to the right of its symbol. When an atom loses an electron, '+' sign is shown in the superscript and '–' sign is shown if an electron is gained by an atom. Some times, two or more atoms of different elements collectively lose or gain electrons to acquire positive or negative charge. Thus we can say, an atom or a group of atoms when they either lose or gain electrons, get converted into ions or radicals.

Types of Ions

Ions are classified into two types. They are: cations and anions.

Cations

If an atom loses one or more electrons during a chemical reaction, it will have more number of positive charge on it. These are called cations (or) positive radicals. Sodium atom loses one electron to attain stability and it becomes cation. Sodium ion is represented as Na^{+}.

Anions

If an atom gains one or more electrons during a chemical reaction, it will have more number of negative charge on it. These are called anions or negative radicals. Chlorine atom attains stable electronic configuration by gaining an electron. Thus, it becomes anion. Chlorine ion is represented as Cl^{-}.

Different valent ions

During a chemical reaction, an atom may gain or lose more than one electron. An ion or radical is classified as monovalent, divalent, trivalent or tetravalent when the number of charges over it is 1,2,3 or 4 respectively. Based on the charges carried by the ions, they will have different valencies.

Valency of Anions (negative radicals) and Cations (positive radicals)

The valency of an anion or cation is a number which expresses the number of hydrogen atoms or any other monovalent atoms (Na,K,Cl….) which combine with them to give an appropriate compound. For example, two hydrogen atoms combine with one sulphate ions (SO_4^{2-}) to form sulphuric acid (H^2SO^4). So, the valency of SO_4^{2-} is 2. One chlorine atom (Cl) combines with one ammonium ion (NH_4^+) to form NH_4Cl. So, the valency of NH_4^+ is 1. Valencies of some anions and cations and their corresponding compounds are given below.

Compound	Name of the anion	Formula of anion	Valency of anion
HCl	Chloride	Cl^-	1
H_2SO_4	Sulphate	SO_4^{2-}	2
HNO_3	Nitrate	NO_3^-	1
H_2CO_3	Carbonate	CO_3^{2-}	2
H_3PO_4	Phosphate	PO_4^{3-}	3
H_2O	Oxide	O^{2-}	2
H_2S	Sulphide	S^{2-}	2
NaOH	hydroxide	OH^-	1

Compound	Name of cation	Formula of cation	Valency of cation
NaCl	Sodium	Na^+	1
KCl	Potassium	K^+	1
NH_4Cl	Ammonium	NH_4^+	1
$MgCl_2$	Magesium	Mg^{2+}	2
$CaCl_2$	Calcium	Ca^{2+}	2
$AlCl_3$	Aluminium	Al^{3+}	3

Chemical formula or Molecular formula

Chemical formula is the shorthand notation of a molecule of a substance (compound). It shows the actual number of atoms of each element present in a molecule of a substance. Certain steps are followed to write down the chemical formula of a substance. They are given below.

1. Write down the symbols of elements/ ions side by side so that the positive radical is on the left and the negative radical is on the right hand side.
2. Write the valencies of the two radicals above their symbols to the right in superscript (Signs '+' and '-' of the ions are omitted).
3. Reduce the valencies to simplest ratio if needed. Otherwise interchange the valencies of the elements/ions. Write these numbers as subscripts. However, '1' appearing on the superscript of the symbol is omitted.

- Thus, we arrive the chemical formula of the compound.
- Let us derive the chemical formula for calcium chloride.

1. Write the symbols of calcium and chlorine side by side. Ca Cl

2. Write the valencies of calcium and chlorine above their symbols to the right.
   Ca_2 Cl^1
3. Interchange the valencies of elements. Ca Cl^2

   Thus the chemical formula for calcium chloride is $CaCl_2$

Naming chemical compounds

A chemical compound is a substance formed out of more than one element joined together by chemical bond. Such compounds have properties that are unique from that of the elements that formed them. While naming these compounds specific ways are followed. They are given below.

In naming a compound containing a metal and a non-metal, the name of the metal is written first and the name of the non-metal is written next after adding the suffix-ide to its name.

Examples:

- NaCl - Sodium chloride
- Ag Br - Silver bromide

In naming a compound containing a metal, a non-metal and oxygen, name of the metal is written first and name of the non-metal with oxygen is written next after adding the suffix- ate (for more atoms of oxygen) or –ite (for less atoms of oxygen) to its name.

Examples:

- Na_2 SO_4 - Sodium sulphate
- Na NO_2 - Sodium nitrite

In naming a compound containing two non-metals only, the prefix mono, di, tri, tetra, penta etc. is written before the name of non- metals.

Examples:

- SO_2 - Sulphur dioxide
- N_2O_5 - Dinitrogen pentoxide

Chemical Equation

A chemical equation is a short hand representation of a chemical reaction with the help of chemical symbols and formulae. Every chemical equation has two components: reactants and products. Reactants are the substances that take part in a chemical reaction and the products are the substances that are formed in a chemical reaction.

Steps in writing the skeleton equation

Before writing the balanced equation of a chemical reaction, skeletal equation is written. The following are the steps involved in writing the skeletal equation.

1. Write the symbols and formulae of each of the reactants on the left hand side (LHS) and join them by plus (+) sign.
2. Follow them by an arrow (→) which is interpreted as gives or forms.
3. Write on the right hand side (RHS) of arrow the symbols and formulae for each of the products.
4. The equation thus written is called as skeleton equation (unbalanced equation).
5. If the product is a gas it should be represented by upward arrow (↑) and if it is a precipitate it should be represented by downward arrow(↓).

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\uparrow$$

Balancing chemical equation

According to law of conservation of mass, the total mass of all the atoms forming the reactants should be equal to that of all the atoms forming the products. This law will hold good only when the number of atoms of all types of elements on both sides is equal. A balanced chemical equation is one in which the total number of atoms of any element on the reactant side is equal to the total number of atoms of that element on the product side.

There are many methods of balancing a chemical equation. Trial and error method (direct inspection), fractional method and odd number-even number method are some of them. While balancing a chemical equation following points are to be borne in mind.

1. Initially the number of times an element occurs on both sides of the skeleton equation should be counted.
2. An element which occurs least number of times in reactant and product side must be balanced first. Then, elements occuring two times, elements occuring three times and so on in an increasing order must be balanced.
3. When two or more elements occur same number of times, the metallic element is balanced first in preference to non-metallic element. If more than one metal or non-metal is present then a metal or non-metal with higher atomic mass (refer periodic table to find the atomic mass) is balanced first.
4. The number of molecules of reactants and products are written as coefficient.
5. The formula should not be changed to make the elements equal.
6. Fractional method of balancing must be employed only for molecule of an element (O_2,H_2,O_3,P_4,…) not for compound (H_2O, NH_3,…)

Now let us balance the equation for the reaction of hydrogen and oxygen which gives water. Write the word equation and balance it.

1. Write the word equation. Hydrogen + Oxygen → Water

2. Write the skeleton equation. $H_2 + O_2 \rightarrow H_2O$
3. Select the element which is to be balanced first based on the number of times an element occurs on both sides of the skeleton equation.

Element	H	O
Number of times particular element occurs on both sides	2	2

4. In the above case, both elements occur one time each. Here, preference must be given to oxygen because it has higher atomic mass (refer periodic table).
5. To balance oxygen, put 2 before H2O on the right hand side (RHS).
   $H_2 + O_2 \rightarrow 2H_2O$
6. To balance hydrogen, put 2 near hydrogen (H2) on the left hand side (LHS).
   $2H_2 + O_2 \rightarrow 2H_2O$
   (H = 4 0 = 2) (H = 4 0 = 2)

Now, on both sides number of hydrogen atoms is four and oxygen atoms is two. Thus, the chemical equation is balanced.

Information conveyed by a balanced chemical equation

A balanced chemical equation gives us both qualitative and quantitative information. It gives us qualitative informations such as the names, symbols and formulae of the reactant molecules taking part in the reaction and those of the product molecules formed in the reaction. We also can get quantitative information like the number of molecules/ atoms of the reactants and products that are taking part in the reaction. However, a chemical equation does not convey the following.

1. Physical state of the reactants and the products.
2. Heat changes (heat liberated or heat absorbed) accompanying the chemical reaction.
3. Conditions such as temperature, pressure, catalyst etc., under which the reaction takes place.
4. Concentration (dilute or concentrated) of the reactants and products.
5. Speed of the reaction

Laws of chemical combinations

By studying quantitative measurements of many reactions, it was observed that the reactions taking place between various substances are governed by certain laws. They are called as the 'Laws of chemical combinations'. They are given below.

1. Law of conservation of mass
2. Law of constant proportion
3. Law of multiple proportions
4. Gay Lussac's law of gaseous volumes

In this lesson, we will study about the first two laws. You will study about Law of multiple proportions and Gay Lussac's Law of gaseous volumes in standard IX.

Law of conservation of mass

The law of conservation of mass which relates the mass of the reactants and products during the chemical change was stated by a French chemist Lavoisier in 1774. It states that during any chemical change, the total mass of the products is equal to the total mass of the reactants. In other words the law of conservation of mass means that mass can neither be created nor be destroyed during any chemical reaction. This law is also known as Law of indestructibility of mass.

Consider the formation of ammonia (Haber's process) from the reaction between nitrogen and hydrogen

$N_2 + 3H_2 \rightarrow 2NH_3$
$28_g \quad 6_g \quad 34_g$

During Haber's process the total mass of the reactant and the product are exactly same throughout the reaction.

Now, it is clear that mass is neither created not destroyed during physical or chemical change. Thus, law of conservation of mass is proved.

Law of constant proportions

Law of constant proportions was proposed by the scientist Joseph Proust in 1779. He states that in a pure chemical compound the elements are always present in definite proportions by mass. He observed all the compounds with two or more elements and noticed that each of such compounds had the same elements in same proportions, irrespective of where the compound came from or who prepared it. For example, water obtained from different sources like rain, well, sea, and river will always consist of the same two elements hydrogen and oxygen, in the ratio 1:8 by mass. Similarly, the mode of preparation of compounds may be different but their composition will never change. It will be in a fixed ratio. Hence, this law is also known as 'Law of definite proportions'.

Unit : 5 Movements

Introduction

There are so many movements that happen in our bodies. Sit absolutely still and observe the movements taking place in your body. You must be blinking your eyes from time to time. There will be movements in your body as you breathe. Different parts of your body move while you remain at the same place. There are different ways how animals move from place to place. For example, a cow uses its legs to walk, a snake uses its whole body to slither or crawl, a bird uses its wings to fly, a fish uses its fins to swim and human uses legs to walk. Walking, crawling, flying and swimming - these are only few ways in which animals move from one place to another. Let us learn in detail how these movements take place.

Movement and Locomotion

Although both movement and locomotion sound similar in their meaning, there are few interesting differences between the two terms. Movement is generally defined "as the act of changing the place or position by one or more parts of the body". Movement helps to perform necessary functions such as pumping of blood to different parts of the body in an organism. Movement can be both voluntaryand involuntary. For example, walking is a voluntary movement, while breathing is an involuntary movement.

The movement of an organism from one place to another is known as locomotion. Locomotion helps an organism to find food, avoid harsh weather conditions, escape from their predator etc. Walking, running and swimming are few examples for different types of locomotion. In this process, there is the action of appendages such as limbs, wings, flagella and cilia. In most of the aquatic animals such as fish, whales, and shark, the locomotion results from a series of wave-like muscle contractions. Table 5.1 gives the differences between locomotion and movement.

Table Location and Movement

Locomotion	Movement
Locomotion is the movement of an organism from one place to another	Movement is the act of changing the place or position by one or more parts of the body
It is always voluntary	It can either be voluntary or involuntary
Locomotion takes place at the organism level.	A movement takes place at the biological level.
Locomotion doesn't necessarily require energy	Movement requires energy.

Movement in different Animals

Movement is one of the significant features of living beings. This is the basic mechanism used in majority of the vertebrates including human. Animals exhibit a wide range of movements. In this part let us study about movements in different animals.

Earthworm

The body of earthworm is made up of many rings joined end to end. It has muscles which help to extend and shorten the body. Under its body it has large number of bristles called setae which are connected with muscles. These bristles help to get grip on the ground. During movement, the earthworm first extends the front part of the body, keeping the rear portion fixed to the ground. Then it fixes the front end and releases the rear end. It then shortens the body and pulls the rear end forward. This makes it move forward by small distances. Repeating such muscle contraction and relaxation the earthworm can move through soil. A slimy substance secreted by its body helps this movement.

Cockroach

A cockroach has three pairs of jointed legs, which help it to walk, run and climb. It also has two pairs of wings for flying. Large and strong muscles help in the movement of legs. The body is covered by chitin, a light protective material. Chitin is shed regularly so that the body can grow.

Birds

Birds can walk on the ground and fly as well. Some birds can also swim in the water. A bird has streamlined body. Its bones are light and strong. They are hollow and have air spaces between them. The hind limbs of birds are modified as claws, which help them to walk and to perch. The breast bones are modified to hold massive flight muscles which help in moving wings up and down. Birds have special flight muscles and the forelimbs are modified as wings.The wings and tail have long feathers, which help in flying. Birds show two types of flight: gliding and flapping

Gliding: During gliding the bird has its wings and tail spread out. In this movement the bird uses air currents for going up and down.

Flapping: This is an active flight. The bird beats the air by flapping its wings. They use flight feathers for this purpose.

Snake

The body of snake consists of a large number of vertebrae. The adjoining vertebrae, ribs and skin are inter-connected with slender body muscles. When the snake moves, it makes many loops on its sides. The forward push of the loops against the surface makes the snake move forward. Movement of snake is called slithering movement. Many snakes can swim in water also.

Since snakes do not have legs, they use their muscles and their scales to move.

5.2.5 Fish

Fish swims with the help of fins. They have two paired fins and an unpaired fin. The body of a fish is streamlined to reduce friction while moving in water. They have strong muscles, which help in swimming. When a fish swims its front part curves to one side and the tail part stays in the opposite direction. In the next move, the front part curves to the opposite side and the tail part also changes its position to another side. The caudal or tail fin helps in changing direction.

Fish have streamlined body structure which helps them to move smoothly with the flow of water. Muscles and fins on the body and the tail help to keep the balance.

Movements in Human body

Humans can move some parts of their body in different directions; however some body parts can be moved only in one direction. Our body is made up of a frame work of bones called skeleton which helps in the movement of the body. Some of the movements in body parts of human are:

(a) Movement of eyelids.
(b) Movement of the heart muscles.
(c) Movement of teeth and jaw.
(d) Movement of arms and legs.
(e) Movements of head.
(f) Movements of neck.

Movement of some organs happens because of the combined action of bones and muscles. In such cases, movement is possible along a point where two or more bones meet.

- A Cheetah can run 76 kilometrer per hour.
- A Hippopotamus can run faster than a man.
- Cockroach is the fastest animal on 6 legs covering a metre per second.
- The fastest mammal, the Dolphin can swim up to 35 miles per hours.

Types of Movements

When we talk about locomotion and movement, there are three types of movements.

Amoeboid movement

It is brought about by pseudopodia which are appendages which move with movement of protoplasm within a cell.

Ciliary movement

This movement is brought about by appendages called as cilia which are the hair like extensions of the epithelium. Both these kinds of movements are seen with cells of the lymphatic system.

Muscular movement

It is a more complex movement which is brought about by the musculoskeletal system. This type of movement is seen in the higher vertebrates.

To understand more about the movements brought about by the musculoskeletal system, we need to understand the joints, skeleton and types of muscles.

Joints

The point at which two separate bones meet is called a joint. Depending on the type of movement they allow, joints can be of three types: fixed, slightly moveable and moveable joints.

Fixed or Immoveable joints

In this type of joint no movement is possible between the two bones. The structures between the bones of the skull box are examples of immoveable joints.

Slightly moveable joints

Here, only very little (partial) movement occurs between the two bones. The joint between

Joints are the place where two bones meet or connect. Ligaments are short bands of tough fibrous connective tissues that function to connect one bone to another, forming the joint. Tendons are made ofelastic tissues and they also play a key role in the functioning of joints.

a rib and the breast bone or between the vertebrae is the example for slightly movable joint.

Freely movable joints

In this type, varying degree of movements is possible between the two bones forming the joint. There are six major types of movable joints. They are given below in Table 5.2.

Table 5.2 Types of movable joints

Joint	Examples	Description	Mobility
Ball and Socket	Shoulder Hip	A ball shaped head of one bone articulates with a cup like socket of an adjacent bone.	Movement can occur in three planes. This joint allows the greatest range of movement.
Hinge	Elbow Knee Ankle	A cylindrical protrusion of one bone articulates with a trough-shaped depression of an adjacent bone.	Movement is restricted to one plane. This joint allows bending and straightening only.
Pivot	Spine (Atlas / Axis joint at the top)	A rounded or pointed structure of one bone articulates with a ring Shaped structure of Radius Ulnaan adjacent bone	Movement is restricted to one plane. This joint allows rotation about its longitudinal axis only.
Condyloid	Wrist	Similar to a ball and socket joint but with much flatter articulating surfaces forming a much shallower joint.	Movement can occur in two planes. This joint allows the second greatest range of movement
Gliding	Spine (between the bony processes of	Articulating surfaces are almost flat and of a similar size.	Gliding allows movement in three planes, but it

	the vertebrae)		is severely limited.
Saddle	Thumb, shoulder and inner ear.	One part is concave (turned inward) at one end and looks like a saddle. The other end is convex (turned outward), and looks like a rider in a saddle.	Flexion-extension and abduction-adduction movements are seen

Synovial joints

A synovial joint is a joint which makes connection between two bones consisting of a cartilage lined cavity filled with fluid, which is known as a diarthrosis joint. These are the most flexible type of joint between bones, because the bones are not physically connected and can move more freely in relation to each other. Synovial joints have four main distinguishing features. They are shown in Table 5.3.

Inflammation of joints is a condition that usually results either due to friction of articulating cartilage or due to lack of synovial fluid in the joint. During this condition, the person feels acute pain in joints particularly while moving joints. This disease is referred to as arthritis. Arthritis ishowever also caused due to the deposition of uric acid crystals in the joints.

Feature of synovial joint

Feature	Structure	Function
Ligament	A band of strong fibrous tissue.	To connect bone to bone.
Synovial fluid	A slippery fluid with the consistency of eggwhites that is contained within the joint cavity	To reduce friction between the articular cartilage in the joint.
Articular cartilage	Glassy-smooth cartilage that is spongy and covers the ends of the bones in the joint.	To absorb shock and to prevent friction between the ends of the bones in the joint.
Joint	A tough fibrous tissue that has two	The fibrous capsule helps to

Capsule	layers, with the fibrous capsule lying outside the synovial membrane	strengthen the joint, while the synovial membrane lines the joint and secretes synovial fluid.

Skeleton

The skeleton system provides the hard structure or framework to the human body which supports and protects the body. It is composed of connective tissues like bones, cartilage, tendons and ligaments. If the skeleton is without joints, no movement would take place and the significance of human body will be no more than a stone. On the basis of presence in the body, skeleton is of two types.

Exoskeleton

It is the skeleton that is found on the exterior layer of the body and it basically originates from embryonic ectoderm or mesoderm. Like scales in the fishes, outer hard layer of the tortoise and feathers of the birds it is dead and it protects and preserves the inner organs.

Endoskeleton

It is the skeleton that is found inside the human body and it originates from the mesoderm. These are found in almost all vertebrates and form the main body structure.

Functions of skeleton

The skeletal system serves five important functions in the human body.

1. It provides structure and shape to the body.

2. It supports and surrounds the internal organs of the body.

3. Calcium and phosphorus, the two minerals that the body needs for important regulatory functions, are stored inside the bones.

4. Red blood cells are produced in the bone marrow.

5. The bones of the skeletal system act as levers for muscular action. Muscular movement would not be possible without tendons (fibrous cords of tissue that attach muscle to bone) and ligaments (fibrous cords of tissue that attach bone to bone).

- The femur or thighbone is the longest and strongest bone of the human skeleton.
- The stapes in the middle ear is the smallest and lightest bone of the human skeleton.

Constituents of skeleton

Human skeleton consists of bone, cartilages and ligaments. Bones comprise the hard framework of the body. Cartilages are the supporting and connecting structures. For example, the cartilage supports the projecting external ears and the tip of the nose. Ligaments bind the bones together. There are different types of bones in human skeletal system. They are:

Long bones: Found in arms and legs.

Short bones: Found in wrist ankle, vertebral column.

Flat bones: Found in skull, ribs, shoulder and hips.

Irregular bones: Found in spine and vertebral column, mandible, palatine, inferior nasal concha, and hyoid

Parts of skeleton

The skeletal system is composed of bones and the related structures that aid body movement. It is divided into two major parts: the axial skeleton and the appendicular skeleton.

I. Axial skeleton

The axial skeleton consists of the bones along the axis, or central line of the human body. The axial skeleton consists of the skull, facial bones, sternum, ribs, and vertebral column.

a. Skull

Skull is a hard structure made up of small bones. It is formed by 22 bones out of which 8 bones are fixed together to form the cranium and 14 bones fuse to form the face. The only bone which has movable joint is the lower jaw. This movable joint is supported by muscles and ligaments. Skull placed on the top of thebackbone can be moved up, down and sidewards.

b. Vertebral column

Vertebral column running at the back of the body is also called as spine or the backbone. It is in the trunk region to offer support to the upper part of the body. Vertebral column is made up of individual bones called as vertebrae. Total vertebral column consists of 7 cervical vertebrae, 12 lumbar vertebrae, 5 fused sacral and 3 fused coccygeal vertebrae. Vertebral column runs from the base of the skull to the hip bone forming a tube. Spinal cord passes through this hollow tube. Vertebrae are joined by gliding points which allow the body to be bent back, front or side wards.

The functions of vertebral column are given below.

- It protects the spinal cord.
- It supports the head.
- It serves as an attachment for the ribs.
- It provides support and place of attachment for the pectoral and pelvic girdle.
- It provides movement for the human skeleton.
- It helps in walking and standing erect with correct posture.

c. Sternum or Rib cage

Rib cage occupies the chest region. It is a cone-shaped structure made up of 12 pairs of ribs. Ribs are attached to vertebrae at the back which curve around to form a cage. 10 pairs of ribs are attached to the breast bone at the front. 2 pairs of lower ribs are free at front. These are called as free-floating ribs. Rib cage is set up in such a way that it can contract and expand during the process of breathing. Rib cage protects the underlying lungs, heart and some part of liver.

Humans and giraffes have the same number of bones in the necks, but the vertebrae in a giraffe's neck are much, much larger.

II. Appendicular skeleton

The appendicular skeleton contains the bones in the appendages of the body, as well as the structures that connect the appendages to the axial skeleton. Specifically, the appendicular skeleton comprises the shoulder girdle; the arm, wrist, and hand bones; the pelvic girdle; and the leg, ankle, and foot bones.

a. Shoulder bone or Pectoral bone

Shoulder bone is formed by collar bone at the front and the shoulder blade at the back. The collar bone is supported by breast bone at one end and the shoulder blade at the other end. The shoulder bone encloses a socket like cavity into which fixes the ball of the upper arm. This forms a ball and socket joint. This girdle is also called as pectoral girdle.

b. Pelvic bone

Pelvic bone is also called as pelvic girdle. It is made up of strong bones to balance entire weight of the body. Pelvic girdle is formed by five fused vertebrae at the back and form a cavity in the centre while reaching the front part. The thigh bones are attached to either side of the girdle with a ball and socket joint.

c. Arm bone

Arm bone is the upper limb made up of humerus, radius, ulna, carpals, metacarpals and phalanges. All these bones are joined by hinge joints which allow the limb to move only in one direction. Humerus makes up the upper arm. Fore-arm is made up of radius and ulna. Wrist is made up of carpals. Palm is made up of metacarpals. Fingers are made up of phalanges.

d. Leg bone

Leg bone is the lower limb made up of femur, tibia, fibula, tarsals, metatarsals and phalanges. All these bones are joined by hinge joints which allow the limb to move only in one direction. Knee is covered by a cap like structure called as patella or a knee cap. Femur makes up the thigh bone. Leg is made up of tibia and fibula. Ankle is made up of tarsals.Foot is made up of metatarsals. Toes are made up of phalanges.

Muscles

The muscles in the body provide the means of all movements. They cover the skeletal framework and also give shape to the body. Muscles help to maintain body posture while sitting, standing or walking. Most muscles are long bundles of contractile tissue. Each muscle usually has two ends - a fixed end where the muscle originates and a movable end which pulls some other part. This moveable end is drawn out to form a tough structure the tendon which is attached to the bone. When stimulated by anerve the muscle contracts to become shorter and thicker and thus it pulls the bone at the moveable end. Muscles can only contact and relax, they cannot lengthen.

- There are muscles in the root of your hair that give you goose bumps.
- It takes 17 muscles to smile and 42 muscles to frown.
- The hardest working muscle is in eye.

Muscles often work in pairs which work against each other. These are called antagonisticpairs. The muscles in the upper arm control the bending and straightening of the arm. The two muscles, the biceps and triceps are working against each other. When the biceps contracts the lower arm is raised and the arm bends. Inthis position the triceps muscle is relaxed. To straighten the arm the reverse happens. The triceps contracts straightening the arm, while the biceps relaxes. Antagonistic muscles can befound all over the body. In the iris of the eye there are two sets of muscle. There are radial muscles which radiate from the pupil like spokes of a bicycle and there are circular muscles. The radial muscles make the pupil of the eye wider, while the circular muscles make the pupil smaller.

5.6.1 Types of Muscles

Muscles found in higher vertebrates are of three types:

- Striated or skeletal muscles or voluntary muscles.
- Unstriated or smooth muscles or involuntary muscles
- Cardiac muscles

Table 5.4 Types of muscles

Muscle	Location	Characteristics
Striated /Skeletal / Voluntary muscle	Attached to bones. Found in arms, legs, neck.	Multinucleate, Unbranched, Voluntary.
Non striated / Smooth /Involuntary muscle	Attached to soft parts of the body like blood vessels, iris, bronchi and the skin.	Single, central nucleus Involuntary
Cardiacmuscle	Heart	Branched, 1 -3 central nuclei Involuntary

Coordination of Muscles

Most actions in our body like standing, walking, running, playing tennis etc., require combined action of several muscles. To a great extent the muscles have to be coordinated for a particular kind of movement.

Muscles move body parts by contracting and then relaxing. Muscles can pull bones, but they can't push them back to the original position. So they work in pairs of flexors and extensors. The flexor contracts to bend a limb at a joint. Then, when the movement is completed, the flexor relaxes and the extensor contracts to extend or straighten the limb at the same joint. For example, the biceps muscle,
in the front of the upper arm, is a flexor, and the triceps, at the back of the upper arm, is an extensor. When you bend your elbow, the biceps contracts. Then the biceps relaxes and the triceps contracts to straighten the elbow.

WATER

Introduction

Thirukkural says, without water there would be no life on the earth. Just like other living organisms, we also need water to survive. However, we need water for so many activities like cooking, washing, cleaning and irrigation. Water resources are getting depleted nowadays because of growing demand from increasing populations and lifestyle changes. There is also a reduction in the supply of water due to pollution of water sources and climate change which contributes to the rising variability in rainfall. We all depend on water for our living and so every individual is responsible for saving water. In this lesson, we will learn about the sources, properties and uses of water and also about water pollution and water treatment methods.

Composition

Three fourths of our planet earth is filled with water. Water exists in three states namely solid, liquid and gas. Water on the surface of the earth is found mainly in oceans (97.25%), polar ice caps and glaciers (2.05%) and the remaining is in lakes, rivers and aquifers - ground water. Even our body is made up of 65% of water but it is not apparent. Water is a chemically stable compound. Its chemical name is dihydrogen monoxide (H2O). It can be broken up into hydrogen (H2) and oxygen (O2) when an electrical current is passed through it. The process of breaking down of water molecules by the passage of electric current is known as electrolysis of water.

Electrolysis of Water

Electrolysis of water can be easily demonstrated with the help of an experiment. In this experimental set up, a glass beaker is fixed with two carbon electrodes and it is filled with water up to one third of its volume. The positive carbon electrode acts as anode and the negative carbon electrode acts as cathode. Two test tubes are placed on the electrodes as shown in Figure 4.1.

The electrodes are connected to a battery and current is passed until the test tubes are filled with a particular gas. If the gas collected is tested using a burning splint we can notice that the gas in cathode side burns with a popping sound when the burning splint is brought near the mouth of the test tube. This property is usually shown by hydrogen gas and so it is confirmed that the gas inside the test tube is hydrogen. The burning splint placed near the anode side burns more brightly confirming that it is oxygen gas. This experiment shows that water is made up of hydrogen and oxygen. The ratio of hydrogen and oxygen is 2:1. Hence, for every two volumes of hydrogen collected at the cathode, there is one volume of oxygen collected at the anode.

Preparation of Water

Water was fi rst prepared in 1781 by an English scientist Henry Cavendish. He discovered hydrogen gas when active metals reacted with sulphuric acid. Th e hydrogen gas released was highly inflammable and burnt to form a colourless product called water.

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

$$2H_2 + O_2 \rightarrow 2H_2O$$

Water is also produced by the reduction of metal oxide by hydrogen, burning of hydrogen in air and burning of hydrocarbons in air. Respiration of plants and animals also releases water.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + Energy$$

GlucoseOxygen CarbonWater
dioxide

Henry Cavendish was a British philosopher, scientist, chemist, and physicist. Cavendish is noted for his discovery of hydrogen. He called it inflammable air. He mixed metals with strong acids and created hydrogen. He created carbon dioxide also by combining metals with strong bases.

Laboratory preparation of water

The apparatus used for the preparation of water in the laboratories is as shown in Figure 4.2. In this method, pure hydrogen gas is passed through anhydrous calcium chloride to absorb water vapour, if present. Dry hydrogen coming out of the opening is burnt with sufficient supply of air. The burnt hydrogen gas forms droplets of water, when it comes in contact with the cold flask. Distilled water without any dissolved matter is obtained by this method.

Properties of Water

Water has some important properties which are familiar to us. But these properties are unique to water. Some of the physical and chemical properties are explained below.

Physical properties

Nature

Pure water is a clear and transparent liquid. It is colourless, odourless and tasteless.

Boiling point

The boiling point of water is 100°Cat atmospheric pressure. At this temperature, water boils and changes to steam. The boiling point of water increases with increase in pressure. For example, when a pressure cooker is heated, a high pressure is built inside it. The high pressure increases the boiling point of water. Thus, water remains a liquid at a higher temperature (> 100°) in the cooker. This cooks the food faster.

Pure water has the following physical properties.

- Pure water boils at 100° C at one atmospheric pressure.
- Pure water freezes at exactly 0°C at one atmospheric pressure.
- Pure water has a density of 1 gm/cm^3

Freezing point

Water freezes at 0°C and forms ice. Thus, the freezing point of water is 0°C. The freezing point of water decreases with increase in pressure.

When the skaters move on ice, they exert pressure on it. This pressure lowers the freezing point. As a result, the ice melts underneath the skate and allows the skaters to glide across the ice with little effort. When the skaters move forward pressure is decreased and the water re-freezes to ice again.

Density

When ice cubes are put in a glass of water at room temperature, they float on the surface of the water. This is because ice is lighter than water. It means that the density of ice is lower than that of water.When the winter temperature is below 0°C, the water in the lake will start freezing. The frozen ice will float at the top and cover the lake. Since ice is a bad conductor of heat it does not allow heat to pass through it. So, the water below the ice remains in liquid form, where most of the aquatic life lives. This enables the aquatic animals and plants to survive even in extreme cold conditions. Density of water at different temperature.

Density of water at different temperature

Temperature	Density
0°C	0.91 g/cc (ice)
0°C	0.97 g/cc (water)
4°C	1 g/cc
>4°C	< 1 g/cc

Anomalous expansion of water

For the same mass of ice and of water, the volume of ice is more than that of water. It is an unusual physical property of water. In the Himalayas the temperature can go down even below 0°C. The water in the water pipes will freeze at this temperature to ice. If the pipes are not strong they can crack, develop leaks or even burst. This is because freezing of water will cause an expansion in the volume.

Latent heat of fusion of ice

If ice cubes are heated in a beaker in which a therometer is placed, the therometer does not register any rise in temperature till all the ice melts. The question arises where does the heat energy go if there is no rise in temperature. The heat energy is utilised in changing the state of ice from solid to liquid. The amount of heat energy required by ice to change into water is called latent heat of fusion of ice. Ice has the highest latent heat of fusion, i.e., 80 calories/g. or 336 J/g.

The freshness of fish and meat can be maintained by placing them in contact with ice. With its larger latent heat, ice is able to absorb a large quantity of heat from the fish as it melts. Thus, food can be kept at a low temperature for an extended period of time.

Latent heat of vaporization of water

When water attains the temperature of 100°C, it starts changing its state from liquid to gaseous state. However, the temperature of water does not rise above 100°C. It is because the supplied heat energy only changes the state of the boiling water.This heat energy is stored in steam and is commonly called latent heat of vaporization of steam.The steam has the highest latent heat of vaporization and its value is 540 calories/g or 2268 J/g.

Specific heat capacity

The amount of heat that is needed to raise the temperature of a unit mass of a substance by 1°C is called specific heat capacity of that substance.The specific heat capacity of water is very high. One gram of water requires 1 calorie of heat to raise its temperature by 1°C. Due to its high specific heat capacity, water takes time to become hot as well as to cool down. Thus, water can absorb a lot of heat and retain it for a longer time. This property of water is used to cool engines. Water is circulated around car engine using the radiator pump and the heat is absorbed. Thus the engine is protected from getting too hot.

Chemical properties

Action towards litmus paper

Pure water is neutral and it shows no action towards litmus paper.

Stability

Water is a very stable compound. It does not decompose into elements, when heated to ordinary temperatures. However, if it is heated to 2000°C, 0.02% of water decomposes to form hydrogen and oxygen gas.

$$2H_2O \xrightarrow{2000^o C} 2H_2 + O_2$$

Catalytic nature

Water acts as a catalyst in a number of reactions. Perfectly dry hydrogen and chlorine gases do not react in the presence of sunlight. However in the presence of traces of water, the reaction takes place with explosion to produce hydrogen chloride.

$$H_2 + Cl_2 \xrightarrow[\text{Sunlight}]{\text{Moisture}} 2HCl$$

Reaction with metals

Water reacts with some metals. Metals such as sodium, potassium and calcium react vigorously with water at room temperature. Sodium reacts with water to form hydrogen gas and sodium hydroxide solution. Due to the heat evolved in this reaction the hydrogen (gas) catches fire and burns.

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

Magnesium is little more sluggish. It reacts with hot water and gives hydrogen and magnesium hydroxide solution.

$$2Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$$

Many other metals react with water to form oxides and hydroxides. Iron is one such metal which forms iron oxide, called rust. Iron is used in many buildings, factories, bridges, ships and vehicles. The slow and gradual rusting of iron is called corrosion.

Copper does not react with water at any temperature.That is why it is used for making pipes and boilers.

Reaction with non-metals

Red hot carbon (coke) reacts with steam to produce water gas (Carbon monoxide + H_2).

$$C + H_2O \xrightarrow{1000^o C} CO + H_2$$

Chlorine gas dissolves in water and produces hydrochloric acid.

$$2Cl_2 + 2H_2O \xrightarrow{\text{Sunlight}} 4HCl + O_2$$

Water - A Universal Solvent

A solvent is a substance which dissolves other molecules and compounds. For example, in a salt solution, water is the solvent and salt is the solute. Water has a unique property to dissolve more substances than any other liquids. It can dissolve solids such as salt and sugar, liquids such as honey and milk and gases such as oxygen and carbon dioxide in it. Water can dissolve more number of substances than any other solvent. Therefore, it is called as universal solvent.

You can see a number of concentric rings of solid matter deposited on the watch glass. These are the dissolved solids left behind after the evaporation of water. Salts, minerals and impurities are the solids dissolved in water. Dissolved salts are important for the following reasons.

- They are essential for the growth and development of plants.
- They add taste to water.
- They supply the essential minerals needed for our bodies.
- Most of the chemical reactions important for our living take place in the cells

Tap water, river water and well water contain dissolved solids but rainwater and distilled water do not contain dissolved solids. Hence concentric rings are not formed in the rain water and distilled water after evaporation.

Apart from solids and minerals, air is also dissolved in water. Air is present in dissolved state in all natural sources of water. The solubility of oxygen in water is higher than the solubility of nitrogen. Air dissolved in water contains approximately 35.6% oxygen along with nitrogen and carbon dioxide. Air being dissolved in water is important for the following reasons.

- Air dissolved in water is important for the living organisms to survive.
- Fish extracts the oxygen from the water and expels water through the gills. Fish can survive in water only through the dissolved oxygen present in water.
- Aquatic plants make use of dissolved carbon dioxide for photosynthesis
- Carbon dioxide dissolved in water reacts with limestone to form calcium bicarbonate. Marine organisms such as snails, oysters, etc., extract calcium carbonate from calcium bicarbonate to build their shells.

Potable Water

Imagine you are swimming in the sea and by accident you swallow some sea water. How would you feel? You would probably feel like vomiting! The sensation of feeling nauseous is because of a lot of salt in the water. Every litre of sea water contains 35 grams of dissolved salts most commonly known as sodium chloride (NaCl). Such water is called saline water. It is not suitable for drinking and is said to be non-
potable water.

The water suitable for drinking is called potable water. Every litre of potable water contains 1- 2 grams of dissolved salts, mainly common salt. In addition to the common salt, there are small amounts of calcium (Ca), magnesium (Mg), potassium (K), copper (Cu) and zinc (Zn). The minerals in water give it a certain taste. In addition, these minerals are useful for our body's metabolism. Potable water also contains dissolved air.

> The salinity of water is more in the Dead sea. It is actually a salt lake as it has a single source of water and is not connected to the ocean. It is landlocked and this causes the water to evaporate. This has led to a steady increase in its degree of salinity. Now the salinity is so high such that the marine life cannot survive in it. This is why it is called the Dead sea.

Characteristics of Potable Water

The following are the characteristics of potable water.

- Potable water should be colourless and odourless.
- It should be transparent.
- It should be free from harmful micro- organisms such as bacteria, virus and protozoa.
- It should be free from suspended impurities.
- It should contain some minerals and salts, necessary for our body and some dissolved gases to add taste.

Purification of Water

Out of the total fresh water available on the earth, only 1% is present in water bodies such as rivers and lakes and the rest is frozen in glaciers and polar-regions Water from these water bodies is unfit for drinking, cooking, washing or bathing because it contains suspended and dissolved impurities. It also contains micro-organisms such as bacteria. If this water is consumed without purifying, it can cause water-borne diseases such as typhoid and cholera. Therefore, before water reaches our homes, it is treated and purified to make it potable. In conventional water treatment plants water is subjected to different processes for purification. These processes are discussed here.

> Every year 4.6 million children die due to diarrhea. Access to clean water improves hygiene and health.

Sedimentation

Water from lakes or rivers is collected in large sedimentation tanks. There, it is allowed to stand undisturbed so that suspended impurities settle down at the bottom of the tank. Sometimes, a chemical substance such as potash alum is added to water, to speed up the process of sedimentation. This process is called loading. The particles of potash alum combine with the suspended impurities and make them settle down at a faster rate.

Filtration

Water from the sedimentation tanks is then, pumped to the filtration tanks. Filtration tanks contain filter beds made up of gravel, sand, pebbles, activated charcoal and concrete. Water passes through these layers and becomes free from any remaining dissolved or suspended impurities completely.

Sterilisation

The filtered water is treated chemically to remove the remaining germs or bacteria. This process is called sterilisation. The chemicals that are used in this process are chlorine and ozone. The process of adding chlorine, in adequate amounts, to water is called chlorination. The water from filtration tanks is pumped into chlorination tanks, where chlorine is added to remove harmful bacteria and other germs. Ozonisation is a process in which water is treated with ozone gas to kill the germs present in it.

The sterilisation of water can also be done by exposing it to air and sunlight. Oxygen from the air and sunlight destroy the germs present in water. Aeration is the process in which air under pressure is blown into filtered water. This also helps to kill the germs.

RO purifiers are the purifiers that can remove the dissolved impurities and germs. They also improve the taste of water. RO stands for the name of the technology, reverse osmosis, used in these purifiers. Some RO purifiers also have a UV (ultraviolet) unit that destroys the germs present in water.

Hardness of Water

We use soaps and detergents to wash clothes. They form lather with water that quickens the process of removal of dirt from the clothes. Water contains a number of dissolved salts and minerals. When these salts are present in very small quantities in water, it is called soft water. In this water, soaps or detergents form lather easily.

Sometimes, minerals and salts are present in water in such a large quantity that soaps or detergents form a thick precipitate called scum instead of forming lather. This makes the removal of further dirt difficult. Such water is called hard water. Hardness of water is due to the presence of dissolved salts of calcium and magnesium. Hardness may be temporary or permanent. Temporary hardness is due to the presence of carbonate and bicarbonate salts of calcium and magnesium, and permanent hardness results due to the presence of chloride and sulphate salts of calcium and magnesium.

Disadvantages of Hard water

- It is not good for washing clothes. It forms scum with soap and detergents, which makes the soap ineffective and also spoils the clothes further.
- It damages the utensils and containers in which it is stored and forms a hard layer.
- It forms scales on the machine parts used in industries and decreases their efficiency.
- It results in stomach ailments if consumed for a long period.

Removal of hardness

Different methods are followed to remove the hardness from water depending on whether it is temporary hardness or permanent hardness. Some of them are explained below.

Boiling

Temporary hardness is easily removed from water by boiling. When heated, the calcium hydrogen carbonate decomposes producing insoluble calcium carbonate. The insoluble carbonates are then filtered and removed from water. This makes the hard water soft and fit for use.

Adding washing soda

Washing soda is used to remove permanent hardness of water. Adding washing soda converts chlorides and sulphates into insoluble carbonates. These insoluble carbonates are removed by filtration.

Ion – exchange

Another method used to remove the hardness of water is to pass it through a column of ion-exchange resins where calcium and magnesium ions get replaced by sodium ions. This converts hard water into soft water.

Distillation

Temporary and permanent hardness both can be removed by the method of distillation. The water obtained after distillation is called distilled water. It is the purest form of water.

Distilled water and boiled water have no taste. The pleasant taste of drinking water is due to the presence of dissolved substances which include air, carbon dioxide and minerals.

Water Pollution

Contamination of water bodies as a result of human activities is known as water pollution. Contamination of water bodies occur when harmful substances such as chemicals, sewage and waste are released into them. Contamination produces physical, chemical and biological change in the quality of water. It degrades the water quality and renders it toxic to living organisms. Drinking polluted water has serious negative effects on human health.

Water Resource in Tamil Nadu

Fresh water resources are the sources of water that are useful to society for domestic, agricultural or industrial uses. These include surface and ground water. Examples of surface water include rivers, reservoirs, eris and tanks. There are 17 major river basins in Tamil Nadu with 61 reservoirs and approximately 41,948 tanks. Eris and tanks are traditionally used in Tamil Nadu to collect rainfall during the monsoon which can be used throughout the year. Groundwater sources are called aquifers. Aquifers are layers below the ground made of coarse sand and gravel that contain spaces allowing rainwater collection. The use of groundwater is possible through open wells and bore wells.

About 90% of the available surface water has already been tapped mainly for agriculture and irrigation.

Sources of Water Pollution

When you look around you can see polluted water bodies in your surroundings. You can see lot of unwanted and harmful substances such as waste and sewage thrown into them. These substances are called pollutants. These pollutants are released by various means from different sources. In general, sources of water pollution are classified as natural sources and man-made sources. Some of the sources of water pollution are explained below.

Household Detergents

Household and cleaning detergents are a major cause of water pollution. Synthetic (non- biodegradable) detergents have chemicals that do not break down and can end up polluting both surface and groundwater. Excessive use of detergents negatively affects fish and other organisms. Some shampoo, face wash, shower gel and toothpaste have small round pieces of plastic added to them. These are called microbeads. They are added for different reasons like scrub and clean your skin, polish your teeth etc. When we use products with microbeads, they go down our drain and pollute water bodies. Fish and other animals eat them by accident and get sick.

Domestic Sewage

Wastewater that is disposed of from households is known as domestic sewage. Domestic sewage should be treated before being disposed of into a water body like a river, a lake, etc. Untreated sewage contains impurities such as organic matter from food waste, toxic chemicals from household products and it may also contain disease-causing microbes.

The largest source of water pollution in India is untreated sewage. On an average, a person uses 180 litres of water per day for washing clothes, cooking, bathing, etc.

Domestic waste and plastics

Solid waste including plastics are disposed of or end up in water bodies such as eris, rivers and the ocean. Plastics block drains spreading vector borne diseases such as malaria and dengue. Waste in water bodies negatively impact aquatic life.

Plastic sheets are used in agriculture to grow vegetables. At the end of the season, these plastic sheets are ploughed back into the soil. The plastic sheets break into tiny pieces and get eaten by earth worms, which is harmful to their health and that of soil.

Agricultural activities

Fertilizers, pesticides and insecticides used in agriculture can dissolve in rainwater and flow into water bodies such as rivers and lakes. This causes an excess of nutrients such as nitrates and phosphates as well as toxic chemicals in water bodies which is called Eutrophication and they can also be harmful to aquatic life.

Industrial waste

Many industries release toxic waste such as lead, mercury, cyanides, cadmium, etc. If this waste is unregulated and is released into water bodies it negatively impacts humans, plants, animals and aquatic life.

Oil spills

There are large crude oil and natural gas reserves below the sea bed. With the increasing exploration of crude oil in the oceans, accidents in drilling and transporting oil have also increased. Oil spills cause water pollution which is harmful to aquatic life. The oil which remains floating on the water surface blocks sunshine, reduces the oxygen dissolved in water and suffocates marine organisms.

Thermal pollution

Large amounts of water are used for cooling purposes in thermal and nuclear power plants and many industries. Water used for cooling purposes is discharged back to a river or to original water source at a raised temperature and sometimes with chemicals. This rise in temperature decreases the amount of oxygen dissolved in water which adversely affects the aquatic life.

Common pollutants

Pollutants are generally classified as domestic pollutants, agricultural pollutants and industrial pollutants. The sources and effects of various water pollutants are shown below in.

Micro-plastics can be found in almost every freshwater source. They have been found from the freezing waters of the Arctic and Antarctic to the bottom of the deep-sea floor up to 5,000 meters deep. Micro-plastics have been found in bottled water and tap water around the world.

Controlling Water Pollution

Water is precious and it is essential for our survival. But today almost every water body is polluted with waste ranging from plastics to toxic substances. We can all take immediate steps to save our precious water from pollution. Some simple ideas to avoid water pollution are given below:

- Use detergents that are biodegradable and avoid those that contain toxic chemicals.
- Wear clothing that is made from natural fibres such as cotton and avoid wearing synthetic fibres such as nylon.
- Do not throw waste such as plastics into water bodies. Always separate your waste into recyclable, non-recyclable and biodegradable so that it does not cause pollution.
- Domestic waste water should be treated properly, and all harmful substances should be removed from it, so it can be reused for flushing toilets and gardening.
- Use bio-pesticides (natural pest control) instead of chemical pest control.
- Use compost made from cow dung, garden waste and kitchen waste as a fertiliser.
- Water released from industries should be treated before being discharged.

Pollutants	Sources	Effects
Domestic		
Sodium sulphates and phosphates	Detergents	In humans they cause developmental, reproductive and neuro toxicity and endocrine disruption. Phosphates make bacteria and algae grow faster, and use up all the dissolved oxygen. This leads to a decrease in animal and plant diversity.
Plastic fibres and microbeads	Plastic clothing and hair, beauty and skin products	These end up in water bodies such as lakes, rivers and the ocean. Here they attract toxic chemicals. Marine animals often eat them as they confuse them as their natural source of food and the toxins can move up the food chain.

Agriculture		
DDT	Insecticides	If affects the central nervous system of insects, animals and humans. It accumulates in the food chain and impacts the top predators the most.
Nitrates and phosphates	Fertilisers	Bacteria and algae grow faster and they use up all the dissolved oxygen and this leads to a decrease in animal and plant diversity.
Industrial		
Lead, Mercury, Cadmium, Chromium and Arsenic	Chemical, textile and Leather industries and leachate from open dumping of solid waste	Toxic to animals, plants and bacteria in the water. Pollutes potable ground water. Negatively impacts human health.

Unit- 15ACIDS AND BASES

Introduction

In our daily life we come across different food substances. Some substances like fruits, tamarind, graphs, curd and lemon are sour. They are said to be acidic. Some substances like sodium bicarbonate and green tea are bitter in taste. They are said to be basic. This means that they contain either acid or base. But what are acids and bases? Acids and bases are one of the important chemical compounds which play a significant role in every field of science. Acids and bases are everywhere right from the soap used for shower to the vinegar present in the kitchen. Acids and bases react with each other and also with water. As a result they are important biologically, industrially and environmentally. For example, among the medicines we use, aspirin is acidic and antacids
are basic. Similarly, many biological molecules are also either acids or bases. Dietary fats are acids and the chemical compounds in DNA are bases. In this lesson we will study about the properties and uses of acids, neurtralisation of acids and bases and acid-base indicators.

Acids

The term acid is derived from the Latin word 'acidus' which means sour. Thus, the chemical compounds which have sour taste are called acids generally. All acids contain one or more replaceable hydrogen atoms in their molecules and when dissolved in water they release H^+ ions. For example, Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4) and Nitric acid (HNO_3) release hydrogen ions (H^+) when dissolved in water.

Hydrochloric + Water → Hydrogen + Chloride

$$HCl + H_2O \rightarrow H^+ + Cl^-$$

Sulphuric acid + Water → Hydrogen + Sulphate
ion ion

$$H_2SO_4 + H_2O \rightarrow 2H^+ + SO_4^{2-}$$

> Swedish chemist Svante Arrhenius proposed a theory on acids. According to him, an acid is a substance which furnishes H+ ions or H_3O^+ ions in aqueous solution.

Thus, acids are defined as the chemical substances which release hydrogen ions when dissolved in water.

Acids can be classified into organic acids and inorganic acids depending on the sources. Some acids occur naturally in fruits and vegetables. These are called organic acids. Examples: Citric acid, tartaric acid etc.

Organic acids and their sources

Name of the Acid	Source
Citric acid	Oranges, Lemon
Lactic acid	Sour milk
Oxalic acid	Tomatoes
Acetic acid	Vinegar
Malic acid	Apple
Tartaric acid	Tamarind

On the other hand, man produces acids artificially in industries. These acids are called mineral acids or inorganic acids. Examples: Hydrochloric acid (HCl), Sulphuric acid (H_2SO_4), Nitric acid (HNO_3) etc., There are many more classifications of acids. You will study about them in your next class.]

Properties of Acids
Physical properties

- Acids are sour in taste.
- They are corrosive in nature. Strong acids can spoil substances like human skin, clothes and paper.
- Generally acids exist in liquid state but few acids exist in solid state too. E.g. Benzoic acid
- Acids are colourless.
- Acids change the colour of the indicators. Blue litmus paper turns red and methyl orange turns pink when treated with acids.
- They are soluble in water.
- Solutions of acids conduct electricity.

Benzoic acid

Wefeelhungryduetothecorrosive action of hydrochloric acid on the inner lining of the stomach. When the level of hydrochloric acid goes higher, it causes ulcer.

Chemical properties
Reaction with metals

Metals like zinc, magnesium, aluminum, iron etc., react with acids like hydrochloric acid, sulphuric acid to form metal salts and release hydrogen gas.

Metal + Dilute acids → Metal salt + Hydrogen

Example:

Zinc + Hydrochloric → Zinc chloride + Hydrogen
acid

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2\uparrow$$

Iron + Sulphuric acid → Ferrous + Hydrogen
sulphate

$$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2\uparrow$$

Copper or brass cooking vessels are coated with tin metal (eyam). If it is not coated the organic acids present in the food materials will react with copper and make the food poisonous. The tin isolates the vessel from the action of acids and prevents food poisoning.

Reaction with metal carbonates and bicarbonates

When carbonates and bicarbonates come into contact with dilute acids carbon dioxide is given out along with water. For example, limestone (calcium carbonate) reacts with dilute sulphuric acid to form calcium sulphate, carbon dioxide and water.

Calcium + dil Sulphuric → Calcium + Carbon + Water
carbonate acid sulphate dioxide

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + CO_2 + H_2O$$

Reaction with metal oxide

Oxides of various metals react with dilute acids to form their metallic salts and water.

Metal oxides + dilute Acid → Metal salts + Water

Example:

Calcium + Hydrochloric → Calcium + Water
oxideacid chloride

$$CaO + 2HCl \rightarrow CaCl_2 + H_2O$$

Uses of Acids

- Hydrochloric acid present in our stomach helps in the digestion of foodstuff.
- Vinegar (acetic acid) is used to preserve food materials.

- Benzoic acid is also used to preserve food materials like pickles.
- Sodium or potassium salts of higher fatty acids are used to make washing and bathing soaps.
- Sulphuric acid is called the king of chemicals. It is an effective dehydrating agent. It is used in various industries to make detergents, paints, fertilizers and many more chemicals.
- Hydrochloric acid, Nitric acid and Sulphuric acid are important laboratory reagents.
- Cells of all living organisms contain the fundamental nuclear material called nucleic acids. Animals have deoxyribo nucleic acid (DNA) whereas plants contain ribo nucleic acid (RNA).

> Pickles remain in good condition for long time because they contain vinegar (acetic acid) or benzoic acid.

Bases

We use soaps for bathing as well as washing. Soaps are slippery in nature. Do you know why? Soaps are slippery due to the presence of 'base'. Bases are chemical substances that are corrosive and bitter in taste. A lot of bleaches, soaps, detergents, kinds of toothpaste, etc., are bases. In contrast to acids which release hydrogen ions in water, bases release hydroxide ions in water.

Thus, the chemical substances that release hydroxide ions when dissolved in water are called as bases. Examples: Sodium hydroxide (NaOH) and Potassium hydroxide (KOH).

Sodium hydroxide → Sodium ion + Hydroxide ion

$$NaOH \rightarrow Na^+ + OH^-$$

Potassium hydroxide → Potassium ion + Hydroxide ion

$$KOH \rightarrow K^+ + OH^-$$

Water soluble bases are called Alkalis. Bases like sodium hydroxide, potassium hydroxide, calcium hydroxide and ammonium hydroxide are highly soluble in water and hence they are called alkalis. Certain chemical substances which do not release hydroxide ions when dissolved in water also behave as bases. Examples: Sodium carbonate, Sodium bicarbonate, Calcium carbonate etc.

Common bases in some products

Base	Formula	Products
Magnesium hydroxide	$Mg(OH)_2$	Milk of magnesia
Sodium hydroxide	NaOH	Detergent

Ammonium hydroxide	NH_4OH	Solution for cleaning windows
Calcium hydroxide	$Ca(OH)_2$	Lime water
Potassium hydroxide	KOH	Soap

Sodium carbonate (Na2CO3) is commercially called washing soda. Similarly sodium bicarbonate (NaHCO3) is commercially called baking soda. Caustic soda is sodium hydroxide (NaOH) and caustic potash is potassium hydroxide (KOH).

Properties of Bases

Physical properties

- Bases generally exist in solid state but some bases exist in liquid state also. E.g. Ammonium hydroxide, calcium hydroxide
- Bases give soapy touch only in aqueous media not in dry nature.
- Bases are bitter in taste.
- Bases are corrosive in nature. When come in contact with the skin frequently they form painful blisters.
- Bases are generally colourless.
- Bases also change the colour of the indicators. Red litmus paper turns blue when treated with bases. Similarly, they turn methyl orange yellow and phenolphthalein pink.
- Bases also conduct electricity in aqueous solution.

Chemical properties of bases
Reaction with metals

Generally metals do not react with bases. Metals like Aluminium and Zinc react with bases like sodium hydroxide forming aluminates and release hydrogen.

Aluminum + Sodium hydroxide + Water → Sodium aluminate + Hydrogen

$$2Al + 2NaOH + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$$

Reaction with metal oxides

All bases react with non metallic oxides to form salt and water. For example sodium hydroxide reacts with carbon dioxide to form sodium carbonate.

Sodium hydroxide + Carbon dioxide → Sodium carbonate + Water

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

Reaction with ammonium salts

Bases react with ammonium salts to form metal salts, ammonia gas and water.

Sodium hydroxide + Ammonium chloride → Sodium chloride + Ammonia + Water

$NH_4Cl + NaOH \rightarrow NaCl + NH_3 + H_2O$

Though acids and bases have some unique properties there are certain similarities between them. Some of them are given below.

- They are corrosive in nature.
- They undergo ionization in aqueous solution.
- They conduct electricity in aqueous solution.
- They undergo neutralization reaction.

Some of the differences between acids and bases are given in Table.

Difference between acids and bases

Acids	Bases
They produce H+ ions in water.	They produce OH– ions in water.
They are sour in taste	They are bitter in taste.
Few acids are in solid state.	Most of the bases are in solid state.
Acids turn blue litmus paper red.	Bases turn red litmus paper blue.

Uses of Bases

1. Potassium hydroxide is used to make bathing soaps.
2. Sodium hydroxide is used to make washing soaps.
3. Sodium hydroxide is also used in paper industries, textile industries and in the preparation of medicines.
4. Calcium hydroxide is used for white washing.
5. Aluminum hydroxide and magnesium hydroxides are used in antacids to cure acidity problems.

6. Ammonium hydroxide is used to manufacture fertilizers, nylon, plastics and rubber.

Neutralisation Reaction

When neutrality is achieved between two different chemical substances with different chemical properties through a reaction then it is called neutralization in chemistry. Thus neutralization is a chemical reaction in whichan acid and a base react with each other to form salt and water. Neutralization reaction between an acid and a base can be written as:

Acid + Base → Salt + Water

Acid – Base reaction

Similarly some other acids also produce their salts when they react with some bases. Some of the salts produced by neutralization reaction are given below in Table.

Salts produced by neutralisation

Acid	**Base**	**Salt**
Hydrochloric acid HCl	Sodium hydroxide NaOH	Sodium chloride NaCl
Sulphuric acid H_2SO_4	Sodium hydroxide NaOH	Sodium sulphate Na_2SO_4
Nitric acid HNO_3	Sodium hydroxide NaOH	Sodium nitrate $NaNO_3$
Acetic acid CH_3COOH	Sodium hydroxide NaOH	Sodium acetate CH_3COONa

Neutralisation reactions in our daily life

Balancing acids and bases is important for our health and for our environment. We come across various neutralization reactions in our daily life. Let us study about the importance of some of those reactions.

Ant bite

Whenever bees or red ants bite they inject an acid called formic acid. These acids cause pain a suitable base in the form of calcium hydroxide (readily available at home) is applied so as to neutralise the formic acid.

Wasp bite

When we are bitten by wasp, we feel the burning sensation and pain. It is due to an alkaline substance injected by the insect. To neutralise the alkalinity we use vinegar which is an acid.

Tooth decay

Generally it is advised by the doctors that we should brush our teeth twice a day. This is because the bacteria present in our mouth decompose the food particles stuck in the gaps between our teeth thereby causing acid formation which leads to tooth decay. To prevent this we have to neutralize the acid. When we brush with tooth powder or tooth paste containing weak bases, the acid gets neutralized. So our teeth will be strong and healthy.

Acidity

As we know, hydrochloric acid present in our stomach helps the digestion of food material along with the enzymes secreted by liver, gallbladder and pancreases. Sometimesdue to excessive production of hydrochloric acid in our stomach we feel burning sensation in food pipe and in chest area. If this happens again and again ulcer will be formed in stomach and food pipe, which further aggravates the conditions. In order to neutralize, antacids which are nothing but weak bases like aluminum and magnesium hydroxides are used. As a result the acidity is removed.

Agriculture

Acidic soil is not suitable for plant growth. So farmers add lime fertilisers such as powdered lime (CaO), limestone ($CaCO_3$) or ashes of burnt wood to the soil to neutralise the acidity.

Industries

Effluents from the industries contain acids such as sulphuric acid. It is treated by adding lime to neutralise it before it is discharged into rivers and streams. Similarly, in power stations fossil fuels such as coal are burnt to produce electricity. Burning fossil feuls will liberate sulphur dioxide gas as an acidic pollutant in the air. Hence, power stations treat this acidicgas using powdered lime (CaO) or limestone ($CaCO_3$) to neutralise it so that air pollutant can be prevented.

Indicators

An indicator or acid– base indicator is a chemical substance which indicates the acidic or basic nature of a solution by suitable colour change. These may be natural or synthetic.

Natural indicators

Natural indicators are chemical substances which are obtained from the natural resources. Litmus, turmeric juice, China rose petals, red cabbage, grape juice and beetroot juice are the indicators obtained from natural resources.

Turmeric indicator

By adding small amount of water to turmeric powder a paste is prepared. This is applied on a blotting paper or filter paper and dried. These strips are used as indicators to find the nature of the solution. In acidic solution turmeric indicator paper has no change in colour. That means it remains yellow. In basic solution the colour changes from yellow to red.

Hibiscus flower indicator

Some hibiscus flowers soaked in warm water for about 5 to 10 minutes forms a solution. This solution can be used as indicator. In acidic solution, the colour will be changed to deep pink or deep red. In basic solution, the colour will be changed into a green.

Beet root juice indicator

Extracts of beet root are also used as an indicator for identifying the acidic or basic nature of a solution.

Litmus

Litmus is the most common indicatorz used in the laboratories. Litmus is a natural indicator which is extracted from lichens. It is available in the form of solution or in the form of strips prepared by absorbing litmus solution on filter paper. It is either red orblue in colour. Blue litmus paper turns red in acidic solution and red litmus paper turns blue in the basic solution.

Synthetic indicators

An indicator prepared from artificial substances is known as synthetic indicators. Phenolphthalein and methyl orange are the examples for synthetic indicators.

Phenolphthalein

Phenolphthalein is a colourless compound. Its alcoholic solution is used as an indicator. It is colourless in acidic solution but turns pink in basic solution.

Methyl orange

Solid methyl orange is dissolved in hot water and its filtrate is used as an indicator. It turns red in acidic solution and yellow in basic solution.

The following table gives the colour changes of different indicators in acidic and basic medium

Colour Changing Indicators

Indicator	Acidic Solution	Basic Solution
Blue litmus	Red	No change in colour
Red litmus	No change in Colour	Blue
Phenolphthalein	Colourless	Pink
Methyl orange	Red	Yellow

16. CHEMISTRY IN EVERYDAY LIFE

Introduction

When we hear the word chemistry we think of chemical reactions conducted in the laboratories. But chemistry is beyond that. We can find chemistry in everything in our surrounding. It is in the air we breathe, the food we eat and everything we use in our daily life. We are nothing without chemistry even our body is made of elements like nitrogen, phosphorous, hydrogen, oxygen, calcium, potassium, sulphur, magnesium etc. All the chemical reactions taking place in our body are due to chemistry. In a nutshell it can be stated that we can clear our mystery, create a new history through chemistry. Our whole life is dependent on various chemical compounds. Among them, hydrocarbons are the most important one. We can say that the whole civilization is driven by hydrocarbons because they make up the fossil fuels petroleum and natural gas. In this lesson we are going to study about different types of hydrocarbons, fossil fuels like petroleum and coal, characteristics of fuel and solar energy and its applications.

Hydrocarbon

Hydrocarbons are the organic compounds consisting of hydrogen and carbon atoms. They are combustible and produce large amount of heat energy along with carbon dioxide and water vapour, on burning. Hence, many hydrocarbons are used as fuels.

Sources of Hydrocarbons

Hydrocarbons occur naturally and they are found in fossil fuels like crude oil, natural gas and coal. About 300 million years ago plants and animals died and they were buried on the ocean floor. Overtime they were covered by silt and soil layers.

Then they were buried deep inside the earth and compressed through temperature and pressure and converted to fossil fuels like oil and natural gas. These fuels are found in porous rocks which lie below large bodies of water, especially oceans. By drilling these rocks hydrocarbons can be extracted. Hydrocarbons are present in different trees and plants also.

Properties of Hydrocarbons

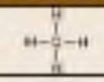
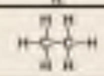
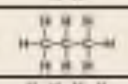
Among all the chemical compounds hydrocarbons have some unique properties. Some of them are given below.

- Most of the hydrocarbons are insoluble in water.
- Hydrocarbons are less dense than water. So they fl oat on top of water.
- Most hydrocarbons react with oxygen to produce carbon dioxide and water.
- Hydrocarbons can be gases (e.g. methane and propane), liquids (e.g. hexane and benzene) or waxes (paraffin).
- Hydrocarbons are capable of making bonds with one another. This property is known as catenation. Due to this property they form more number of complex molecules.

Types of Hydrocarbons

In hydrocarbons carbon and hydrogen atoms are linked together through different chemical bonds. Depending on the bond between these atoms there are number of hydrocarbons. The four general classes of hydrocarbons are: alkanes, alkenes, alkynes and arenes. Some of the common hydrocarbons are methane, ethane, propane, butane and pentane. Methane is the simplest hydrocarbon in which four hydrogen atoms are linked with one carbon atom. It is a colourless, odourless and inflammable gas. It is an eco-friendly fuel because it does not produce any harmful products. It is used as a fuel in electricity generation. Methane is also known as marsh gas as it is present in marshes. Dead and decaying plants and animals release methane gas. It is a renewable source of energy. Sewage sludge can also be decomposed by microorganisms to produce methane gas along with impurities like carbondioxide and hydrogen sulphide. After removing these impurities, methane gas can be used as an efficient fuel.

Make a model using clay and match sticks for the following hydrocarbons.

Name	Formula	Structure
Methane	CH_4	
Ethane	C_2H_6	
Propane	C_3H_8	
Butane	C_4H_{10}	
Pentane	C_5H_{12}	

Propane is an odourless and highly inflammable gas. It is heavier than air. It is liquefied through pressurisation and commonly used as LPG (Liquefied Petroleum Gas) along with butane. Propane is used as fuel in heating, cooking, and vehicles. Propane can also be used as refrigerants.

Propane is used in LPG cylinders. Since it is an odouress gas, any leakage cannot be detected. Hence, a chemical by name Mercaptan is mixed with LPG to help in detection of any leakage of LPG.

Butane is a gas at room temperature and atmospheric pressure. They are highly flammable, colorless gases that quickly vaporize at room temperature. Butane is used as a fuel gas and propellant in aerosol sprays such as deodorants. Pure forms of butane can be used as refrigerants. Butane is also used as lighter fuel for a common lighter or butane torch. Pentanes are liquids with low boiling point. They are used as fuels and solvents in the laboratory. They are also used to produce polystyrene.

15.2 Natural Gas

Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane along with other higher alkanes and a small percentage of carbon dioxide, nitrogen and hydrogen sulphide (H_2S). If thenatural gas contains lower hydrocarbons like methane and ethane, it is called dry gas. If higher hydrocarbons like propane and butane are also present in the gas, it is called wet gas.

Natural gas is always found above the oil in the oil wells. This gas is trapped inside the small spaces in underground rocks called reservoirs. Conventional natural gas can be extracted through drilling wells. Natural gas can also be found in reservoirs with oil and is extracted along with oil. This is called associated gas.

Natural gas is a fossil fuel used as a source of energy for heating, cooking and electricity generation. Natural gas occurs in Tripura, Rajasthan, Maharashtra, Andhra Pradesh (Krishna, Godavari Basins) and Tamil Nadu (Cauveri Delta). It is also formed by the decomposition of organic matter in marshy areas and waste sewages. The natural gas formed by this way contains mainly methane.

Uses of Natural Gas

- Natural gas is used as an industrial and domestic fuel.
- It is used in thermal power stations.
- It is used as fuel in vehicles as an alternative for petrol and diesel.
- When heated it decomposes and forms hydrogen and carbon. Hydrogen thus formed is used in the manufacture of fertilizers.
- It is used to manufacture chemicals, fabrics, glass, steel, plastics and paints.
- It is also used in electricity generation.

> Moderate temperature and humidity is needed to keep paintings and other ancient artifacts from being destroyed by environmental factors. Thus natural gas is used in museums to protect the monuments.

15.2.2 Advantages of Natural Gas

- It produces lot of heat as it is easily burnt.
- It does not leave any residue.
- It burns without smoke and so causes no pollution.
- This can be easily supplied through pipes.
- It can be directly used as fuel in homes and industries.

15.2.3 Compressed Natural Gas

When the natural gas is compressed at high pressure, it is called Compressed Natural Gas (CNG). Nowadays it is used as fuel in automobiles. The primary hydrocarbon present in

CNG is methane (88.5%). Natural gas is liquefied for shipping in large tankers. This is called Liquefied Nitrogen Gas (LNG). CNG is stored at high pressure whereas LNG is stored in ultra cold liquid form. CNG has the following properties.

- It is the cheapest and cleanest fuel.
- Vehicles using this gas produce less carbon dioxide and hydrocarbon emission.
- It is less expensive than petrol and diesel.

The average composition of CNG.

Constituents	Percentage
Methane	88.5
Ethane	5.5
Propane	3.7
Butane	1.8
Pentane	0.5

15.3 Other Gases

Apart from natural gas, there are some other gases used as fuel. Producer gas, coal gas, bio gas and water gas are some of them.

Producer Gas

Producer gas is a gaseous mixture of carbon monoxide and nitrogen. It is produced by passing air mixed with steam, over red hot coke at a temperature of 1100 ˚C. It is used as an industrial fuel for iron and steel manufacturing.

Producer gas is known by different names in different countries. It is referred as Wood gas in USA and as Suction gas in UK.

Coal Gas

It is a mixture of gases like hydrogen, methane and carbon monoxide obtained by the destructive distillation of coal. Heating coal in the absence of air is called destructive distillation. It is used in heating open hearth furnace in the manufacture of steel. It is also used as a reducing agent in certain metallurgical operations.

Water Gas

It is a gaseous mixture of carbon monoxide and hydrogen. It is made by passing steam over incandescent coke at a temperature of 1000°C.

$$C_{(g)} + H_2O_{(g)} \xrightarrow{1000^o C} CO_{(g)} + H_{2(g)}$$

It is also called as syngas or synthesis gas as it is used to synthesize methanol and simple hydrocarbons. It is used as an industrial fuel also.

Bio Gas

Bio-gas is a mixture of methane and carbon dioxide. It is produced by the decomposition of plant and animal waste which form theorganic matter. The breaking down of organic matter in anaerobic condition (ie. in the absence of oxygen) leads to the formation of biogas. It is an example for renewable source of energy.

15.4 Coal and its types

Coal is one of the fossil fuels. It is a mixture of free carbon and compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur. Three hundred million years ago, some plants grew into giant ferns and mosses. These plants got buried into the bottom of the soil. They slowly started to decompose and formed a dense, sponge like material called peat. Over time peat was compressed due to high temperature and pressure and coal was formed. As coal contains mainly carbon, the slow process of conversion of dead vegetation into coal is called carbonization.

Extraction of Coal

Coal is extracted from the coal beds found below the surface of the earth. Coal found inside the earth is broken into pieces by explosivesand brought above. Depending on the depth of the coal bed, coal is extracted in two ways.

Surface mining

If the coal beds lie within 22 feet of the earth's surface, the top soil is removed and coal is dug out. This is called surface mining.

Underground mining

In some places, coal beds are found very deep inside the earth. In that case underground tunnels are made to get this coal. This is called underground mining or deep mining.

Coal reserves can be found in about 70 countries worldwide. The largest coal reserves are available in United State, Russian, China, Australia and India. The US is the internationalleader in coal reserves, with nearly 30% of the world's supply. Coal mining was started in India in 1774. India now ranks third among the coal producing countries in the world. USA and China have two third of the world's coal reserve.

Types of Coal

Coal is classified into four main categories based on the amounts of carbon it contains and the heat energy it can produce. They are lignite, sub bituminous, bituminous and anthracite. Among these four types anthracite is the most desirable one due to its high heat content.

Lignite

Lignite is a brown colored coal of lowest grade. It has least content of carbon. The carbon content of lignite is 25 – 35%. Lignite contains a high amount of water and makes up almost half of our total coal reserves. It is used for electricity generation. The other uses include generating synthetic natural gas and producing fertilizer products.

Sub bituminous

When lignite becomes darker and harder over time sub-bituminous coal is formed. Sub bituminous coal is a black and dull coal. It has higher heating value than lignite and contains 35-44% carbon. It is used primarily as fuel for electricity power generation. This coal has lower sulfur content than other types and burns cleaner.

Bituminous

With more chemical and physical changes, sub-bituminous coal is developedinto bituminous coal. Bituminous coal is dark and hard. It contains 45-86% carbon. It has high heating value. It is used to generate electricity. Other important use of this coal is to provide coke to iron and steel industries. By-products of this coal can be converted into different chemicals which are used to make paint, nylon, and many other items.

Anthracite

It is the highest grade coal. It is hard and dark black in colour. It has a very light weight and the highest heat content. Anthracite coal is very hard, deep black and shiny. It contains 86-97% carbon and has a heating value slightly higher than bituminous coal. It burns longer with more heat and less dust.

15.4.3 Uses of coal

- Coal is used to generate heat and electricity.
- It is used to make derivatives of silicon which are used to make lubricants, water repellents, resins, cosmetics, hair shampoos, and toothpaste.
- Activated charcoal is used to make face packs and cosmetics.
- Coal is used to make paper.
- Coal helps to create alumina refineries.

- Carbon fibre which is an extremely strong but lightweight material is used in construction, mountain bikes, and tennis rackets.
- Activated carbon, used in filters for water and air purification and in kidney dialysis machines is obtained from coal.

15.4.4 Products obtained from coal

Coal when heated in the absence of air does not burn but produces many by-products. This process of heating coal in the absence of air is called destructive distillation of coal. Thousands of different products have coal or coal by-products as their components. Some of them are soap, aspirins, solvents, dyes, plastics, and fibres, such as rayon and nylon. The main by products obtained during destructive distillation are coke, coal tar, ammonia and coal gas.

Destructive Distillation of Coal

The destructive distillation of coal can be carried out in the laboratories. The apparatus is as shown in

Finely powdered coal is taken in a test tube and heated. At a particular temperature coal breaks down to produce coke, coal tar, ammonia and coal gas. Coal tar is deposited at the bottom of the second test tube and coal gas escapes out through the side tube. The ammonia produced is absorbed in the water, forming ammonium hydroxide. Finally a black residue called coke is left in the first tube.

Coke:

Coke contains 98% carbon. It is porous, black and the purest form of coal. It is a good fuel and burns without smoke. It is largely used as a reducing agent in the extraction of metals from their ores. It is also used in making fuel gases like producer gas and water gas which is a mixture of carbon monoxide and hydrogen.

Coal tar:

Coal tar is a mixture of different carbon compounds. It is a thick, black liquid with unpleasant smell. The fractional distillation of coal tar gives many chemical substances like benzene, toluene, phenol and aniline. They are used in the preparation of dyes, explosives, paints, synthetics fibers, drugs, and pesticides. Another product obtained from coal tar is naphthalene balls which are used to repel moth and other insects.

Coal Gas:

Coal gas also known as town gas is mainly a mixture of gases like hydrogen, methane and carbon monoxide. The gases present in coal gas are combustible and hence, it is an excellent fuel. It has high calorific value.

Ammonia:

The other by product obtained from coal is ammonia. It is used for making fertilizers such as ammonium sulphate, ammonium superphosphate etc.

It is also known as Black Diamond owing to its precious nature. On destructive distillation, 1000 kg of coal gives 700 kg of coke, 100 litres of ammonia, 50 litres of coal tar and 400 m3 of coal gas.

Petroleum

The term 'petroleum' is derived from the latin words 'petra' meaning rock and 'oleum' meaning oil. It is a fossil fuel formed from the remains of ancient marine organisms through death and decay. Petroleum is a complex mixture ofhydrocarbons that occur in Earth in liquid, gaseous, or solid form. The term petroleum commonly denotes the liquid form, crude oil. But technically petroleum also includes natural gas and bitumen, a solid form. The natural gas and the crude oil constitute the primary fossil fuels.

Ancient cultures used crude oil for binding materials. It was also used as a sealant for waterproofing various surfaces.

Occurrence of Petroleum

The chief petroleum producing countries are U.S.A, Kuwait, Iraq, Iran, Russia and Mexico. In India, petroleum is found in Assam, Gujarat, Maharashtra (Mumbai), Andhra Pradesh (Godavari and Krishna basin) and Tamil Nadu (Cauveri Basins). By drilling through the earth the crude oil is pumped out from the well as a black liquid.

The first oil well in the world was drilled in Pennsylvania, USA in 1859. The second oil well was drilled in Makum, Assam, India in 1867.

Refining of crude petroleum

Thecrude petroleum obtained from the well is a dark colored viscous liquid which contains many impurities such as water, solid particles and gases like methane and ethane. To make it useful for different purposes, it must be separated into various components. The process of separating petroleum into useful by-products and removal of undesirable impurities is called refining. The steps involved in this process are given below.

Separation of water

The crude oil obtained from the oil wells will have salt water mixed with it. As the first step the water is removed from the crude oil.

Removal of sulphur compounds

The crude oil will have harmful sulphur compounds as impurities. In this step these impurities are removed.

Fractional distillation

Petroleum is a mixture of various constituents such as petroleum gas, petrol, diesel, kerosene, lubricating oil, paraffin wax, etc. The process of separation of various constituents or fractions of petroleum is done by fractional distillation in fractionating columns. The process of heating a mixture of liquids having different boiling points and then separating them by cooling is called fractional distillation.
Crude petroleum is first heated to about 400°C in a furnace. As the vapours of crude oil move up the tower, the various fractions condense according to their boiling point ranges. The various fractions of petroleum obtained are tabulated below. Many useful substances are obtained from petroleum and natural gas. These are termed 'petrochemicals'. These are used in the manufacture of detergents, fibres, and other man-made plastics like polythene. Hydrogen gas obtained from natural gas, is used in the production of fertilizers. Due to its great commercial importance, pertoleum is also called 'black gold'.

Uses of Petroleum

Products obtained from crude oil have a number of uses.

- Liquefied Petroleum Gas or LPG is used in houses as well as in the industry.
- Diesel and petrol are used as fuels for vehicles. It is also used to run electric generators.
- Petrol is used as a solvent for dry cleaning.
- Kerosene is used as a fuel for stoves and also in jet planes.
- Lubricating oil reduces wear and tear and corrosion of machines.
- Paraffin wax is used to make candles, ointments, ink, crayons, etc.
- Bitumen or asphalt is mainly used to surface roads.

Extraction of Petroleum

Fuel

Any substance that can produce heat and energy on burning is called fuel. We use this heat for various purposes such as cooking, heating and many industrial and manufacturing purposes. Some of the fuels that we use in our daily life are wood, coal, petrol, diesel and natural gas.

Types of fuel

Fuels are classified into different types according to their physical state. They are classified into solid, liquid and gaseous fuels.

Solid fuels

Fuels like wood and coal are in solid state and they are called solid fuels. This type of fuel was the first one to be used by man. These fuels are easy to store and transport. The production cost is also very low.

Liquid fuels

Most of the liquid fuels are derived from the fossil remains of dead plants and animals petroleum oil, coal tar and alcohol are some of the liquid fuels. These fuels give more energy on burning and burn without ash.

Gaseous fuel

Coal gas, oil gas, producer gas and hydrogen are some of the gaseous fuels. These fuels can be easily transported through pipes and they do not produce pollution.

Characteristics of fuel

An ideal fuel should have the following characteristics.

- It should be readily available
- It should be easily transportable
- It should be less expensive
- It should have high calorific value
- It should produce large amount of heat
- It should not leave behind any undesirable substances

Efficiency of Fuel

Any fuel contains carbon as its main constituent. During the combustion of fuel carbon combines with oxygen and liberates large amount of heat. It is expected that a fuel liberates maximum amount of heat in the short time. The efficiency of a fuel can be understood from the following terms.

Specific Energy

Specific energy is the amount of energy produced by unit mass of a fuel. It is defined as the energy per unit mass. It is used to measure the stored energy in certain substances. Its unit is Jkg-1.

Calorific Value

It is the quantity of heat produced by the complete combustion of fuel at constant pressure and normal conditions. It is measured in terms of 125kg-1.

Calorific value of fuel

Fuel	Calorific Value (KJ/kg)
Cow dung cake	6000 – 8000
Wood	17000 – 22000
Coal	25000 – 33000
Petrol	45000
Kerosene	45000
Diesel	45000
Methane	50000
CNG	50000
LPG	55000
Biogas	35000 – 40000
Hydrogen	150000

Octane Number

Octane number denotes the amount of octane present in petrol. The fuel having high octane number is called as an ideal fuel.

Cetane Number

Cetane Number measures the ignition delay of the fuel in diesel engine. When cetane number is higher the ignition delay is shorter. The fuel with high cetane number is called as the ideal fuel.

Difference between Octane number and Cetane number

Octane Number	Cetane Number
Octane rating is used for petrol	Cetane rating is used for diesel
It measures the amount of octane present in petrol.	It measures the ignition delay of the fuel in diesel engine.

Octane number of petrol can be increased by adding benzene or toluene.	Cetane number of diesel can be increased by adding acetone.
The fuel with high octane number has low cetane number	The fuel with high cetane number has low octane number.

Alternative Fuel

The natural resources in the world have been used by man in a rapid way and so very soon they will be exhausted. The traditional fuel that we use today including petroleum are non renewable and they would be depleted soon. It is estimated that coal will last for 148 years, petroleum for 40 years and natural gas for 61 years. So we need to find alternative sources of energy. More over fossil fuels emit harmful gases like carbon dioxide, carbon monoxide and sulfur dioxide which pollute the atmosphere. Burning fossil fuels also cause temperature rise in the earth's atmosphere. Many believe that fuel which does not cause pollution is needed to enhance the quality of our environment. Some of the alternative fuels are given below.

Bio diesel

Bio diesel is a fuel obtained from vegetable oils such as soya bean oil, jatropha oil, corn oil, sunflower oil, cotton seed oil, rice-bran oil and rubber seed oil.

Hydrogen - The future fuel

Hydrogen could be the best alternative fuel in the future. It is a clean fuel as it gives out only water while burning. Moreover, it has the highest energy content. It does not pollute air.

Wind energy

Wind energy is obtained with the help of wind mills. When wind blows, they rotate the blades of the wind mills and current is produced in the dynamo. Wind mills are mostly located at Kayathar, Aralvaimozhi, Palladam and Kudimangalam in Tamil Nadu.

Gobar Gas

Gobar gas is obtained by the fermentation of cow dung in the absence of air (anaerobic conditions). It mainly contains methane and a little ethane. It is widely used in rural areas for cooking and operating engines.

Solar Energy

Sun is the first and foremost energy source that makes life possible on our earth. Solar energy is the only viable fuel source of non depleting nature for, sun provides a free and renewable source of energy. It is the renewable type of energy without endangeringthe environment. It is the potential source to replace the fossil fuel in order to meet the needs of the world. With the advancements in science and technology, solar energy has become more affordable, and it can overcome energy crisis. Solar energy is a clean energy. With the minimum efforts maximum energy can be harnessed using various equipments.

Applications of Solar Energy

Solar energy has wider applications in various fields.

- It is used in solar water heater.
- It is used in drying of agricultural and animal products.
- It is used in electric power generation.
- It is used in solar green houses.
- It is used in solar pumping and solar distillation. It is used for solar cooking and solar furnaces also.