Science

Grade - 9

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Preface

The curriculum and curricular materials have been developed and revised on a regular basiswith the aim of making the education objective-oriented, practical, relevant and job oriented.It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in the students and equip them with morality, discipline and self reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledgeof science, information and communication technology, environment, health and population and life skills. It is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, valuesand ideals. It has become the need of the presenttime to make the students aware of respect for ethnicity, gender, disabilities, languages, religion, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens. This textbook has been developed in line with the Secondary Level Science Curriculum, 2071 by incorporating the recommendations of various education commissions and the feedback obtained from various schools, workshops, seminars and interaction programs attended by the teachers, students and parents.

In bringing out the textbook in this form, the contribution of the Executive Director of the Curriculum Development Centre (CDC) Krishna Prasad Kapri, Dr. Hridhaya Ratna Bajracharya, Prof. Dr. Chidananda Pandit, Umanath Lamsal, Parvati Bhattarai, Uttara Shrestha and Puspa Raj Dhakal. Language of the book was edited by Ramesh Prasad Ghimire. The layout of this book was done by Jayaram Kuikel. CDC extends sincere thanks to all those who have contributed in developing this textbook.

This textbook contains a variety of learning materials and exercises which will help learners to achieve the competency and learning outcomes set in the curriculum. Each unit contains various interesting activities and the content required for meaningful learner engagement and interaction. There is uniformity in the presentation of the activities which will certainly make it convenient for the students. The teachers, students and other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning material.

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Content

Unit 1

Measurement

Have you ever purchased daily used items like rice, pulse, milk, oil, clothes, etc. from the market? Can the shopkeepers give you all these items as much as you want without measuring them? The shopkeepers do not give anything without measuring. They give you things like rice, pulse, etc. by measuring them in the kilogram (kg) unit. In the same way, they measure oil in litre, clothes in metre and deliver you the required quantity.

In every school, the bell rings after the fixed period of time (45 minutes) according to the daily class routine. Likewise, the earthquake is measured in Richter scale.

The different physical quantities like mass, volume, length, time, magnitude of earthquake, etc. are measured by comparing with some standard known quantities called units. Kilogram (kg), liter (l) metre (m), second (s), Richter scale, etc. are some of the units of physical quantities.

The standard known quantity which is used to measure a physical quantity is called a unit.

Types of units

The units of the physical quantities have been categorized into two groups. They are:

1. **Fundamental Units**
2. **Derived Units**

1. Fundamental Units

The unit of mass is kilogram, the unit of time is second and the unit of length is metre. The above mentioned physical quantities like time, mass, length, etc. have their own existence. Similarly, their units also do not depend upon other units as well as other units of the measurement do not affect them. Such types of units are called fundamental units. In brief, the fundamental units are defined as:

Those units of measurement which have their own independent existence and do not depend upon other units are called fundamental units.

Let's study the fundamental units from the given table:

S.N.	Physical quantities	Name of the Units	Symbols
1.	Length	metre	m
2.	Mass	kilogram	kg
3.	Time	second	s
4.	Temperature	kelvin	K
5.	Luminous intensity	candela	cd
6.	Electric current	ampere	A
7.	Amount of substance	mole	mol

Figure no. 1. 1: Beam balance and standard masses

Different types of physical devices are used to measure the various fundamental quantities. For example a beam balance is used to measure mass, a watch is used to measure time, a meter scale is used to measure length, a thermometer to measure temperature, an ammeter is used to measure electric current and so on.

Derived Units

The unit of density is kg/m^3 . It includes two fundamental units i.e. kilogram (kg) and metre (m). In the same way, the unit of force is newton (N) or $kgms^{-2}$. In this unit there are three fundamental units i.e. kilogram (kg), metre (m) and second (s). The above units of density and force are derived by the combination of two or more fundamental units. These units fully depend on the fundamental units. Such types of dependent units are called derived units. We can define derived units in the following way.

Those dependent units which are formed by the combination of two or more fundamental units are called derived units.

Various derived units are used in the study of science. Let's study some of the important physical quantities and their derived units from the following table:

Some physical quantities, their derived units and symbols:

Quantities	**Formulae**	**Derived Units**	**Fundamental Units Involved**
Area	length × breadth	metre × metre	m^2
Volume	length × breadth × height	metre × metre × metre	m^3
Density	$\frac{\text{mass}}{\text{volume}}$	$\frac{\text{kilogram}}{\text{metre}^3}$	$Kg/m^3 = kgm^{-3}$
Velocity	$\frac{\text{displacemen}}{\text{time}}$	$\frac{\text{metre}}{\text{second}}$	$m/s = kgm^{-1}$
Acceleration	change in velocity / time	$\frac{\text{metre}}{\text{second} \times \text{second}}$	$m/s^2 = ms^{-2}$
Force	mass × acceleration	kilogram × metre second^2 or newton	kg m/s^2 or N kg ms^{-2} or N
Pressure	$\frac{\text{force}}{\text{area}}$	newton/metre^2 or Pascal	Kg/ms^2 or Pa $=kg\ m^{-1}s^{-2}$ or Pa
Work	force × distance	newton × metre or Joule	kgm^2/s^2 or J $=kgm^2s^{-2}$ or J
Power	$\frac{\text{work}}{\text{time}}$	newton × metre/ second or watt	kgm^2/s^3 or W $=kg\ m^2s^{-3}$ or W
Moment	force × distance	newton × metre	kgm^2/s^2 = kgm^2s^{-2}
Frequency	$\frac{1}{\text{second}}$	$\frac{1}{\text{second or Hertz}}$	s^{-1}or Hz

In this way, the units which depend upon the fundamental units as well as can be expressed in terms of fundamental units are called derived units.

Activity 1

List out the different units used to measure various physical quantities in your daily life. Classify these units into two groups, as fundamental units and derived units and fill in the following table.

Do you know?
A gold smith uses tola unit to measure the quantity of gold. Similarly, till today, in the villages, there is a traditional way of measuring paddy, rice, milk, ghee, etc. by using *mana* and *pathi*.

Fundamental Units	Derived Units

Differences between fundamental and derived units

S.N.	Fundamental Unit	S.N.	Derived Unit
	They do not depend upon other units.	1.	They depend upon fundamental units.
	Till today, only seven fundamental units are used. Examples: kilogram(kg), metre (m),second(s), etc.	2.	Many derived units can be formed from these seven fundamental units. Examples: newton(N), joule (J), Pascal (P), watt (W), etc.

We use a unit along with a numerical value while expressing amount of the physical quantity.

Measurement of a physical quantity = digit × unit

For example, 10 N force, 3 kg mass, etc.

SI System

To bring the uniformity in the measurement all over the world, a conference of scientists was held in 1960 AD in Paris, the capital of France. The conference introduced the different standard units in the measurement. Now, these standard units are being used all over the world.

The system of measurement introduced by the Paris Conference to bring uniformity in measurement all over the world is called **SI system.** Similarly, those standard units of measurement which are introduced by the Paris conference of the scientists held in 1960 AD are called **SI units.** Its full form is System International de'units.

The Paris conference made SI units. These SI units are used by all countries of the world making the measurement system consistent worldwide. According to the SI system, different physical quantities are well defined and their models are made. These models are distributed to different countries of the world to make their prototype. On the basis of these models and their prototypes, different physical quantities are being measured all over the world. So, this system has played a vital role to bring uniformity in the measurement of all the countries of the world. All the fundamental and derived units, given in the third page are SI units.

Do you know?

In SI system, the mass of the cylinder, made from the platinum-iridium alloy and kept at 0^0C in the office of International Bureau of weights and measures in France is called one kilogram. The mass of this cylinder is equivalent to the mass of one liter water kept at 4^0C.

Why is SI unit needed? Think for a while.

You know, in Nepal, gold is measured in *tola* but in other countries of the world, gold is measured in gram or kilogram. If we send three tola of gold to America, the Americans don't know the mass of the gold without measuring it again and they don't know at what cost it should be sold. After measuring, its quantity can be known in gram and then its trade can be done easily. It is difficult to run trade and business at international level by using different units in different countries. So, SI unit is needed to make the transaction easy.

Points to Remember

1. The standard known quantity which is used to measure a physical quantity is called a unit.
2. We use a unit along with a numerical value while expressing amount of the physical quantity, i.e. physical quantity = digit × unit

Example: mass (m) = 2 kilogram (kg)

3. Those units of measurement which have their own independent existence and do not depend upon other units are called fundamental units. For example; unit of length is metre (m), unit of mass is kilogram (kg), unit of temperature is kelvin (k), etc.
4. Those dependent units which are formed by the combination of two or more fundamental units are called derived units. For examples; unit of

force is newton (N), unit of work is joule (J), unit of pressure is Pascal (Pa), etc.

5. Those standard units of measurement which are introduced by the Paris conference of the scientists held in 1960 AD are called SI units. They are introduced to bring uniformity in the measurement all over the world.

Exercise

(A) Tick (✓) the correct answer from the given alternatives.

1. Which one of the following physical quantities is formed after dividing mass by volume?

   (i) Weight (ii) Velocity (iii) Density (iv) Work

2. Which one of the following physical quantities has its S.I. unit m/s?

   (i) Acceleration (ii) Velocity (iii) Force (iv) Density

3. Which one of the following is not a fundamental unit?

   i) Candela (Cd) (ii) Kelvin (K) Ampere (A) (iv) Pascal (Pa)

4. Which one of the following is a derived unit?

   (i) Kilogram (kg) (ii) Watt (W)

   (iii) Second (s) (iv) Kelvin (K)

5. Newton is the derived unit of force. Which of the following fundamental units are involved in it?

   (i) kgm/s^2 (ii) kgm^2/s^2 (iii) kg/m^2s^2 (iv) Kgm/s

(B) Answer the following questions.

1. What is unit? Write down the units of mass, temperature, power and density.
2. Write any three differences between fundamental units and derived units.
3. What is SI system? Why has SI system been developed? Give reasons.
4. What is the unit of pressure? Why is it called a derived unit? Give

reasons.

5. Why is the unit of temperature called a fundamental unit? Give reasons.
6. Find the fundamental units involved in the following derived units.

   (i) Newton(N) (ii) Watt (W) (iii) Joule (J)

   (iv) Pascal (Pa) (v) Cubic metre

7. The standard weights (dhaks) and meter scales of the shops in the market are verified in every two years by the department of measurement of Nepal, Why?

Project Work

Search the different types of units used in your village or city from past to till today. Fill the findings in the table shown below. Which unit would be more reliable between the old one and the new one? Give reasons.

Physical Quantities	**Units Used in the Past**	**Units Being Used at Present**
Length		
Mass		
Time		

Glossary

Unit = the standard known quantity

Frequency = the number of waves produced in one second

Unit 2

Force

While travelling on the bus, what do we feel when it stops or moves suddenly? Why does it happen so? Think for a while. In the same way, when we hit a ball on a wall, it rebounces towards us. Such types of incidents felt by us in our daily life are related to speed, rest, inertia and effect of force. In this lesson, we will study about the scientific facts, principles and rules related to them.

Rest and Motion

Nobody in this universe stays permanently at rest. All the things and objects remain in motion. Flying birds, running vehicles, walking men, etc. are in motion. Our earth is in the state of motion. All the bodies present in this universe such as constellations, galaxies, sun, stars, planets, satellites, etc. are in motion.

We say the houses around us are at rest. Similarly, we say the flying, running, walking and flowing things are in motion. When we say the houses around us are at rest, it means they don't change their position with respect to their surrounding objects. But the moving objects change their position with respect to their surrounding objects. An object may be in motion with respect an object. But at the same moment the same object may be in rest with respect to another object. For example; while travelling in a bus, the passengers in it are at rest with respect to the same moving bus, but at the same time they feel themselves in motion with respect to the trees, electric poles, houses, etc. present along the road side. So, rest and motion are the relative terms. Thus, we can define motion and rest as follows.

Motion: When an object changes its position with respect to its surrounding objects, it is said to be in motion.

Rest: When an object does not change its position with respect to its surrounding objects, it is said to be in rest.

Speed and Velocity

The speed of an object gives information on how it is moving; it means whether it is moving fast or slow. It does not give information about the

direction of its motion. So, **the total distance covered by an object per unit time in any direction is called its speed.** Its SI unit is metre per second (m/s).

$$\text{Speed} = \frac{\text{Total distance covered in any direction (d)}}{\text{Time taken (t)}}$$

Speed is a scalar quantity as it has only magnitude but no direction.

The distance covered by a body in a fixed direction is called **displacement**. It has both magnitude and direction. If a person moves four metre towards east, his displacement is four metre. Here, four metre is magnitude and east is direction.

The total displacement covered by an object per unit time is called its velocity. Similar to the displacement, velocity also has both magnitude and direction. Its SI unit is metre per second (m/s).

$$\text{Velocity} = \frac{\text{Total distance covered in a fixed direction or displacement (d)}}{\text{Time taken (t)}}$$

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

(Where, v= velocity, d= displacement and t= time)

In SI system, the unit of displacement is metre (m) and the unit of time is second. So the unit of velocity is metre per second (m/s).

Velocity is a vector quantity as it has both magnitude and direction.

Example: 1

A motorcycle covers 120 metre distance in four seconds in a straight road. Find its velocity.

Here,

Displacement (d) = 120 metre

Time taken (t) = 4 second

Velocity (v) = ?

We know,

$$\text{Velocity (v)} = \frac{d}{t} = \frac{120}{4} = 30\text{m/s}$$

Do you know?

Penguin falcon is a bird having the fastest speed, whose speed is 349 km/hr. Leopard has the speed of 112 km/hr. Man has average speed of 5 km/hr. In the same way, an aeroplane has the speed of 1100 km/hr.

Uniform Velocity

If an object covers equal distance in equal interval of time in a fixed direction in a straight line, the velocity of the object is called uniform velocity. To become the uniform velocity, the direction of the speed must have a fixed direction. It is not said a uniform velocity if an object is moving in a circle covering the fixed distance in per second. This is because the object changes its direction in every point.

Non-unification Velocity

If an object covers unequal distance in a fixed direction in each second, it is said to be in non-uniform velocity. In the same way, if it covers an equal distance in each second in different directions, it is also said to be in non-uniform velocity. In this situation, the speed of the body is equal but its velocity is unequal.

Acceleration

The velocity of different kinds of objects in our surrounding might be both uniform and non-uniform. According to the situation, sometimes the velocity should be decreased and sometimes it should be increased. In this way, everything might have variation in velocity along with the time. If an object shows unequal velocity in a given interval of time, then the change in its velocity does not become zero. Such type of motion is called accelerated motion.

For example; If you apply more force on the peddle of your bicycle, the velocity of the bicycle increases and if you apply the brake, its velocity decreases. Here, the motion of the bicycle is called accelerated motion.

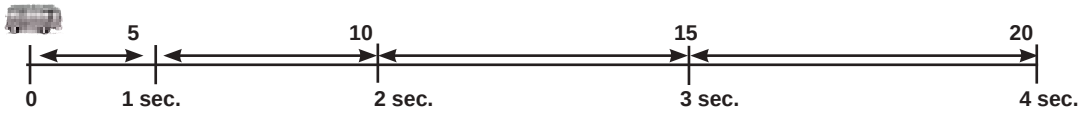
The rate of change in velocity of an object is called acceleration.

$$\text{Acceleration (a)} = \frac{\text{Change in velocity}}{\text{Time taken}}$$

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

(Where, v = final velocity, u = initial velocity, t = time taken)

The SI unit of acceleration is m/s^2. An object has zero acceleration if it moves with the uniform velocity. The negative acceleration is called **retardation**. If the velocity of an object goes on decreasing, it is said to have retardation.



In the given figure, the vehicle has covered 5 m in the first second. After that, it has covered 10 m, 15 m and 20 m in the 2nd, 3rd and 4th second respectively. In this way, the velocity of the vehicle is increasing by 5 metre per second (5 m/s). Hence, the vehicle has 5 m/s^2 acceleration.

In the above figure, the increasing velocity has been shown. If the initial velocity is more than the final velocity, the velocity goes on decreasing. The decreasing rate of velocity in per unit time is known as **retardation**.

Equations of motion

The relation among displacement (s) initial velocity (u), final velocity (v), acceleration (a) and time taken (t) is called equation of motion.

We can derive equation of motion from the definition of average velocity and of acceleration.

Suppose a body is moving with an equal acceleration along a straight line, then

Displacement = s Initial velocity = u
Final velocity = v Acceleration = a
Time taken = t

The relation among a, v, u and t

From the definition of acceleration,

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

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

$$\text{Or, } at = v - u$$

$$\therefore v = u + at \quad \ldots\ldots\ldots\ldots\ldots(i)$$

The relation among s, u, v and t

$$\text{Average velocity} = \frac{\text{Initial velocity + Final velocity}}{2}$$

The total distance covered by an object = Average velocity Time taken

$$\text{Total distance covered (s)} = \frac{\text{Initial velocity + Final velocity}}{2} \times \text{time}$$

$\therefore s = \frac{u + v}{2} \times t$ .....(ii)

The relation among u, a, s and v

The total distance covered by an object = Average velocity Time taken

$S = \frac{u+v}{2} \times t$

or, $S = \frac{u+v}{2} \times \frac{v-u}{a}$ $\left[\because a = \frac{v-u}{t}\right]$

or, $S = \frac{v^2 - u^2}{2a}$

$\therefore$ 2as = $v^2 = v^2 - u^2$ ..... (iii)

The relation among u, v, a and t

The total distance covered by an object = Average velocity Time taken

or, $S = \frac{u+v}{2} \times t$

or, $S = \frac{u+u+at}{2} \times t$ $[\because v = u + at]$

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

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

$\therefore$ $S = ut + \frac{1}{2}at^2$ ..... (iv)

Things to consider

1. If a body is starting from rest, its initial velocity becomes zero. (u = 0)
2. If a body finally comes at rest after covering certain distance, the final velocity becomes zero.(v = 0)
3. If a body is retarding, the acceleration has negative value.

Some solved numerical problems

Example: 1

A vehicle starting from rest accelerated at a rate of 0.5 m/s^2. What is the final velocity of the vehicle after four minute? And how much distance does it cover?

Here,

Initial velocity (u) = 0 m/s

Time (t) = 4 minute

= 4 × 60 = 240 second

Final velocity (v) = ?

Acceleration (a) = 0.5 m/s^2

Distance covered (s) =?

We know,

v= u + at

v= 0 + 0.5 × 240 = 120 m/s

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

Or, $120^2 = 0 + 2 \times 0.5 \times s$

Or, s = 14400 m

∴ s = 14.4 km

Hence, the final velocity of the vehicle is 120 m/s and the distance covered (s) is 14.4 km

Example: 2

A car starting from rest maintains an acceleration of 0.2 m/s^2 upto two minutes. Now, find the distance covered in the given time.

Here,

Time (t) = 2 minutes

= 2 × 60 = 120 seconds

Initial velocity (u) = 0 m/s

Acceleration (a) = 0.2 m/s^2

Distance covered (s) =?

We know,

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

$= 0 \times t + \frac{1}{2} \times 0.2 \times (120)^2$

$= \frac{1}{2} \times 0.2 \times 14400$

= 1440 m

Hence, the distance covered by the vehicle is 1440 m

Example: 3

A car starting from rest accelerated at a rate of 0.5 m/s^2 up to two kilometres. What would be the final velocity of the car and how much time would it take to cover 1.6 km?

Here,

Initial velocity (u) = 0 m/s

Distance covered (s) =1.6 km

=1.6 ×1000 = 1600 m

Acceleration (a) = 0.5 m/s^2

Final velocity (v) = ?

Time (t) =?

According to the formula,

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

$= 0^2 + 2(0.5)1600$

=1600

$v = \sqrt{1600} = 40$ m/s

Again,

$v - u = at$

$t = \frac{v-u}{a} = \frac{40-0}{0.5} = 80$ s

Therefore, the car would take 80 seconds to cover 1.6 km distance and would acquire 40 m/s final velocity.

Inertia

Nothing can change its own position by itself. A body at rest tries to be at rest and a body in motion tries to be in motion in the same direction with the same velocity. Only an external force can change its position. In this way, **the tendency of a body to maintain its state of rest or uniform motion in a straight line is called inertia.**

Types of Inertia

There are two types of inertia. They are:

(A) Inertia of motion (B) Inertia of rest

(A) Inertia of motion

The inertia present in a moving object is called inertia of motion. Due to the inertia of motion, the moving object continues its motion with the same velocity towards the same direction. Let's study some of the examples of inertia of motion.

Due to the inertia of motion, a fan keeps on moving for some time even after the electricity is switched off. Electric fan runs because of electric power, but it keeps on moving even after the electric supply is cut off. The fan should be stopped as soon as the switch is off but it doesn't stop because of inertia of motion.

Due to inertia of motion, the passengers in a moving bus are thrown ahead when the bus stops suddenly. When the bus is in motion, the passengers are also in motion along with the bus but when the bus stops suddenly, the lower part of the passengers come to the rest but the upper part of the body tries to be in motion due to inertia of motion. As a result, the upper part of the body is thrown ahead due to the inertia of motion.

(B) Inertia of rest

The inertia present in a resting body is called inertia of rest. Due to inertia of rest, a resting body tries to be at rest.

Due to inertia of rest, a mango fruit falls down from the branch while shaking it forcefully.

In the beginning, the fruit along with the branch remains at rest. When we shake the branch, it comes into motion, but due to inertia of rest, the mango fruit tries to be at rest. As a result of inertia of rest of the fruit, it detaches from the branch and falls down.

Due to the inertia of rest, the dust particles of the clothes fall down when we beat the clothes.

Relation between Mass and Inertia

We can push a bicycle by applying certain force but we can't push a truck by applying the same magnitude of force. This is because; the inertia of rest of a truck is more than that of a bicycle. Form the given example; we can say that a body having more mass has more inertia and a body having less mass has less inertia. The following activity gives clear concept regarding these facts.

Activity 1

Bring two bricks having different masses and hang them as shown in the given figure. Push both the bricks. Which brick needed more force to push? Think for a while. Surely, it takes more force to push away the full brick. Pull both bricks up to a certain distance and let them oscillate. Now observe, which brick oscillates for a longer time? Obviously, the full brick oscillates for longer time than the half brick. The full brick has more mass than that of half brick. Therefore, it takes more force to push the full brick. Moreover, the full brick needs more time to come into rest than that the half brick. From the above activity we can understand that a body having more mass has more inertia and a body having less mass has less inertia.

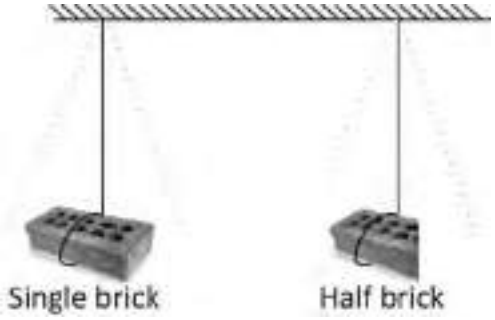


Figure no. 2.1 Oscillation of the bricks

Momentum

It takes more force to bring a body having more mass into rest from the motion. In the same way, it needs more force to bring a body into rest having more velocity. From the statement, it is clear that the magnitude of motion of a body depends on its mass and velocity. So, the magnitude of motion of a body is called its momentum.

Mathematically, **the product of mass of a body and its velocity is called momentum.**

Momentum = mass × velocity

In the above formula, unit of mass is kg and unit of velocity is m/s. So, SI unit of momentum is kgm/s. The momentum of a body at rest is zero.

Momentum of a body depends on the mass and its velocity. A body having more mass and velocity; has more momentum than the body having less mass and less velocity. That is why, while hitting with a badminton cock and a cricket ball, the cricket ball hurts more than the badminton cock.

Newton's Laws of Motion

You might have heard the name of the famous scientist, Newton, of Britain. The laws of motion formulated by him are famous till today. He formulated three laws of motion in 1687. Now, let's discuss these three laws.

Newton's first law of motion

Do the following activity yourself to understand what Newton's first law of motion is.

Activity 2

As shown in the given figure, put the dices of carom upon each other and make a mound. Put the mound on the carom board. Now, hit the lowermost dice of the mound with a large dice or a striker. And observe what happens.

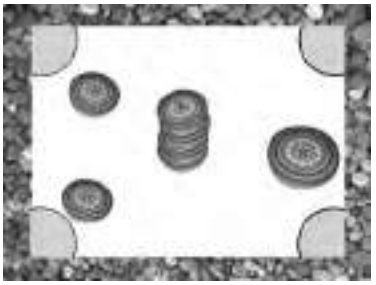


Fig. 2.2 Carom board with mounds of dices

The lowest dice on the mound of the dices comes out from the mound but other dices remain at the same position in the same way. When, the striker hits the lowermost dice, the lowermost dice comes into motion and moves out from the mound. But, other dices over it have no any effect of force and remain at rest. This is why they stay at their own position. On the basis of the given activity, we can define Newton's first law of motion.

Newton's first law of motion states that "**everybody continues to be in its state of rest or uniform motion in a straight line unless an external force is applied on it."**

This law is fully related to the law of inertia. It means that, force is required to change the inertia of rest of a body into inertia of motion and inertia of motion of a body into inertia of rest. Hence, Newton's first law of motion is also called law of inertia. This law also gives the definition of force.

Newton's second law of motion

Newton's second law of motion states that "**acceleration produced on a body is directly proportional to the force applied on it and inversely proportional to its mass"**

Perform the following activities to understand this law.

Activity 3

Effect of force in acceleration

Take a football and strike it with a leg keeping it on the ground. Acceleration is produced after striking the football. Again, strike the football with more force than earlier. Now, more acceleration is produced in the football.

From the above activity, it is clear that **acceleration is directly proportional to the applied force if mass is kept constant.**

Mathematically,

Acceleration (a) α Force (F) (When mass of the body is kept constant)

(Note: In the above example, the mass of the football is constant.)

Effect of mass in the acceleration

Take a spring balance. Pull two objects having different masses with the help of spring balance turn by turn. What difference do you find in the motion of these two objects? Think for a while. More acceleration is produced in the object having less mass and less acceleration is produced in the object having more mass.

From this activity it is clear that, **the acceleration produced in a body is inversely proportional to its mass, if force is kept constant.**

Acceleration (a) $\propto \frac{1}{m}$ (If force is kept constant)

(Note: in the above activity, equal force has been applied in both objects.)

Hence, if force (F) produces an acceleration (a) in a body having mass (m), then from the newton's second law of motion,

Acceleration (a) Force (F) $a \propto F$.....(i) (If mass of the body is kept constant)

Acceleration (a) $a \propto \frac{1}{m}$ .....(ii) (If applied force is kept constant)

Combining both equations,

$$a \propto \frac{F}{m}$$

Or, $F \propto ma$ .....(iii)

$F = kma$ (Here, k is a constant)

In equation (iii) if $a = 1\ m/s^2$, $m = 1$ kg, the value of F becomes 1N. So, in this condition the value of k also becomes 1. Therefore;

F = ma

With the help of this formula, we can solve mathematical problems to calculate force. So, Newton's second law of motion provides measurement of force.

The force which produces 1m/s² acceleration in a body of mass 1 kg is called 1 Newton.

Example 1

A car of 1200 kg mass is moving with the velocity of 50 m/s. After seeing a child on the road, the driver applies brake and the velocity of the car is decreased to 20 m/s in 20 seconds. Now, calculate retardation of the car? How much force does the driver apply in the car?

Here,

Initial velocity of the car (u) = 50 m/s

Final velocity (v) = 20 m/s

Time taken (t) = 20 second

Mass of the car (m) =1200 kg

Acceleration of the car (a) = ?

Force applied in the car (F) = ?

We know that,

Acceleration of the car (a)

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

$$= \frac{20-50}{20} = \frac{-30}{20}$$

$$= -1.5 m/s^2$$

(Here, negative sign shows the retardation)

Again,

$F = ma$

Or, $= 1200 \times 1.5$

Or, $= 1800$ N

Therefore, the retardation of the car is 1.5 m/s² and the force applied in the car is 1800 N.

Newton's third law of motion

Have you walked on a muddy road? It is not as easy to walk on the muddy road as it is on the dry land. The land should apply the upward force on the legs to bear our body weight. But, the muddy land can't apply required force easily. This is why; our legs sink into the mud. When the force exerted by our legs on the ground becomes equal to the force applied by the ground on our legs, we can walk and stand easily balancing our body.

Activity 4

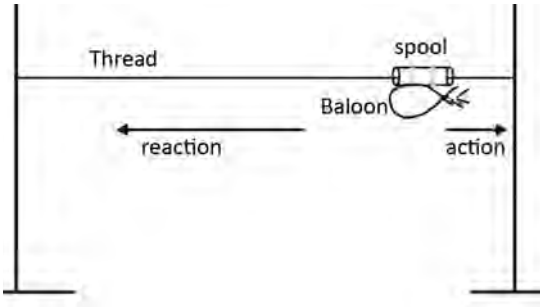


Figure no. 2.3

Take a thin thread and insert it into a small pipe of straw or spool. Now, tie both the ends of the thread to the poles or walls. After blowing a balloon, tie its mouth with a thread and stick it with the pipe of spool as shown in the given figure. Now, release the air from the balloon and observe. While releasing the air from the balloon's mouth, observe the direction of the spool and balloon. When the balloon's mouth is opened, air from the balloon pushes the balloon in the opposite direction opposite the direction of released air. The releasing air from the balloon is an action and movement of the balloon is a reaction. That is why; the air from the balloon and the attached spool move in the opposite directions. On the basis of this activity, we can state Newton's third law of motion.

Newton's third law of motion states that "**every action has equal but opposite reaction"**

The third law of motion describes the features of force. It also proves that forces act in pair. According to this law, every action has equal but opposite reaction. Now, let's discuss the following incidents on the basis of newton's third law of motion.

- ☞ While launching a rocket into the space, the hot gases produced by the rapid burning of fuel rush downward but the rocket goes upward.
- ☞ While firing a gun, bullet moves in the forward direction but the gun recoils in the backward direction.
- ☞ While rowing a boat, water is pulled in backward direction but the boat moves forward.
- ☞ While opening an air filled balloon turning its mouth downward, the air comes down but the balloon moves upward.

Balanced and Imbalanced Forces

If resultant of the applied forces on an object is zero, such forces are called balanced forces. Balanced forces can't bring a body into motion. For example; in the game tug of war, the rope remains steady if both the team apply equal force to the opposite direction.

If resultant of the applied forces on an object does not become zero, such forces are called imbalanced forces. Imbalanced forces bring an object into motion. While pushing a bicycle, frictional force creates obstruction to bring it into motion but our force is more than the frictional force and hence motion is produced in the bicycle. At this time, the resultant of the applied forces in the bicycle does not become zero.

Things to Remember

1. When an object does not change its position with respect to the object in its surroundings, then the position of the object is called rest. When an object changes its position with respect to the objects in its surroundings, then the position of the object is called motion.
2. The total displacement covered by an object per unit time is called its velocity. Its SI unit is metre per second (m/s) and it is a vector quantity.
3. If an object covers equal distance in equal interval of time in fixed direction in a straight line, the velocity of the object is called uniform velocity.
4. If an object covers unequal distance in a fixed direction in equal interval of time it is said to be in non-uniform velocity.
5. The magnitude of motion of a body is called its momentum. It is the product of mass of a body and its velocity. Its SI unit is Nm or kgm/s.
6. The momentum of a body at rest is zero.
7. The tendency of a body to maintain its state of rest or uniform motion in a straight line is called inertia.
8. The inertia present in a resting body is called inertia of rest. The inertia present in a moving object is called inertia of motion.
9. Newton's first law of motion states that "everybody continues to be in the state of rest or uniform motion in a straight line unless an external force is applied on it." Newton's first law of motion is also called law of inertia.
10. Newton's second law of motion states that "acceleration produced on a body is directly proportional to the force applied on it and inversely proportional to its mass". From the definition, we can write $F = ma$.
11. Newton's third law of motion states that "every action has equal but opposite reaction"

Exercise

(A) Tick (✓) the correct answer.

1. What is it called when an object covers certain displacement per unit time?

   (i) Velocity (ii) Speed (iii) Displacement (iv) Acceleration

2. What is the product of mass and velocity called?

   (i) Momentum (ii) Velocity (iii) Moment (iv) Acceleration

3. Acceleration produced in a body is directly proportional to the force applied on it and inversely proportional to its mass. Which Newton's law of motion does it state?

   (i) First law (ii) Second law (iii) Third law (iv) Fourth law

4. To which Newton's law of motion is the lunching of rocket into the space related?

   (i) First law (ii) Second law (iii) Third law (iv) Fourth law

(B) Answer the following questions.

1. What is inertia? Write down the relation between mass and inertia?
2. What is acceleration? What would be the acceleration in a body moving with uniform velocity and why?
3. State Newton's first law of motion and write down any three examples to justify it.
4. State Newton's second law of motion and prove $F = ma$
5. Newton's first law of motion is also called the law of inertia, why? Clarify your answer.
6. An electric fan continues in its motion even after the switch is put off, why?
7. Dust particles fall down when a carpet or a piece of cloth is beaten by a stick, why?
8. While swimming a person pushes water backward, why?
9. A cricket player catches the ball leaning towards to the ground, why?
10. Prove that $s = ut + 1/2\ at^2$.
11. State Newton's third law of motion and write any three applications of it.
12. Prove that $v^2 = u^2 + 2as$.

(C) Solve the given numerical problems.

1. A man is running on the straight road with the uniform velocity of 3 m/s. Calculate acceleration produced by him. [Ans: 0 m/s^2]
2. A motorcycle starting from rest covers 200 metre distance in 6 second. Calculate final velocity and acceleration of the motorcycle. [Ans: a = 11.1 m/s^2 , v = 66.6 m/s]
3. A bus is moving with the velocity of 36 km/hr. After seeing a boy at 20 m ahead on the road, the driver applies the brake and the bus gets stopped at 10 m distance. Now, calculate retardation as well as time taken by this bus to stop. [Ans: a = -10 m/s^2 , t = 1s]
4. A train is moving with the velocity of 45 km/hr. The driver applies brake and the train gets stopped in 6 second. Now, calculate retardation as well as distance covered by the train before coming to the rest]. [Ans: a = 2.08 m/s^2 , s = 112.44 m]
5. A car starting from rest attains a velocity of 90 km/hr in 10 second. Now, calculate acceleration as well as distance covered by the car. [Ans: a = 2.5 m/s^2 , s = 125 m]
6. A car of 900 kg mass is moving at the velocity of 60 km/hr. It is brought into rest at 50 metre distance by applying brake. Now, calculate the force required to stop the car. [Ans: 2500 N]

Project work

Take a kinetic trolley and a spring balance. Prove Newton's second law of motion by showing the relation between acceleration with applied force and mass of the body. Take the help of your teacher if required.

Glossary

Inertia = the tendency of a body to be in its own state

Acceleration = the rate of change in velocity

Mass = the total amount of matter contained in a body

Unit 3

Machine

There is an enamel tin can with tightly fitted cap. If you are given to open the cap, then how do you open it? Can you open this cap easily without using any tool? You cannot open the cap easily without using any tool. For this, take a spoon and insert its one end in between cap and tin can and apply force on the another end. Now, the cap opens easily. The cap which cannot be opened easily with our hands can be opened easily with the help of spoon using less force. What difference can be felt while taking out water from the well using pulley and without pulley? If we do not use pulley, then we need to pull water in upward direction, which is a difficult task. But, if we use pulley, it is easy to pull water in the convenient direction with the help of less force.

Do you know?

Once a man had to lift a heavy load. He brought a long stick and inserted its one end in the lower end of the load and applied downward force from another end. He felt easy to lift the load. From this incident the first simple machine had been invented

The simple tool which makes our work easier, faster and more convenient is called a simple machine.

Some of the examples of simple machines are screw driver, pulley, inclined plane, wheel and axle, sewing machine, fire tong, screw jack, ladder, axe, sickle, etc. To operate these tools no external fuel like diesel, petrol, electricity, etc. is required. We can use these tools only with the help of muscular force. In this unit, we will study in detail about mechanical advantage, velocity ratio, efficiency of these tools and moment.

Mechanical Advantage (M.A.)

Using simple machines we can lift heavy load by applying less effort. Machine makes the work easy. In mathematical term, it is called mechanical advantage. We can define mechanical advantage in the following way.

The ratio of load lifted by a simple machine to the effort applied on it is called mechanical advantage.

$$(M.A.) = \frac{(load)\ L}{(effort)\ E}$$

Mechanical advantage does not have any unit as it is a simple ratio between two forces.

A man lifted a load of 500 N using a simple machine. If he applied 100 N effort, then the mechanical advantage of this machine is (M. A.) = $\frac{500N}{100N} = 5$. From the above example it is clear that, this simple machine helps to lift a load which is five times the effort applied

The simple machine which has mechanical advantage more than one multiplies the effort and the simple machine which has mechanical advantage less than one speeds the doing work. Similarly, the simple machine which has mechanical advantage one makes the work easy and changes the direction of effort.

Velocity Ratio (V.R.)

The ratio of velocity of effort to the velocity of load is called the velocity ratio of the simple machine.

$$\text{Velocity Ratio (V.R.)} = \frac{\text{(Velocity of effort)}}{\text{(Velocity of load)}}$$

If load and effort cover certain distance in the same time, then

$$\text{Velocity Ratio (V.R.)} = \frac{\text{(Distance covered by effort/time)}}{\text{(Distance covered by load/time)}}$$

$$\text{Velocity Ratio (V.R.)} = \frac{\text{(Distance covered by effort)}}{\text{(Distance covered by load)}}$$

$$\text{Velocity Ratio (V.R.)} = \frac{\text{(Effort distance (ED))}}{\text{(Load distance (LD))}}$$

Thus, **the ratio of distance covered by effort to the distance covered by load is called velocity ratio.**

Velocity ratio does not have any unit as it is a ratio of two distances.

By using a simple machine, if effort covers 50 metre distance and load covers 25 metre distance, then the velocity ratio of this simple machine becomes 50/25 =2. From this example it is clear that, in this simple machine distance covered by load is two times less than the distance covered by effort.

Velocity ratio of any simple machine is always more than mechanical advantage because velocity ratio is not affected by friction but mechanical advantage is affected by friction.

Efficiency

The percentage ratio of output work to the input work of a simple machine is called efficiency.

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

Output work: The work done by the load on the simple machine is called output work. Mathematically output work can be written as;

Output work = Work done by the load = Load × Load distance

Input work: The work done by the effort on the simple machine is called input work. Mathematically input work can be written as;

Input work = Work done by the effort = Effort × Effort distance

$$\text{Efficiency } (\eta) = \frac{(\text{Load} \times \text{Load distance})}{(\text{Effort} \times \text{Effort distance})} \times 100$$

$$\text{Efficiency } (\eta) = \frac{(\text{Load} / \text{Effort})}{(\text{Effort distance} / \text{Load distance})} \times 100\ \%$$

$$\text{Efficiency } (\eta) = \frac{(\text{Mechanical advantage})}{(\text{Velocity ratio})} \times 100\ \%$$

$$\therefore \text{Efficiency } (\eta) = \frac{(\text{M.A.})}{(\text{V.R})} \times 100\ \%$$

In each and every machine, the input work is always greater than output work. Thus, no machine has 100 % efficiency. To have 100 % efficiency, all the input work must be converted into output work. But, due to friction, it is not possible to convert all the input work into output work. If a machine has input work equal to output work, then it is called a perfect machine. The machine having equal amount of input work output also has equal mechanical advantage and velocity ratio equal. In such kind of machine, the input work does not lose and all the input work is converted into output work. So, the machine has 100 % efficiency. This type of machine is only possible in the theory.

In the practical life, there does not exist frictionless machine. So, some part of the input work is used to overcome the friction. This is a reason why output work is always less than input work and the efficiency is less than 100 %. We can increase efficiency of a machine by using oil or grease but we cannot make it a perfect machine.

A machine has 80% efficiency. What does it mean?

A machine has 80% efficiency. It means that only 80 % input work is converted into output work and rest 20 % input work is converted into heat and other forms of energy due to friction.

Principle of the simple machine: In the balanced condition the input work is equal to the output work.

Output work = Input work

Load × Load distance = Effort × Effort distance

Mechanical advantage (M.A.) and velocity ratio (V.R.) of the different simple machines

Lever

In any kind of lever mechanical advantage and velocity ratio can be calculated by using the following formulae.

$$\text{Mechanical advantage (M.A.)} = \frac{\text{Load}}{(\text{Effort})}$$

$$\text{Velocity ratio (V.R.)} = \frac{(\text{Effort distance (ED)})}{(\text{Load distance (LD)})}$$

In first class lever, fulcrum lies in between load and effort. In this condition, load distance may be greater or lesser or equal to the effort distance. Therefore, velocity ratio of these machines may be greater or lesser or equal to one.

In second class lever, load lies in between effort and fulcrum. In such condition, effort distance is always greater than load distance. Therefore, velocity ratio is always more than one.

In third class lever, effort lies in between fulcrum and load. In this condition, load distance is greater than effort distance. Thus, velocity ratio is always less than one.

In metal cutting scissors the handle is made longer than that of cloth cutting scissors. So, velocity ratio of the metal cutting scissors becomes more than cloth cutting scissor. As a result, it is easy to cut metal by applying less effort.

Example 1

On the basis of the given figure, calculate efficiency of the lever.

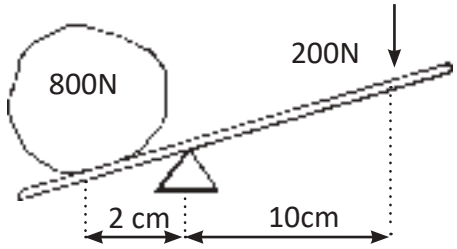


Figure no. 3.1: Lever

Here,

Load (L) = 800 N

Effort (E) = 200 N

Load distance (LD) = 2 cm

Effort distance (ED) = 10 cm

$$\text{Mechanical advantage (M.A.)} = \frac{\text{Load}}{(\text{Effort})} = \frac{(800\ \text{N})}{(200\ \text{N})} = 4$$

$$\text{Velocity ratio (V.R.)} = \frac{(\text{Effort distance (ED)})}{(\text{Load distance (LD)})} = \frac{(10\ \text{cm})}{(2\ \text{cm})} = 5$$

$$\text{Efficiency } (\eta) = \frac{(\text{M.A.})}{(\text{V.R})} \times 100 = \frac{4}{5} \times 100\% = 80\%$$

So, mechanical advantage of the lever is 4, velocity ratio is 5 and efficiency is 80 %.

Pulley

Pulley is a circular disc with groove and rope and can rotate freely about a fixed axis. We use pulley to take out water from a well, to lift heavy loads to the upper floor of a building, etc.

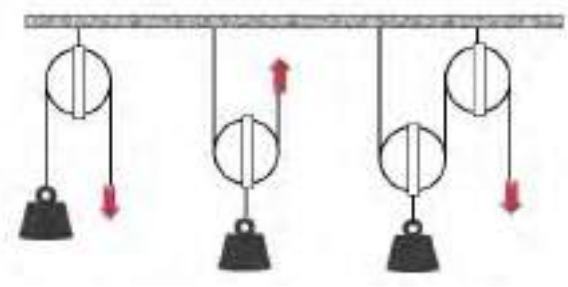


Figure no. 3.2: Fixed and movable pulley

Activity: 1

Connect different types of pulleys. Calculate effort required to lift 0.4 N load in all the pulley systems separately.

Similarly, how much effort is required to lift 0.6 N and 0.8 N loads? To lift load up to 30 cm, how much effort distance is required in all the pulley systems, calculate with the help of metre scale. Put the readings in the given table and calculate velocity ratio, mechanical advantage and efficiency.

Pulley system	Distance covered by load	Distance covered by effort	Velocity ratio	Load	Effort	Mechanical advantage	Efficiency
1. Fixed pulley	30 cm			0.4 N 0.6 N 0.8 N			
2. Movable pulley	30 cm						
3. Block and tackle	30 cm						

There are two types of pulley systems. They are fixed pulley system and movable pulley system. In a single fixed pulley, the velocity ratio is one. In this pulley, mechanical advantage is one or less than one and in absence of friction, load may become equal to the effort. In presence of friction, efficiency of this machine also gets reduced. In a fixed pulley, effort becomes equal to the load even it is in use, why? Fixed pulley changes the direction of the effort. To lift a load without pulley, it requires to pull or lift the load in upward direction directly, which is a difficult task. If we use fixed pulley, we can lift the load in upward direction by pulling the rope in downward direction. Thus, being the load and velocity equal, fixed pulley changes the direction of the effort and makes the work easy.

From the above activity, it is clear that, in the pulley system, the velocity ratio and mechanical advantage increase as the number of pulleys increases. To calculate velocity ratio in the pulley system, we can use the following formula.

Velocity ratio (V.R.) = The number of rope segments used to hold the load
= The number of pulleys used

Note: In a single movable pulley, the velocity ratio is two.

Exercise 2

A pulley system has efficiency 80 %. Calculate mechanical advantage to make its velocity ratio 4. How much amount of effort is required to lift 1000 N load by using this pulley system?

Here, Efficiency = 80 %

Mechanical advantage = 4

Load = 1000 N

Number of pulleys = ?

Effort = ?

Form the formula,

$$\text{Velocity ratio (V.R.)} = \frac{\text{(Mechanical advantage)}}{\text{Efficiency}} \times 100\ \%$$

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

So, the number of pulleys should be 5.

$$\text{Now, Effort} = \frac{\text{Load}}{\text{(Mechanical advantage)}} = \frac{(1000\ \text{N})}{4} = 250\ \text{N}$$

Inclined plane

Slopping roads, steep roads, steps, wooden plank, ladder, etc. are the examples of the inclined plane. Screw nail and jack screw are also provided with spiral inclined plane. Inclined plane is an useful simple machine to lift the heavy load from ground to the certain height. Similar to the other simple machines, incline plane also can lift heavy loads by using less effort.

Mechanical advantage in inclined plane is also the ratio of load lifted to the effort applied.

$$\text{Mechanical advantage (M.A.)} = \frac{\text{Load}}{\text{(Effort)}}$$

The velocity ratio in the inclined plane is the ratio of length of slope to the vertical height of the inclined plane. Mathematically, it can be expressed as;

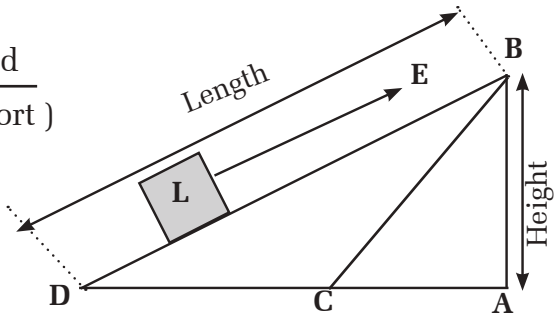


Figure no.3.3: Inclined plane

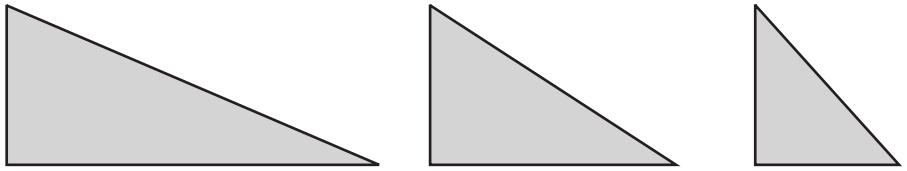
$$\text{Velocity ratio (V.R.)} = \frac{\text{(Length of the slope (d))}}{\text{(Height of the inclined plane (h))}}$$

$$\text{Velocity ratio (V.R.)} = \frac{d}{h}$$

Keeping the height of the inclined plane constant, if we increase the length of the slope, then both mechanical advantage and velocity ratio increase. At the constant height of the inclined plane, if we increase the length of the slope, then the angle of inclination with the ground also decreases. For example, in the above diagram height of the inclined plane is AB and slope of the inclined plane is BC. In the constant height, if slope is made BD in place of BC, then velocity ratio increases because length of the slope increases in BD than in BC. From the above activity, we can conclude that keeping the height of the inclined plane constant if we increase length of the slope, then velocity ratio increases and similarly if we decrease the length of the slope, then velocity ratio decreases.

Activity 2

Bring three wooden planks of the lengths 100 cm, 200 cm and 300 cm respectively. Put these wooden planks inclining on the bench of 80 cm height as shown in the given figure. Take the weight of a kinetic trolley or other similar type of the object with the help of spring balance. Measure the effort required to pull the weight in these wooden planks one by one and fill in the given table.



Experiment No.	Slope of the inclined plane(d)	Height of the inclined plane(h)	Velocity ratio (VR)	Load (L)	Effort (E)	Mechanical advantage(MA)	Efficiency
1.	100 cm	80 cm					
2.	200 cm	80 cm					
3.	300 cm	80 cm					

Answer the following questions.

1. Does mechanical advantage increase as length of the slope is increased?

2. What effect do you find in the efficiency as length of the slope is increased? Write down with the reason.

We can calculate efficiency by using another method.

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

Or,

$$\text{Efficiency } (\eta) = \frac{(\text{Length of the slope} \times \text{Effort})}{(\text{Height of the inclined plane} \times \text{Load})} \times 100\ \%$$

Wheel and axle

Wheel and axles are very important simple machines. They are widely used in our daily life. Screw driver, spanner, handle of the door, bicycle handle, bicycle paddle, etc. are some examples of the wheel and axle.

Wheel and axle is made by combining two cylinders as shown in the figure. The cylinder of the big radius is called wheel and the cylinder of the small radius is called axle. The effort applied on the wheel gets magnified and heavy load can be lifted easily from the axle. The various devices do not have the same structure as the structure of wheel and axle shown in the given figure, but they are based in the principle of wheel and axle.

The ratio of radius of wheel to the radius of axle is called velocity ratio of the wheel and axle. We can use the following formula to calculate velocity ratio of the wheel and axle.

$$\text{Velocity ratio (V.R.)} = \frac{(\text{Radius of wheel (R)})}{(\text{Radius of axle (r)})}$$

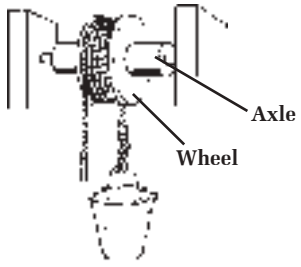


Figure no. 3.4: Wheel and axle

Activity 3

Take a wheel and axle. Wound a rope on the axle and suspend a certain load in it. Similarly, wound a rope on the wheel and tie a spring balance with it. Suspend the spring balance and measure the effort required to balance the load. Repeat the above experiment taking the different weights. Measure the radius of wheel and radius of axle. Put the value of load, effort, radius of wheel and radius of axle in the given table and calculate mechanical advantage, velocity ratio and efficiency.

Experiment no.	Load	Effort	Mechanical advantage	Radius of wheel	Radius of axle	Velocity ratio (R/r)	Efficiency
1.							
2.							
3.							

Answer the following questions.

1. What are the distances covered by the load and effort when the wheel makes one complete rotation?
2. Calculate input work and corresponding output work.
3. What is the efficiency?
4. What factors affect in its efficiency?

Wheel and axle is also called a continuous lever because both wheel and axle continuously rotate around a fixed point or an axis, as well as axis (fulcrum) lies in between load and effort similar to the first class lever.

Figure 3.5: Continuous lever

Moment

When force is applied on an object, then either this object moves in a straight line or rotates in a circular path. While opening or closing the door at our home, the applied force helps the door to rotate around a certain axis. This turning effect of force is called moment. To unscrew a nut we apply force on the spanner. The force applied on the spanner helps to unscrew the nut. Here, the effect seen in the nut is a called moment. Mathematically moment can be expressed as:

Moment = Force × Perpendicular distance from line of action of force to the axis of rotation Or, Moment = F × d

Factors affecting turning effect of force (moment)

1. Magnitude of force.
2. The perpendicular distance from line of action of force to the axis of rotation.

The SI unit of moment is newton metre or Nm.

Activity 4

Take a spanner and fit it with a nut to unscrew. Apply force from another end of the spanner and try to unscrew. Change the point of action of force and reach at the middle of the spanner. Where did you feel easy to apply force in between end and middle?

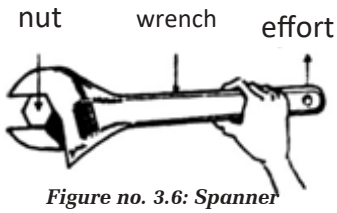


Figure no. 3.6: Spanner

Obviously, you felt easy to apply force at the end of the spanner to unscrew the nut. It means that as the perpendicular distance between force and the axis of rotation increases the magnitude of moment also increases. The magnitude moment is equal to the product of force and the perpendicular distance from line of action of force to the axis of rotation.

Law of moment

Law of moment states that, "**in the equilibrium condition the sum of clockwise moments about a point must be equal to the sum of the anticlockwise moments about the same point."**

Activity 5

Verify the law of moment

Fit the apparatus as shown in the given figure. Suspend different loads on the both sides of the scale. The suspended scale turns in the clockwise direction if there is more load in the right hand side and similarly, the scale turns in the anticlockwise direction if there is more load in the left hand side. Now, suspend the scale making the equal loads on the both sides. Find out load, effort, load distance and the effort distance from the figure. Multiply load with load distance and effort with effort distance. Here, the product of load and load distance becomes equal to the product of effort and effort distance. This experiment verifies the law of moment.

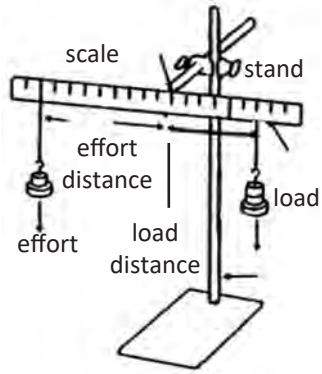


Figure no. 3.7: Moment of Law

Points to remember

1. The simple tools which make our daily works easier, faster and more convenient are called simple machines.

2. The simple machine has simple structure. It does not need any fuel to operate.
3. The ratio of load lifted by a simple machine to the effort applied on it is called mechanical advantage. It does not have any unit.
4. The ratio of distance covered by effort to the distance covered by load is called velocity ratio. It is not affected by friction and does not have any unit.
5. The percentage ratio of output work to the input work of a simple machine is called efficiency.
6. The machine which has both input work and output work equal is called perfect machine. It has 100% efficiency. This type of machine is not possible in our daily life.
7. The turning effect of force is called moment. Its unit is Nm.
8. Law of moment states that, in the equilibrium condition the sum of clockwise moments about a point must be equal to the sum of the anticlockwise moments about the same point.

Exercise

(A) **Tick (✓) the correct answer in the given alternatives.**

1. What is the efficiency of a perfect machine?

   (i) 100% (ii) 90% (iii) 80% (iv) 50%

2. Which work is done by effort?

   (i) Input work (ii) Output work (iii) Both (iv) None of them

3. Which is not affected by friction?

   (i) Mechanical advantage (ii) Velocity ratio

   iii) Efficiency (iv) None of them

4. What is the velocity ratio of a movable pulley?

   (i) One (ii) Two (iii) Three (iv) Four

5. To lift a load in a truck of 2 m height, a wooden plank of 6 m long is made inclined. What would be the velocity ratio of that inclined plane?

   (i) One (ii) Two (iii) Three (iv) Four

(B) **Answer the following questions.**

1. What is mechanical advantage? Write down its unit.
2. What is a perfect machine? Why is this machine not possible in the real life?
3. What is moment? Write down the law of moment. A long spanner is used to unscrew the tight nut, why?
4. A machine has mechanical advantage 2, what does it mean?
5. A simple machine has efficiency 90%. What does it mean? No machine has 100 efficiency, why?
6. Write down the factors on which moment depends upon.
7. How is velocity ratio of wheel and axle calculated? Why is wheel and axle called a continuous lever? Write the correct reason.
8. Mechanical advantage of a machine is always less than velocity ratio. Why?
9. Why is oiling done time and again in a sewing machine?
10. There is a rusted nut. We have two spanners each of 15 cm and 20 cm respectively. Which spanner is suitable to open this nut and why?
11. A tall tree has more chance to break during the storm, why?

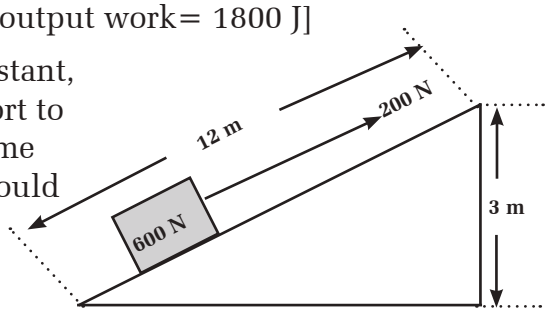
(C) **Solve the given numerical problems.**

1. A lever raised 500 N load using 200 N effort. If load distance and effort distance are 20 cm and 60 cm respectively, calculate mechanical advantage, velocity ratio and efficiency of this lever. [MA = 2.5, VR =3 and = 83.33%]
2. A lever has efficiency 60% and mechanical advantage 4, then
   (i) Calculate effort required to lift 1000 N load. [250 N]
   (ii) Calculate velocity ratio of the lever. [VR = 6.66]
   (iii) Find out output work to turn load up to 20 m. [20,000 Nm]
3. In the given figure of the inclined plane a load is being lifted from the ground. On the basis of the figure answer the following questions.
   (i) Calculate velocity ratio and mechanical advantage of the given simple machine. [VR = 4, MA = 3]
   (ii) Calculate efficiency. [57%]

(iii) Find out output work and input work done to lift the load at the top.

[Input work = 2400 J and output work= 1800 J]

(iv) Keeping the efficiency constant, if we apply only 150 N effort to lift the same load at the same height how much slope should be maintained? [d = 16 m]



4. 20 N effort is used in the 20 cm long spanner to unscrew a nut, then calculate momentum to unscrew the nut. [4 Nm]

Project work

Visit a furniture industry near your house. Look at the different kinds of simple machines used over there. Observe those machines yourself as well as ask the carpenters and fill in the given table.

Name of simple machine	Type of simple machine	Use of the simple machine

Glossary

Output work = the work done by load

Input work = the work done by effort

Perfect machine = the machine which has 100% efficiency

Moment = turning effect of the force

Direction of clock = the direction in which the needles of the clock revolve

Unit

4 Work, Energy and Power

We are doing different kinds of works in our daily life, for example carrying the load, bricks, walking, running, etc. In physics, work is said to be done if force produces displacement on an object in the direction of force applied. The capacity of doing work is called energy. Heat, light, sound, magnet, nucleus, etc. are some forms of energy. Humans and machines have different capacity of doing work. On the basis of capacity of doing work one body does the same kind of work faster and another body slower. The rate of doing work is called power. In this unit, we study about work, energy and power.

Work

Every day you are coming to the school carrying the books, exercise books and bag. Do you know your weight and the weight of your bag? If you do not know, you can find out with the help of pan balance. Certainly, you are applying force coming to the school carrying your bag. In this way, work has been done if distance is covered by applying force. Similarly, work is done to take out water from the well.

In common language, doing any activity is called work. But, in physics **work is said to be done if force is applied on a body and the body covers certain distance in the direction of force applied.** In mathematics, work is the product of force and distance covered by the body in the direction of force applied. To calculate work done by a man or a machine, we can use the following formula.

Work (W) = Force × distance Or, W = F × d

Work is measured in the unit Joule. In the short form joule is denoted by J. The unit of work i.e. joule can be expressed in $kgm^2s^{-2.}$

There are two types of work. The brief introduction of these works is given below.

Work against Friction

When a body covers certain distance on the surface of another body by applying force then it is called **work against friction.** The applied force is used to bring the body in motion against friction. The work done in the

horizontal line is called work against friction, for example driving the car, running on the ground, playing the carom, etc.

Work against Gravity

Lifting a body vertically upward from the ground is called **work done against gravity.** In lifting the body vertically upward from the ground, we apply force against the force of gravity. Thus, it is called work done against gravity. To calculate such types of work we can use the following formula.

Work done against gravity (W) = mgh

(Where, m = mass of the object, g = acceleration due to gravity and h = height)

Example 1:

A man carries 40 kg cement pack to the roof of a building of 16m height. Calculate the work done by him. ($g = 9.8\ m/s^2$)

Here,

Height of the building (h) = 16 m

Mass of the cement (m) = 40 kg

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

Work done (W) = ?

We know that, W = mgh

$= 40 \times 9.8 \times 16 = 6272$ J

Hence, the work done by this man is 6272 J

Energy

You know that human beings are doing various activities in their daily life. Similarly, different types of machines also do different kinds of works. But, the speed of doing work by human beings and the machines varies from each other. While doing work there occurs transformation of energy. Here, energy is the capacity of doing work.

We need energy to do various activities in our daily life. We cannot do any work without energy. We get energy from different kinds of foods. If we sleep throughout the day, even we need food to get energy. The capacity of doing work by a man or a machine is called energy. There are different kinds of energy such as sound energy, light energy, chemical energy, potential energy, etc. These types of energy are explained in the following ways.

(A) Potential Energy

Activity 1

Stretch a catapult along with a stone and release in the open area where there is no one. This stone covers some distance. In this condition the muscular energy is stored in the rubber of the catapult. The stored energy in the stretched rubber is called potential energy. If a brick is lifted from the ground and kept on a table then potential energy is also stored in the brick.

The energy possessed by a body due to its position or change in its shape is called potential energy.

Water stored in a dam also possesses potential energy. This stored energy in water is due to its height or position. If a spring is compressed or twisted or stretched or winded, then its shapes changes. The potential energy stored in the spring is due to change in its shape. While kicking the football or lifting the leg, the shape of the muscle changes and potential energy is stored in it. The above mentioned examples are related to the potential energy. The potential energy can be calculated by using the following formula.

Potential energy (PE) = mgh

After studying above examples, think for a moment. What kind of relation would there be between energy and work? If we observe mathematically, work done against gravity and stored potential energy are equal to each other.

(B) Kinetic Energy

What happens when a bullet fired from a gun hits the bird? The bird is either killed or injured because the bullet has energy. This energy is called kinetic energy. Similarly, the moving objects such as stone released from the catapult, flowing water, blowing wind, etc. also possess kinetic energy. We know that the hydroelectricity is obtained from the flowing water. Similarly, electricity is generated by rotating the fan using blowing wind. The energy possessed by the flowing water, blowing wind, flying birds, running vehicle, etc. is also kinetic energy.

The energy produced as a result of motion of a body is called kinetic energy.

We can perform the following activities to know the factors on which kinetic energy depends upon.

Activity 2

Throw a cricket ball or a similar kind of another ball towards your friend and tell him to catch it. Throw the same ball with a bit more velocity and tell him again, to catches it. What difference did he find? It is difficult to catch the ball if it has more velocity because the ball has more kinetic energy. So, the stored kinetic energy becomes more if the body has more velocity. Thus, it is more possible to get hurt if the ball with greater velocity hits us.

Again, ask a friend to throw a tennis ball with the same velocity and let another friend to catch it.

A cricket ball has more mass than a tennis ball. So in spite of the same velocity, the cricket ball has more kinetic energy and causes more pain. Thus, wicket keepers use globes, while catching a cricket ball.

From the above activity we can conclude that the kinetic energy possessed by a body depends upon its mass and velocity. The kinetic energy of a body is equal to the half of the product of mass and square of its velocity. Mathematically it can be expressed as:

Kinetic energy (KE) = ½ mass × velocity × velocity Or KE = ½ mv^2

Differences between potential energy and kinetic energy

Basis	Potential energy	Kinetic energy
Definition	The energy possessed by a body due to its position or change in its shape is called potential energy.	The energy produced as a result of motion of a body is called kinetic energy.
Examples	Stretched rubber, water in a dam, water tank on the roof of a building, etc. possess potential energy.	Bullet fired from the gun, flying birds, moving vehicle, flowing water, etc. possess kinetic energy.
Formula	Its formula is PE = mgh	Its formula is KE = ½ mv^2

(C) Electric Energy

The energy produced in a body due to the motion of electrons is called electric energy. Electric energy is used to operate different kinds of electrical devices like telephone, radio, mobile, computer, television, heater, rice cooker, etc. Electric energy is used widely because it can be converted into other forms of energy easily, safely and at low cost.

(D) Heat Energy

The energy produced due to the vibration in the molecules of a body is called heat energy. Heat energy is also produced when we burn fire wood, LP gas, kerosene, petrol, etc. From the solar radiation, the earth gets large amount of heat energy.

(E) Light Energy

Light is a form of energy due to which we can see any object. The main natural source of light is the sun. Plants prepare their own food in presence of the sun light. Nowadays, the use of photocells and solar batteries is increasing to convert solar energy into electric energy.

(F) Sound Energy

The energy produced due to the vibration in a body is called sound energy. Sound is identified by our ears. Sound needs material medium to propagate from one point to another. Sound propagates in the form of waves. All the vibrating objects are the sources of sound energy. For example; radio, television, madal, majura, violin, etc.

(G) Magnetic Energy

The energy stored in a magnet is called magnetic energy. Due to magnetic energy a magnet attracts magnetic substances. Electromagnet has magnetic energy. Magnets are used in the modern devices such as radio, mobile, computer, etc.

(H) Nuclear Energy

The energy produced during nuclear fusion and nuclear fission is called nuclear energy. Large amount of energy is produced in these both process. Nuclear energy remains stored in the atomic bombs.

(I) Chemical Energy

The energy stored in the chemical substances is called chemical energy. Diesel, petrol, cooking gas, kerosene, etc. contain chemical energy. The energy stored in these substances can be converted into other forms of energy like heat, light, etc.

Power

Kushal carried 200 N load upto the height 10 metre in 50 seconds. But, Garima carried the same load in the same height in 40 seconds. Is the work done by Kushal and Garima same? What is the difference in work done by Kushal and Garima?

Here, both of them have done 2000 J work. The work done by them is the same, but Kushal took 50 seconds to do 2000 J work and Garima took 40 second to do the same work. So Kushal did 40 joule work in one second but Garima did 50 joule work in the same time. Here, per second work done by Garima is more, hence the power of Garima is more than Kushal.

The rate of doing work is called power. Or in other words, the rate of transformation of energy is called power.

In mathematical form,

$$\text{Power (P)} = \frac{\text{(Work done)}}{\text{(Time taken)}} = \frac{\text{(Energy transformation)}}{\text{(Time taken)}}$$

Or, $\text{Power (P)} = \frac{W}{t}$ (Where w = work done, t = time taken)

Or, $P = \frac{W}{t} = \frac{(F \times d)}{t}$ (Since $W = F \times d$)

Or, $P = F \times v$ (Since $v = \frac{d}{t}$)

Do you know?

$1kw = 10^3 W$

$1MW = 10^6 W$

$1HP = 746\ W$

The unit of work or energy is joule (J) and the unit of time is second. Thus, the unit of power is joule per second or J/s or Watt.

If we know power of a machine, then we can say how fast the machine can do the work. A tractor can plough one ropani field in one hour but another tractor can plough the same field in 40 minute then the power of the later tractor is more than the former one. A pair of bulls takes 5 hours to plough one ropani field and another pair of bulls takes 4 hours to plough the same field, then the power of the later pair is more than the former one.

The meaning of 60 watt is 60 J/s, or a device does 60 J work in one second. If 60 W is written in an electric bulb, then its meaning is the bulb converts 60 J of electric energy into light and other forms of energy in one second.

Comparison between work, energy and power

S.N	Work	Energy	Power
1.	Work is the product of force and distance covered by the body in the direction of force applied.	Energy is the capacity of doing work.	Power is the rate of doing work.
2.	Its SI unit is joule.	Its SI unit is joule.	Its SI unit is watt.
3.	It is not affected by time.	It is not affected by time.	It is affected by time.

Example 1

A man lifts 150 N load in 40 minute up to the height 40 metre. Calculate power of the man.

Here, load (F) =150 N

Distance (d) = 40 m

Time (t) = 40 minute = 40 × 60 second = 2400 second

Work done (W) = ?

Power (P) = ?

We know that,

$W = F \times d = 150 \times 40 = 6000$ J

$$P = \frac{W}{t} = \frac{6000}{2400} = 2.5 \text{ Watt}$$

So, the power of the man is 2.5 Watt

Example 2

A cycle of mass 15 kg is moving with the velocity 40 m /s . Calculate its kinetic energy.

Here, Mass (m) = 15 kg

Velocity (v) = 40 m/s

Kinetic energy (KE) = ?

We know that,

Kinetic energy (KE) $= \frac{1}{2}mv^2 = \frac{1}{2} \times 15\,(40)^2 = 12000$ J

So, the kinetic energy of the cycle is 12000 J

Example 3

A mass of 60 kg is carried up to the height 15 m. Calculate potential energy stored in it. ($g = 10$ m/s$^{2)}$

Here, Mass (m) = 60 kg

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

Height (h) = 15 m

Potential energy (PE) =?

Potential energy (PE) = mgh = 60 × 10 × 15 = 9000 J

So, the potential energy stored in the above object is 9000 J

Points to remember

1. Work is said to be done if force is applied on a body and the body covers certain distance in the direction of force applied.
2. Energy is the capacity of doing work by an object or a man or a machine. Its S.I. unit is joule (J).
3. The energy possessed by a body due to its position or change in its shape is called potential energy. Potential energy (PE) = mgh.
4. The energy produced as a result of motion of an object is called kinetic energy. The kinetic energy of a body is equal to the half of the product of mass and square of its velocity. Its formula is KE = ½ mv^2
5. The rate of doing work is called power. In other words, the rate of transformation of energy is called power. Its unit is J/s or watt (W).

Exercise

(A) Tick (✓) the correct answer in the given alternatives.

1. Which energy is present in the moving bus?
   (i) Kinetic energy (ii) Potential energy
   (iii) Electric energy (iv) Nuclear energy
2. Among the given alternatives which one is the unit of power?
   (i) Joule (J) (ii) Watt (W)
   (iii) Horse power (HP) (iv) Newton (N)
3. Which energy is stored in the pond water?
   (i) Kinetic energy (ii) Potential energy
   (iii) Heat energy (iv) Magnetic energy
4. Which energy is required for photosynthesis?
   (i) Kinetic energy (ii) Heat energy
   (iii) Light energy (iv) Nuclear energy

(B) Answer the following questions.

1. What is energy? Write down its unit.
2. What kind of energy is called magnetic energy? Write down its application.
3. What kind of energy is called mechanical energy? Write down any three differences between potential energy and kinetic energy.
4. Which kind of energy does a bullet fired from the gun possess? How is this energy stored?

5. In an electric heater 500 W is written. What is its meaning?
6. Define power. Write down its formula and unit.
7. Write down the relation between energy and power. Why does the fast working machine possess more power? Clarify your answer.
8. Which kind of energy is stored in the following objects? Write down in the table.

   (i) Compressed spring (ii) Kerosene (iii) Rolling ball

   (iv) Dry cell (v) Magnet (vi) Glowing bulb
9. Which kind of energy is stored in the stretched catapult? How is this energy obtained?
10. What is nuclear energy? Write down any two applications of this kind of energy.

(C) Solve the given numerical problems.

1. A body of 40 kg mass is carried upto the 20 m height. Calculate the energy stored in it. *[Ans: 8000 J]*
2. A motorcycle of mass 100 kg is moving on the straight line with the velocity 20 m/s. Calculate its kinetic energy. *[Ans: 20,000 J]*
3. Calculate the work done when a body of mass 100 kg is displaced 10 m distance with the acceleration 5 $m/s^{2.}$ *[Ans: 5000 J]*
4. Narayan has 70 kg mass. He climbs a stair of 3 m height in 20 second. Calculate his power. *[Ans: 105 W]*
5. A man of 50 kg mass climbs a stair of 20 steps in 40 second. If each step has 25 cm height, calculate power of the man. *[Ans: 62.25 W]*

Project work

Climb the stair of your house. Manage a watch to measure time and calculate time taken to climb the stair. Measure the height of stair with the help of a metre scale. Take your weight if you visit to the nearby health post. With the help of above readings, calculate work done by you and your power.

Glossary

Work = displacing a body by the application of force

Energy = capacity of doing work

Power = rate of doing work

Unit 5

Light

Have you ever observed a pencil after immersing it partly into a glass containing water? Did you find any difference in the shape of the pencil when immersed into the water? What difference do you observe in the position of a coin when it is kept in the glass of water? On analyzing the above mentioned questions, a pencil is seen bent when immersed into water and coin is seen raised above from its actual position when kept in a glass containing water. What is the reason behind this? Discuss. The above effects are due to the refraction of light. In this chapter, we will study about the refraction of light and the nature of light waves.

Refraction of Light

A ray of light passes along a straight line in a medium. But when a ray of light passes slantingly from one medium to another medium, then some of the light rays return to the previous medium and remaining light rays pass into another medium. Hence, the light rays change their direction or get bent.

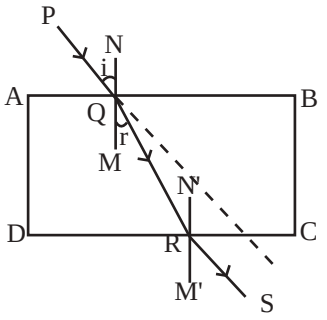


Figure no. 5.1 : ***Refraction of Light***

The process of bending of light rays while passing from one optical medium to another optical medium is called refraction of light.

Activity -1

i. Take a white sheet of paper and put it on a table.

ii. Place a rectangular glass slab on it and draw its boundary ABCD on the white paper with a pencil.

iii. Remove the slab and draw a normal NQM at the point Q on AB as shown in the figure.

iv. Draw a line PQ at the point Q and fix two pins on the line PQ.

v. Now put back the slab at its marked position. Look through the glass slab from opposite side DC and fix two other pins on that side in such a way that all four pins appear to be in the same straight line.

vi. Remove the pins and mark their positions. Draw a straight line through the marked positions and name it RS.

vii. Remove the glass slab and join Q and R as shown in the figure. Draw NM at R as a normal.

Here, PQ is an incident ray. ∠PQN is an incident angle, QR is refracted ray and ∠MQR is the refracted angle. RS is an emergent ray and ∠MRS is an emergent angle.

It is seen that the angle of incident is not equal to the angle of refraction at the time of refraction. The velocity of the light is more in the air than that in the glass. So glass is a denser medium and air is rarer medium in comparison to each other.

Conclusion

i. When a ray of light passes from a rarer medium into a denser medium, it bends towards the normal.

ii. When a ray of light passes from a denser medium into the rarer medium, it bends away from the normal.

iii. When a ray of light passes from one medium into another medium normally, it does not bend.

Causes of Refraction of Light

The velocity of light is different in different media. The velocity of light in air or vacuum is 3×10^8 m/s, in water 2.2×10^8 m/s and in glass 2×10^8 m/s. The velocity of light changes while passing from one medium into another medium. So, a ray bends while passing from one medium into another medium. The more the difference in the velocity of light in two different media, the more it bends.

Comparatively, the medium having more density is called a denser medium and the medium having less density is called rarer medium. When a ray of light passes from rarer medium into the denser medium, the angle of incidence is more than the angle of refraction, but when it passes from denser to rarer medium, the angle of incidence is less than the angle of refraction.

Laws of Refraction of Light

Refraction of light occurs when it passes from one medium to another. The following are the laws of refraction:

i. The incident ray, the refracted ray and the normal lie at the same point on the same plane.

ii. The ratio of Sine of the angle of incidence to the Sine of the angle of refraction is constant for any two given media.

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

(mew) is constant and is called refractive index for any two given media. This is called *Snell's Law*. Refractive index can be calculated as below:

$$\text{Refractive index } (\mu) = \frac{\text{(Velocity of light in air or vacuum)}}{\text{(Velocity of light in any given medium)}}$$

Some illustrations of refraction of light

1. A pencil, partly immersed in water, appears to be bent.

A pencil ABC is obliquely and partly immersed in water as in the given figure. The pencil is seen bent at the point B. The rays C`D and C`E coming from C` are refracted on emerging from water into air. The rays of light C`D and C`E refract at D and E away from the normal as they emerge from water to air. The rays thus refracted fall upon our eyes and it seems as if the light rays are coming from C.

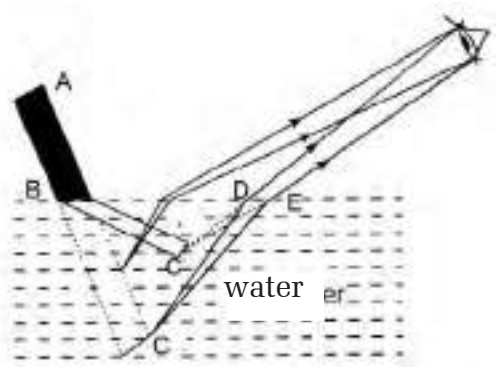


Fig 5.2 Pencil seen bent

Thus C' becomes the image of C and the pencil appears to be bent.

2. A coin kept at the bottom of a glass of water, appears to be raised.

A ray of light AB coming from the coin refracts away from the normal while emerging from water into the air. The refracted ray BC falls into our eyes. The deviated ray AB gets bent. The ray seems to be coming from A'. Thus A' becomes the image of A. As a result, the coin seems raised above from its actual position.

Some examples of the refraction of light are given below. Read them and discuss with friends in the class.

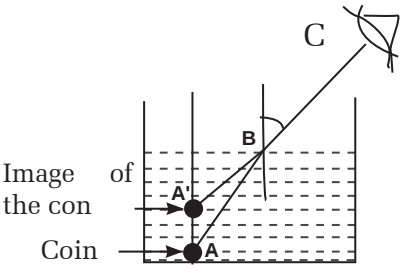


Fig 5.3 Real and apparent depth

Present the conclusion of the discussion to the teacher and make its idea clear.

a) The letters written on the sheet of paper appear to be raised above when a glass slab is kept on it.

b) The legs of a person appear shorter when immersed into a water tank.

c) When outer objects are observed by a person inside water they appear farther than the actual position.

d) A fisherman throws an arrow a bit far from the actual position of the fish in water.

Total Internal Reflection

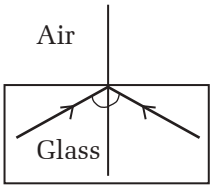


Fig 5.4
Total internal reflection

When a ray of light passes from a denser medium to a rarer medium with the angle of incidence more than the critical angle, the ray is reflected back into the same medium instead of refraction. This process is called total internal reflection. Total internal reflection follows all the laws of reflection. The angle of incidence in a denser medium for which the corresponding angle of refraction in a rarer medium is 90°, is called the critical angle of the given pair of media. The critical angle of water is 49° and that of glass is 42°. The figure given above represents the total internal reflection of light, when it passes from glass to air.

Dispersion of Light

Usually, rainbow is observed on the sunny day when rain fall occurs. Why? Discuss in group. On such day when sunlight refracts on emerging from the water drops, it disperses into the seven colours namely: red, orange, yellow, green, blue, indigo and violet. The band of seven colours is called rainbow.

Activity 2

Make a room dark. Let the sunlight pass inside it through a window or through a small hole on it. Fix a triangular prism on the way to the sunlight and keep a white sheet of paper on the other side of the prism. The light rays that emerge out from the prism are seen colourful. These light rays have seven different colours. Starting from the top of the spectrum, the seven colours will be seen the order red, orange, yellow, green, blue, indigo, violet.

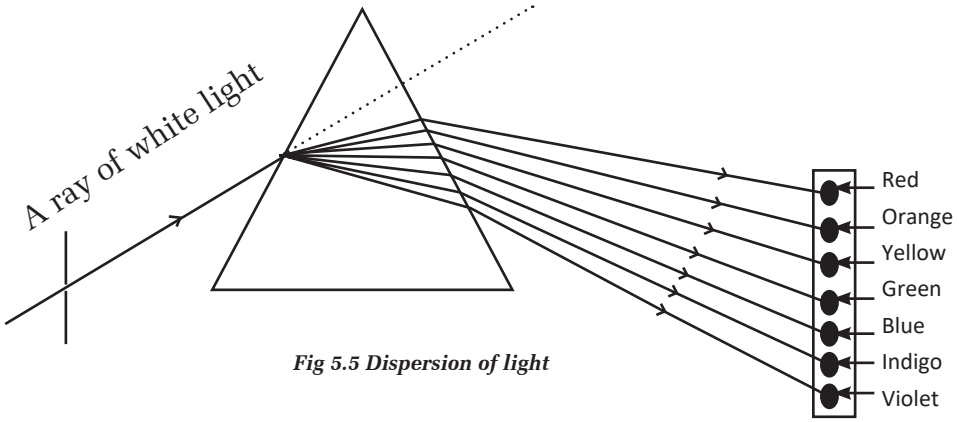


Fig 5.5 Dispersion of light

From the above activity, it is concluded that white light is made up seven different colours. Rainbow is produced due to dispersion of sunlight by the water drops in the air. And a prism also disperses a ray of white light into seven different colours.

Hence, the phenomenon of splitting of a ray of white light into seven different constituent colours is called dispersion of light. A band of seven different colours obtained on the screen or paper when a beam of white light passes through a prism is called the spectrum.

Causes of Dispersion of Light

The main cause of dispersions of light is the difference in the velocity of constituent colours in a medium. The velocity of different coloured rays of light is different in the glass. When a white light falls on the first surface of the prism, the different colours of light deviate/refract towards the base of the prism forming different angles due to their different velocity. Hence, on the first surface of the prism, the seven different colours of the white light separate. Red colour deviates least and violet deviates the most. Hence, different colours of light reach the second surface of the prism forming different angles. Here, refraction of different colours takes place and colours are further separated and emerge out at different angles. These seven colours fall upon screen and can be viewed clearly.

The wave length of red light is the most and has the least frequency. The wave length of violet light is the least and has the highest frequency. The wavelength of red light is 8×10^{-7} m and frequency is 3.75×10^{14} Hz. Similarly the wave length of violet light is 4×10^{7} m and frequency is 7.5×10^{14}Hz. On moving from red to violet light, the wave length gradually decreases but frequency gradually increases.

Electromagnetic Waves

The waves which are not affected by electric and magnetic fields are called electromagnetic waves. They do not require any material medium for their transmission. i.e. they transmit even in vacuum. Light wave is also an electromagnetic wave. There are many rays in the light of sun. Out of them seven colours are detected by our eyes or they are visible to the human eyes-which is called the visible spectrum.

When a white light is passed through a prism, there are some spectra of rays present above the red light and below the violet light. They are invisible to our eyes. It is called invisible spectrum.

Infrared radiations, microwaves, and radio waves have greater wavelengths than the red light. Ultraviolet rays, X-rays and gamma rays have smaller wavelengths than violet light. These waves are harmful to human health. But, they are useful for radio transmission, radiography, radiotherapy etc.

X-ray

The wavelength of X-ray is 0.01 nm to 10 nm. They easily penetrate into the skin and muscles but not into the bones. The uses of X-rays are given below:

i. To find cracks in the bones.

ii. For radiotherapy.

iii. To study the molecular structure of a crystal.

iv. For security check in the airport, custom office etc.

Excessive use of X-rays may cause cancer in human body.

Ultraviolet Ray

The wavelength of ultraviolet ray is 10 nm to 400 nm. These ultraviolet rays should not be exposed to the human body for a long time. They may cause skin cancer and eye cataract. Ultraviolet rays are used for the following activities:

i. To find the purity of jewelleries, eggs, ghee etc.

ii. For the sterilization of medical instruments

iii. To produce vitamin D in the body of plants and animals.

Things to Remember

1. The process of bending light while passing from one medium to another is called refraction of light.
2. Due to the difference in velocity of light in different media, refraction of light occurs.
3. A pencil partly immersed in water appears to be bent and the depth of pond appears less due to refraction of light.
4. When a white ray of light passes through a prism, it splits into seven constituent colours, which is called dispersion of light.
5. Out of the seven colours seen on the screen, red light has the longest wavelength and least frequency.
6. A ray having shorter wavelength bends more and a ray having longer wavelength bends less while passing from one medium to another.
7. Electromagnetic waves are those which are not affected by magnetic and electric field. They can transmit without any material medium.
8. All the rays of sunlight are not visible to our eyes. A band of rays visible to our eyes is called visible spectrum and one which is not visible to our eyes is called invisible spectrum.

Exercise

A. Tick (√) the right answer in the following multiple choice questions.

1. What is the process called when a white light of sun splits into seven colours?

   i) Dispersion ii)Refraction iii) Reflection iv) Synthesis

2. In which direction does a ray of light bend when it passes from air to water?

   i) Away from normal ii) Towards normal

   iii) Straight upward iv) Straight downward.

3. When dispersion of light takes place through a glass prism, which coloured light remains at the top?

   i) Red ii) Yellow iii) Violet iv) Blue

4. Which light wave has the greatest frequency?

   i) X-ray ii) Gamma ray iii) Microwave iv) Radiowave

B. Answer the following questions:

1. What is the refraction of light? Write its laws.
2. Define denser medium and rarer medium with examples.
3. What is the cause of bending of the light on passing from one medium to another medium?
4. A pencil partly immersed in water appears to be bent, why?
5. A coin kept in a glass of water appears raised above from the bottom, why?
6. What is meant by total internal reflection? Write the value of critical angle of glass and water.
7. When outer objects are observed from inside water, they appear at more distance, why?
8. What is dispersion of light? Draw a diagram of dispersion of light through prism and name seven coloured rays of spectrum.
9. Describe the reason of rainbow formation during rainfall in the sky.
10. Mention the uses of X-ray and Ultraviolet ray.

Project Work

1. Take a Newton's disc and rotate it faster. What do you see during rotation? Observe it and find its reason. What does it prove?
2. Take a glass slab. Put it at the centre of a white sheet of paper. Send red light slantingly using laser light on your side of the glass slab. Observe the path of the red light and draw a line along it with the help of a scale. Present it among the friends of your class and discuss.
3. Put water trough slantingly in the sunlight in such a way that the light immersed from water falls on the shadowed wall. What different colours of light do you see on the wall? Observe and describe with reason.

Glossary

Spectrum : A band of rays of different colours seen on the screen after the dispersion.

Critical angle : The angle of incidence in the denser medium when the angle of refraction is 90° in the rarer medium.

Sterilization : Cleaning the medical equipment or other instruments to make them germ free.

Radiotherapy : The method of destroying cancerous cells using electromagnetic rays of short wavelength.

Unit

6

Sound

Everyday sounds of human beings, birds, bell, machine, vehicles, TV, radio etc. are heard. Such objects which produce sound are called sources of sound. Sound is also produced while clapping. If so, how are such sounds produced and heard? Think for a while.

There are different forms of energy. Sound is one of them. It gives the sensation of hearing to our ears. When an object vibrates, sound is produced. Sound transmits through a material medium like solid, liquid and gas. In other words, sound waves cannot propagate without any material medium. Sound may be sharp or flat. Like light, sound also reflects and refracts. On the basis of source of sound and the distance of object on which it reflects, echo and reverberation can be heard. In this chapter, we will discuss about the nature of sound waves, its sources, reflection and refraction of sound, intensity of sound, pitch, velocity and importance of echo.

Nature of Sound Waves

Activity 1: **Sound comes from vibration of object.**

Take a tuning fork. Strike it on a rubber pad and bring it closer to your ears. Do you hear sound? Touch the tuning fork with your fingers and feel the vibration. How do you feel? Share your experience among the friends.

Activity 2: Production of sound waves and its transmission.

Suspend a table tennis ball with the help of thread as shown in the figure. Make a vibrating tuning fork touch that ball gently. What happens? Observe and discuss in the class.

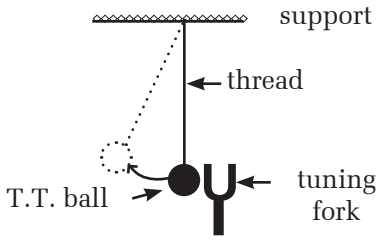


Fig 6.1 Vibration of tuning fork

While striking in this way, the molecules of an object vibrate and sound is produced. If the sound waves produced from a source propagate through mean position of the

molecules, such waves are called longitudinal waves. Sound waves are longitudinal waves. Sound waves are the mechanical waves as they require a material medium for their transmission.

Production and transmission of Longitudinal Waves:

Activity - 3

See a wooden cork putting closer to the surface of a pond where a stone has been thrown. How does cork reach upto the edge? Explain after careful observation.

If the direction of wave transmission and the direction of vibration of molecules become the same, such wave is called longitudinal wave. When one end of long spring is tied at a fixed point and another end is stretched and compressed time and again, the rings in the spring vibrate to and fro along the length of the spring and longitudinal wave is produced. It is seen that the rings of the spring come closer to each other at a place and at another place, the rings are far from (not so closer) each other. The part of the spring where rings are closer is called compression and the part where rings are further is called rarefaction.

Molecules before vibration

Molecules after vibration

Characteristic of sound waves

Frequency:

The number of complete waves produced in one second is called frequency. It is denoted by '*f*'. In SI System, it is measured in Hz. Some other units of frequency are kilohertz, megahertz, and gigahertz.

Time Period: The time taken for the production of one complete wave is called time period. It is denoted by 'T' and its SI unit is second.

f complete waves are produced in 1 second.

1 complete wave is produced in $\frac{1}{f}$ second.

$\therefore$ Time period (T) $= \frac{1}{\text{(frequency)}}$

i.e. $\left(T = \frac{1}{f}\right)$

Wavelength:

The distance covered by a sound wave during one complete vibration is called wavelength. It is denoted by Greek letter (λ) and its SI unit is meter (m).

Amplitude:

The maximum displacement of a sound wave at the time of its transmission from its mean position is called amplitude. It is denoted by 'a' and its SI unit is meter (m).

Wave Velocity:

The distance covered by the sound wave per unit time is called wave velocity. It is denoted by 'v' and its SI unit is meter per second (m/s).

The formula that shows relationship among sound wave, frequency and wave velocity is called wave equation.

i.e.

wave velocity(v)= frequency(f) $\times$ wavelength (λ)

or $v = f \times \lambda$

Example

Find the velocity of sound having 200Hz frequency and wavelength 3.3 m.

Here, Frequency (f) = 200 Hz

Wavelength (λ) = 3.3 m

Wave velocity (v) = ?

We know

Velocity of sound (v) = Frequency (f) × Wavelength (λ)

Or v = 200 Hz × 3.3 m

Or v = 660 m/s

∴ Velocity of sound (v) = 660 m/s.

Relationship between velocity of sound and medium

Sound needs material medium- solid, liquid or gas for its transmission. But the velocity of sound is different in different media. The velocity of sound is less in gases and more in solids. The molecules in solids are very close to each other. As soon as the sound wave pushes one molecule, another molecule gets pushed and wave transmission occurs faster. As a result, the velocity of sound is more in the solids. On contrary to it, due to very loose arrangement of molecules in gases when one molecule is being pushed by wave, it takes time for the molecule to strike another molecule. As a result the wave reaches latter to the next molecule. Thus, the velocity of sound becomes minimum in the gaseous substances.

Velocity of sound at 0°C in different media

Medium	Carbon dioxide	Air	Hydrogen	Water	Glass	Aluminum	Steel	Granite
Velocity(m/s)	258	332	1270	1500	5000	5100	5200	6000

Velocity of sound in air:

Velocity of sound depends on the following factors. These factors help to find or compare the velocity of sound in different air conditions.

1. **Density of air:** Sound travels faster in gases of lower density and vice versa.
2. **Temperature of air:** Higher the temperature of air, lower is the density of the air. So, the velocity of sound is more in hot air and less in cold air.
3. **Humidity of air:** The presence of water vapour in air is called humidity of air. The sound travels faster in more humid air.
4. **Direction of air molecules:** If the direction of wave transmission is the direction of the motion of air molecules, the velocity of sound increases. But it decreases in the opposite direction.

[Note: velocity of sound does not depend on pressure, pitch and amplitude]

Spectrum of sound wave:

A collection of sound wave of different frequencies is called spectrum of sound wave. The frequency of sound wave ranges from 1 Hz to 10^8 Hz. Frequency of sound is different in the different sources. Even the sound with the same velocity may have different frequency. Children and girls produce sharp sound due to higher frequency of their sound. Adult men produce hoarse sound. The frequency of the sound of men is about 6.5 KHz and that of women is 8.5 KHz. Sound of all frequency level is not heard to the human ear. Human ear can hear the sound of frequency ranging from 20 Hz to 20 KHz.

a) Infrasound:

The sound waves having the frequencies below 20 Hz is called infrasound. It is also called subsonic sound or subsound. Such sound cannot be heard to the human ears but can be felt when touched. This type of sound is produced during earthquake and volcanic eruption. Whales and Elephants produce infrasound. Rhinos also produce sound below 6 Hz.

b) Audible Sound:

Sound with the frequencies ranges between 20 Hz to 20 KHz is called audible sound. It is heard to the human ear. Sound of guitar, sound produced while singing song, sound on tuning radio are some examples.

c) Ultrasound:

Sound with frequency more than 20 KHz is called ultrasonic sound or ultra sound. It is not heard to the human ear. Animals like bat, rat, birds and insects can produce and hear this sound. Since it has higher frequency, it has higher energy level. It is widely used in the medical field to examine the internal parts of the body.

Application of Ultrasound:

The sound waves of more than 20 KHz frequency are ultrasounds. They have short wavelength. They transmit from one place to another without deviation and without diminishing energy. With the help of ultrasound, doctors detect the growth and sex of the baby in the womb of mother. It is useful for operation, destroying bacteria, to diagnose the internal disease, to find tumor and its location.

To measure the depth of sea, sonar is used. It has a vibrator of higher frequency source and receiver or detector. Ultrasonic waves are sent from the surface of the sea to its bottom/bed and the reflected waves are received by the receiver. Besides this, the total time taken by the sound wave from its production to its return to the surface is recorded. Hence the depth of the sea is calculated.

Do you know?
Dogs and cats can not produce ultrasound but can hear

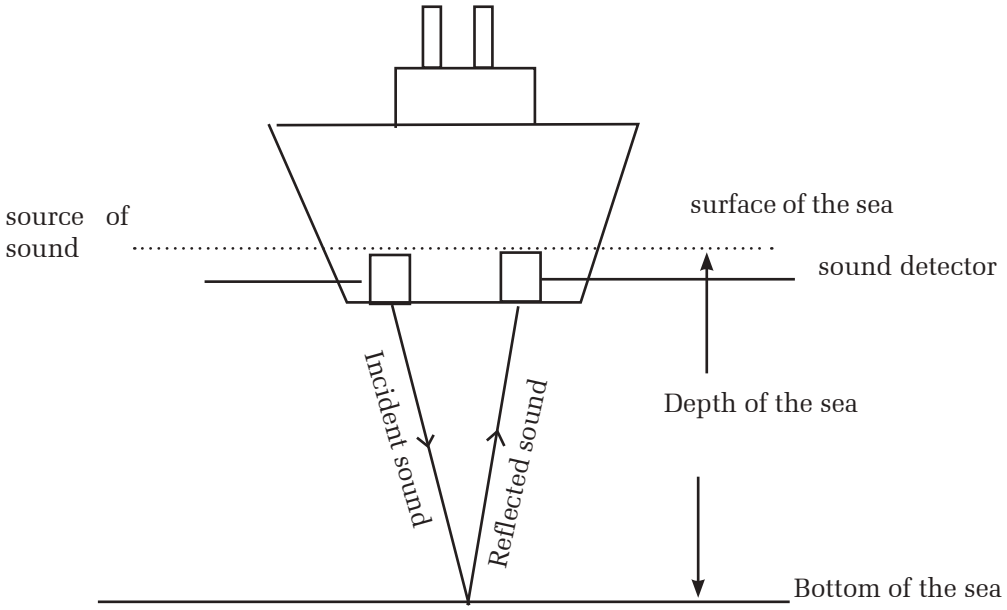


Fig. 6.2. Sonar

Example:

What is the depth of a sea if echo is heard after 4 sec. of sending sound from a ship towards its bottom? The velocity of sound in water is 1500 m/s.

Here,

Velocity of sound in water (v) = 1500 m/s

Total time taken (2t) = 4 sec.

or t = 2 sec.

Depth (h) = ?

We know,

Velocity of sound (v) =

Depth of sea (h) = velocity of sound (v) × Time (t)

= 1500 × 2 m

= 3000 m

∴ The depth of sea (h) = 3,000 m.

Reflection of Sound

Like light waves, sound waves also reflect. When sound waves strike on the wall of a building, surface of a hill, surface of rock etc., they reflect back towards the source, which is called reflection of sound. Hence, the process of returning back of a sound after striking on a hard surface is called reflection of sound. Echo and reverberation are the effects of reflection of sound.

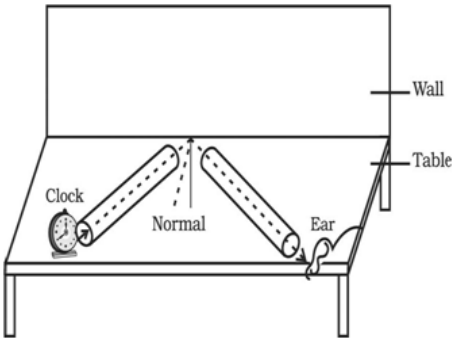


Fig 6.3 Reflection of sound

Echo:

When we speak loudly standing near a hill, we hear original sound and echo. If the reflecting surface is closer to the source of sound, echo cannot be heard. For hearing echo, the distance between source of sound and reflector must be at least 17 m. So, if the sound produced from a source reflects after striking on a surface which is at a distance of more than 17 m., it is called echo.

Conditions for occurrence of echo:

1. The distance between the source of sound and its reflector must be at least 17 m.
2. There should not be any sound absorbing material on the way to the sound waves.
3. The intensity of the sound must be higher enough to hear even after reflection.

The reflected sound that reaches our ears in more than 0.1 sec. can only be distinguished from the original sound.

Suppose, the source and reflector of sound are at the distance of x m. The velocity of sound waves in air is 332 m/s. So, the distance traveled by sound at 0.1 sec. is $2x$ m.

Here, velocity of sound in air (v) = 332 m/s.

Distance covered by sound (s) = $2x$ m.

Time (t) = 0.1 sec.

Distance covered by sound waves ($2x$) = velocity of sound in air × time (t)

i.e. $2x = 332 \times 0.1$ m

$2x = 32.2$ m

$x = 33.2/2$ m $= 16.6$ m.

∴ The minimum distance required for hearing echo is about 17 m (16.6 m).

Reverberation

When we speak in an empty room, sound gets reflected many times and gets mixed with original sound, which prolongates the sound and makes it sharper.

Hence, when source of sound and reflecting surface are at the distance of less than 17 m, it reflects, mixes with the original sound and prolongates. If is called reverberation.

The sound absorbing materials are fixed on the walls of cinema halls to prevent the mixing of reflected sound with original sound so that audiences can hear the original sound clearly.

Conditions required for reverberation

a) The distance between the source of sound and reflecting surface must be less than 17 m.

b) There should not be any sound absorbing materials on the way of the sound waves.

Differences between echo and reverberation

Echo	Reverberation
i. It is a process of reflection of sound waves after striking on the hard surface. ii. The distance between source of sound and reflecting surface is more than 17 m. iii. Intensity of echo is less than the original sound.	i. It is a prolongation of sound after mixing the reflected sound with original sound. ii. The distance between the source and the reflecting surface is less than 17 m. iii. Intensity of reverberation is more than the original sound.

Application of reflection of sound

The reflection of sound is useful for the following works:

a) To find the depth of sea, pond using echo.

b) To find the tumor in brain, stone in kidney.

c) To know the developmental condition of the growing baby in the womb of a mother.

d) For the geologists to predict the minerals.

e) For the soldiers to find the condition of guns of the enemies.

f) To make programs more melodious through reverberations.

Refraction of Sound

Sound refracts like light. The velocity of sound changes while transmitting it from one medium to another. Air may become both rarer or denser due to the difference in temperature. So, refraction of sound occurs even in the air only.

The process of bending of sound waves on passing from one medium to another is called refraction of sound.

When sound waves pass from denser to rarer, they bend away from normal but they bend towards the normal when they pass from rarer to denser medium.

More clear sound is heard at night than in day time, why?

During the day, the land gets heated due to solar radiations. At the time, the air molecules closer to the land also get heated. As the height increases, atmospheric temperature gradually decreases. At this time, upper layer of air acts as a denser medium and lower layer acts as a rarer medium. When the sound waves travel from lower layer to the upper layer of the air, they

bend towards the normal and finally reach high above the earth surface and do not return back.

During night, the land cools gradually due to absence of solar radiations. The

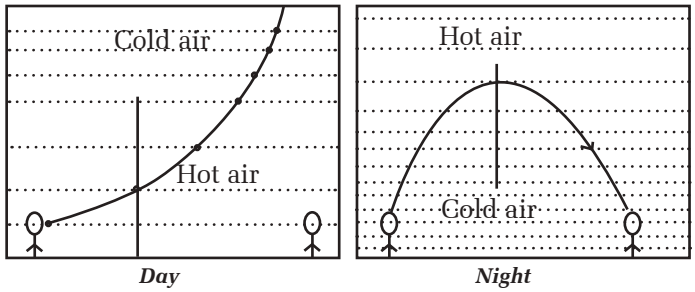


Fig 6.4 Sound transmission during day and night

temperature of lower layer of air is less than the upper layer. As a result lower layers of air act as a denser medium and upper layer as a rarer medium. When sound travels from lower layer to upper layer of air, it bends away from the normal. It refracts again and again and finally returns back towards the earth by total internal reflection. Thus, sound is heard more clearly at night.

Intensity of Sound

Sound waves carry sound energy. The energy carried by sound waves per second from the source is called intensity of sound. Sound with high intensity has more loudness. The loudness of sound is measured in decibel (dB).

Intensity of some sounds

Sound / Activities	Loudness of sound
Whisper	0 – 20 dB
Environment of library	20 – 40 dB
Conversation	40 – 60 dB
Heavy traffic on the road	60 – 70 dB
Sound from press	70 – 80 dB
Railway Station	85 – 110 dB
Motor Cycle	110 – 120 dB
Threshold of pain	120 – 140 dB
Problem in the machine	140 – 160 dB

Do you know?

Sound with intensity more than 120 dB harms our ears

Do you know?

The sound ranging from 65 dB to 40 dB is hard of hearing and the condition of not hearing the sound of intensity up to 80 dB is called deafness. Sound of high intensity harms our ears.

During the transmission of sound, sound energy gets transmitted through its waves. Each wave carries energy every second from the source of sound. When the energy of a wave is higher, it has greater amplitude. The intensity of sound increases, with the increase in its loudness and vice versa.

Factors affecting the intensity of sound

1. **Amplitude:** The intensity of sound is directly proportional to the amplitude of sound.
2. **Distance of listener from the source:-** The intensity of sound decreases as the sound moves away from its source. When the sound transmits in air, certain amount of sound energy is absorbed by air molecules and certain amount gets reflected. The remaining amount of sound energy gets transmitted. So, on increasing the distance of the listener from the source of sound, intensity of sound gradually decreases.
3. **Density of medium:** In the gaseous medium, the intensity of sound is directly proportional to its density. As the density of colder air is more than that of hot air, the intensity of sound is more in the cold air than in the hot air.
4. **Area of vibrating body:-** If the area of vibrating body is larger, the intensity of the sound is higher. For example, in the industrial area, the large sized bell produces sound of higher intensity.
5. **Frequency of sound:-** The intensity of sound is directly proportional to its frequency.

Pitch of Sound

The sounds heard in our surrounding area are of different nature. Some sounds are flat while others are shrill. Sound of low pitch is flat and the sound of high pitch is shrill. The pitch of sound helps to distinguish the flat or shrill sound. As it is not a physical quantity, it does not have any unit. It depends on frequency of sound. Pitch of sound increases with the increase of frequency and vice versa.

Following examples make it clearer

1. The pitch of sound produced by a thin wire of guitar is higher than the pitch produced by a thick wire.
2. The pitch of a baby's sound is more than the adult one.
3. The pitch of a sound produced by a long flute is more than that of a shorter one.

Activity 4

Put a sonometer at the end of a table. Suspend two wires, one thinner and another thicker, tying and passing over two separate pulleys as shown in the figure . Fix one kilogram mass at the end of each wire. Now, vibrate the wires to produce sound from each wire turn by turn and listen carefully.

1. Which wire has more frequency, thinner or thicker?
2. Which wire produces sound of high pitch?
3. What is the relation of pitch of sound with the thickness of wire?

Fig 6.5 Sonometer

The frequency of thick wire is less. The pitch of sound produced by a thin wire is higher and the sound is sharp. Because of equal masses tied at the end of each wire, both wires have got the same tension. When the tension becomes equal in both the wires, the frequency and the pitch of the thin wire are more than that of the thick wire.

Speed of Sound

Speed of sound is different in different media. But it remains the same in a particular medium. Speed of sound is the distance covered by the sound waves in unit time.

Mathematically,

$$\textit{Speed of sound} = \textit{wavelength} \times \textit{frequency}$$

Wavelength is measured in meter and frequency is measured in hertz. Its unit is m/s. There is no difference in the speed of sound even if there is change in wavelength and frequency of sound in a particular medium. It happens because wavelength decreases on increasing the frequency and wavelength increases on decreasing the frequency.

Noise

Sound is necessary for all of us. We express our opinion by producing sound. We know that there are different sources of sound. Some sounds produced from these different sources make positive effects on human mind and some produce negative impact. The sound which produces negative impact on the human beings is called noise. It causes pollution in an environment called noise pollution.

Noise makes communication difficult, difficulty in concentration, causes

increase in blood pressure, problem in nervous system, stress, brings deafness, dizziness and feeling of tiredness (fatigue). By planting trees on both sides of a road and around the industrial area, using silencers in aircraft engines, trucks etc. establishing human settlement area away from airports and industries, the effects of noise to the human being can be minimized. The impact of noise can be reduced by offering the chance of using ear muffs to the labourers of a factory and through awareness programmes.

Activity 5

a) Draw a diagram showing sound waves in your note book with the help of a pencil

b) If you are kept at a place blindfolded how do you distinguish whether you are kept in the room full of materials or in an empty room or open place?

c) By hearing or recording the sound of different animals, find which animals produce sound of low or high intensity .

Things to remember

1. Sound is produced by the vibration in the object and gets transmitted in the form of mechanical wave.
2. If the vibration of molecules takes place along the direction of wave propagation, it is called longitudinal wave.
3. The distance between any two successive compression or rarefaction is called wavelength in case of longitudinal wave.
4. The number of complete waves produced in one second is called frequency.
5. The speed of sound in a gaseous medium depends on its temperature, density, direction of wind and humidity of air.
6. The sound wave of frequency 20 Hz to 20 KHz heard to the human ear is called audible sound. The sound wave having frequency less than 20 Hz is called infrasound and the sound having frequency more than 20 KHz is called ultrasound.
7. As the pitch of sound depends on its frequency, the pitch increases with the increase in frequency.
8. Sound having high amplitude possesses more energy. As a result, such sound is louder.

9. When sound is reflected from a surface at the distance less than 17 m., it gets mixed with original sound and prolongation of sound occurs. The phenomenon is called reverberation.

10. If the reflecting surface and source of sound are at the distance more than 17 m., the original sound and reflected sound is heard clearly. It is called the echo.

11. At night, sound refracts more and more and finally its total internal reflection takes place. So, distinct and clear sound is heard.

12. Noise is an unwanted / unpleasant sound which pollutes the environment and harms the human health.

Exercise

A. Tick (√) the right answer in the following multiple choice questions.

1. What is the time required to define frequency?

   i) 1 sec. ii) 2 sec. iii) 3 sec. iv) 4 sec.

2. What is the frequency of audible sounds?

   i) 2 Hz to 20 Hz ii) 20 Hz to 20 KHz

   iii) 20 Hz to 200 KHz iv) 20 Hz to 200 Hz

3. What is the minimum distance of a reflecting surface from the source of sound to produce echo?

   i) 10 m ii) 20 m iii) 17 m iv) 27 m.

4. What happens to the pitch of sound when frequency is increased?

   i) Increases ii) Decreases iii) No change

   iv) Sometimes increases and sometimes decreases

5. What happens to the loudness of the sound when its amplitude is higher?

   i) High ii) Low iii) No difference iv) High or low.

B. Answer the following questions:

1. There is no effect in the velocity of sound even if there is a change in the frequency and wavelength of sound, why?

2. Define pitch and intensity of sound.

3. What is the frequency of the sound wave which is heard to the human ear?
4. Show the relationship between wavelength frequency and speed of sound.
5. What is ultrasonic sound? Name two animals which produce and can hear ultrasound.
6. Write any two differences between

   i) Echo and Reverberation

   ii) Intensity of sound and pitch of sound.
7. Write any two effects of sound waves of higher intensity to the environment and write any two ways to minimize it.
8. What is ultrasound? Write any two uses of it.
9. Draw a diagram showing two waves in such a way that they have same wavelength but different amplitude.
10. Sound can more clearly be heard during night than in the day time, why?
11. The wall and ceiling of an auditorium hall are covered with sound absorbing materials, why?
12. Ultrasonic sound waves can pass even through the hard solid objects, why?
13. When a listener goes away from the source of sound, it gradually becomes fainter, why?
14. The speed of sound is given in the three different media air, water, and carbon dioxide in the following table. Study the table well and answer the questions given below.

Medium	Speed of sound (m/s)
A	258
B	332
C	1500

   i) What are A and B in the table?

   ii) The velocity of sound is more in C than in A, why?

C. Solve the following mathematical problems.

1. What is the wavelength of the sound when its frequency is 10 Hz? The speed of sound in the air is 332 m/s. [Ans. 33.2 m]
2. What is the speed of the sound wave with the frequency 15 Hz and wavelength 22 m.? [Ans. 330 m/s]
3. The velocity of sound is 332 m/s. Answer the following questions:
   i) What is the minimum and maximum frequency of sound which is heard to the human ear?
   ii) What is the wavelength of the shortest and longest waves heard to the human ear?

Project Work

1. Study the nature of waves produced in a pond when a stone is thrown by its side and explain with a diagram.
2. Name some musical instruments and write the part of each which is responsible for producing sound.
3. What type of wave is produced in a rope when its one end is fixed at a peg and another end is stretched downward? Observe and explain.
4. Ring the bell of your prayer room or of a temple or an instrument and touch the ringing bell. How do you feel? What difference do you find on touching the bell before and after ringing it? Tell your experience to your friends in the classroom.

Vocabulary

Ultrasound : Sound waves of frequency more than 20 KHz.

Sonometer : An empty box with two holes based on tension on the string to show the relation between sound and its frequency.

Elasticity : An object that regains its original shape after distortion.

Inertia : The property of an object due to which it remains in its own position

Unit

7

Current Electricity and Magnetism

How does an electric bulb glow in your villages and cities? How do televisions and computers run in the village? Actually, in our villages or cities, current electricity is used to glow bulbs, to tune radios, to operate computers, to run televisions, to run fans and motors. Electricity is a form of energy. It can easily be converted into other forms of energy like mechanical, light etc. We perform various works easily with the use of electrical energy. So, it is widely used in our daily life.

Electricity and magnetism are interrelated. When a bar magnet is freely suspended, it always points geographical north and south pole, why? It is due to the earth's terrestrial magnetism. In this unit, we'll study about Ohm's Law, resistance, conductivity, magnetic field and terrestrial magnetism.

Some important physical quantities related to current electricity

1. Current electricity:

The flow of electrons in a conducting wire is called current electricity or simply current. Its SI unit is Ampere. An instrument used to measure current is called ammeter. But, to measure very small magnitude of current, galvanometer is used. Both of them are connected in series with the source and electric load in an electric circuit because the amount of current can be measured accurately only when it passes through ammeter or galvanometer.

2. Electromotive force:

The difference of potential between two terminals of an electric source like cell, generator, solar cell/battery etc. when the circuit is open or not connected with a load is called electromotive force. It is measured in the unit volt.

3. Potential difference:

The difference of potential between the two ends of the electric load or between two terminals of the source or between any two points of an electric circuit is called potential difference. It is measured in closed circuit. Its SI unit is volt. Voltmeter is used to measure potential difference. Voltmeter

is connected parallel to the source or an electric load in an electric circuit as it is an instrument of extremely high resistance.

Ohm's Law

The relationship between the potential difference applied across the ends of a conductor magnitude of electric current and the resistance of the conductor was discovered by George Simon Ohm, a German physicist. According to Ohm's Law, the current flowing through a metallic conductor is directly proportional to the potential difference between its two ends, when temperature and other physical factors remain unchanged. If the current flowing in a conductor is I and the potential difference between two ends of the conductor is V,

According to Ohm's Law,

$$I \propto V$$

Or, $$V \propto I$$

$$V = I R \ldots\ldots\ldots\ldots\ldots\ldots(i)$$

Where R is proportionality constant. It is known as electrical resistance.

From equation (i) $I = \frac{V}{R}$

Or electrical resistance (R) $= \frac{\text{(Potential Difference)}}{\text{Current}}$

Or, $R = \frac{V}{I}$

It is seen that the resistance of a conductor is the ratio of the potential difference between its two ends and the current that flows through it.

The unit of electric current flowing in the circuit is ampere (A), the unit of potential difference is volt (V) and that of electrical resistance is Ohm (Ω).

Activity 1: **Experimental verification of Ohm's Law**

Following experiment can be performed to prove Ohm's Law.

First of all, arrange the electric circuit containing four cells, resistor, voltmeter, ammeter and a switch as shown in the figure

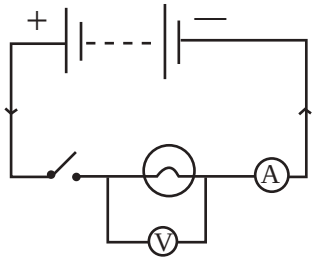


Fig 7.1 Ohm's Law

Now, measure the voltage and current flowing in the circuit, differing the number of cells turn by turn as instructed below and note the readings in the following observation table.

i) Connect only one cell in the circuit and measure current and voltage in the circuit.

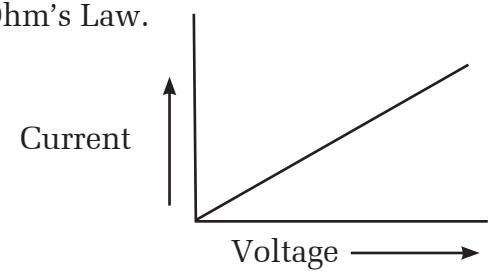
ii) Later on measure current and voltage separately connecting two, three and four cells respectively.

iii) Calculate the electrical resistance produced in the circuit in each case using data as obtained.

Observation Table

SN	Voltage(V)	Current(A)	Resistance Ω [R = V/I]	Conclusions
1. 2. 3. 4.				

Now, sketch a graph using the data in such a way that voltage is placed in X axis and current in Y axis. The nature of graph will be as shown in the figure. It proves Ohm's Law.



This graph proves that the current flowing in the circuit is directly proportional to the voltage or potential difference.

Example 1.

What is the amount of current flowing in the circuit when an electric load of resistance 4Ω is connected to the source of 10V potential difference?

Here,

Resistance (R) = 4Ω Potential difference (V) = 10V Current(I) = ?

From Ohm's Law

$$V = I R$$

Or $10\ V = I \times 4\Omega$

$$\therefore I = \ = 2.5A.$$

Resistance

When current passes through a wire, it partly blocks the flow of current. The capacity of wire to resist the flow of current depends on the property of the substance by which it is made. So, resistance differs depending on the nature of the wire. Hence, the property of a substance by which it resists the flow of current is called resistance. Its unit is Ohm(Ω) and symbol 'R'.

When 1A current flows in a circuit maintaining the potential difference of 1V is called 1Ω (Ohm) resistance. The bigger units of resistance are kiloohm (KΩ) and megaohm (MΩ).

$10^3\Omega = 1K\Omega$, $10^6\Omega = 1M\Omega$.

Metals have many free electrons. So current flows in metals easily. It Means, metals have low resistance. The metals like aluminum, copper have very low resistance. So they are good conductor of electricity.

The resistors of higher resistance are available in the market. They are used to control the amount of current in the circuit. Similarly, rubber, plastic etc. do not have free electrons. They do not allow electricity to pass through them. They are called insulators.

Some substances like silicon, germanium etc. have few free electrons. Small amount of current flows through them. They are called semiconductors. Higher amount of current flows through them with the rise in temperature. They have higher resistance than the good conductors and have lower resistance than the bad conductors.

Factors affecting resistance

Activity 2

Arrange an electric circuit connecting dry cells, bulb, switch and ammeter.

Leave the circuit disconnected as a point where a small piece of wire can be connected as shown in the figure given.

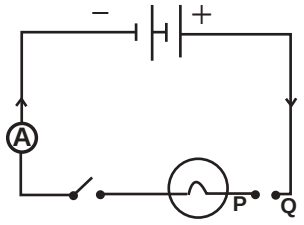


Fig 7.2 Circuit to measure resistance

1. Connect two wires of length 10cm and 100cm of having same thickness to the end point PQ turn by turn and observe by switching on the circuit. In which condition the ammeter shows higher reading? Find. In this case, when the wire of 10cm is connected to the circuit, the ammeter shows greater reading and when 100cm long wire is connected, the ammeter

shows lower reading. It means if the thickness remains the same, the resistance is more in the long wire than in the shorter one.

In other words, resistance(R) of a conducting wire is directly proportional to its length.

i.e. $R \propto l$

Where R is resistance and l is length of conducting wire.

2. Again, two wires of 10cm, length each having different thickness are connected turn by turn at the point PQ. Note down the readings of the ammeter after observation. What did you find? When a thin piece of wire is connected, small amount of current flows through it, but when a thick piece of wire is connected, comparatively large amount of current passes through it.

   It shows that the resistance of a conducting wire is inversely proportional to its thickness (cross sectional area).

   i.e. $R \propto 1/a$

   Where 'R' is the resistance and 'a' is the area of cross section of the wire.

3. Now, a piece of nichrome wire and a piece of copper wire having the same length and thickness are connected one after another. Observe the readings in the ammeter now.

   Here, the resistance of copper wire is less and that of nichrome wire is more. It means resistance differs on the basis of the nature of substance by which a conductor is made.

4. Again, connect a piece of nichrome wire at the part PQ of the circuit. Note the amount of current which the ammeter connected shows. Heat the wire with the help of spirit lamp and again, note the readings of the ammeter. What is the difference of the readings before and after heating the nichrome wire? Discuss. The reading of the ammeter after heating is less than the previous one. It means resistance of a wire increases on increasing its temperature. As a result, the amount of current decreases.

   i.e. $R \propto T$ Where, T is temperature.

The above activities show that the following are the factors affecting the resistance of a conductor.

a) Length of wire b) Thickness (cross sectional area)

c)Temperature d) Nature of the material of the wire.

Conductivity

We know that resistance of any conductor is directly proportional to its length and inversely proportional to the thickness of it.

i.e. $R \propto I$ .....(i)

$R \propto 1/a$ ..... (ii)

From equation (i) and (ii)

$R \propto 1/a$

$\therefore R = \rho 1/a$ ..... (iii)

Do you know?

Most of the metals are conductors. Likewise most of the nonmetals are bad conductors. In spite of being nonmetal, graphite is a good conductor.

Where ρ is a proportionality constant. It is called the resistivity of conductor. Its unit is Ωm. The reciprocal of resistivity is called conductivity. The conductivity of a substance with low resistance is higher and conductivity of the substance with high resistance is lower. The resistance of tungsten, nichrome etc. is high. So, their conductivity is low. Due to lower resistance of copper, silver, gold, etc. they have higher conductivity.

Generally, the conductivity of metals is higher and that of non-metals is lower. Good conductors have high conductivity and bad conductors have low conductivity.

Magnetism

We have discussed about the various properties of magnet in the lower classes. A magnet attracts magnetic substance kept closer to it. A kind of force is experienced when poles of two magnets are brought closer. It is due to the magnetic energy of the magnet. Magnetism is produced due to the parallel alignment of molecular magnets in a magnet. The magnetism is more at the poles and negligible at the middle.

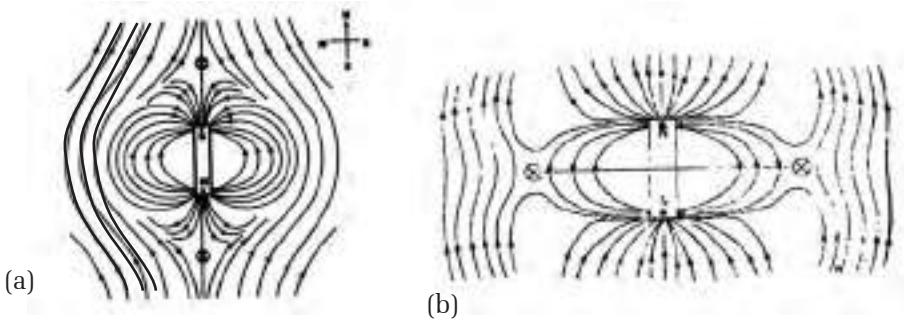
Magnetic Field

The magnetic strength weakens as the magnets are taken away. If a magnet is taken further away, a condition is observed when a magnet does not affect any magnetic substances and other magnets.

A magnet attracts other magnetic substances only within the magnetic field. The region around a magnet upto which a magnet affects other magnetic substances is called magnetic field. It is a vector quantity. The magnetic field of a strong magnet is larger and that of weak magnet is smaller.

Magnetic Lines of forces:

A number of lines of force emerge from the north pole of a magnet in its magnetic field. These curved lines of force move towards the south pole. North pole of a magnetic compass placed inside the magnetic field of another magnet points the direction of lines of force and remains parallel to them. If the path shown by the north pole of a compass is traced, a smooth curved line is obtained, which starts at the north pole and ends at the south pole of the magnet. This curved path is called magnetic line of force.



(a) Pointing north pole of a magnet towards geographical south

(b) Pointing north pole of a magnet towards the geographical north

Fig 7.3 Magnetic lines of force

Fig (a) shows the magnetic lines of force drawn by pointing north pole of a bar magnet towards the geographical north.

Fig (b) shows the magnetic lines of force drawn by pointing north pole of a bar magnet towards the geographical south.

A tangent drawn at any point on a line of force shows the direction of magnetic field at that point.

Activity 3

Put a bar magnet at the centre of a white sheet of paper pointing N-S directions. Draw its outline with the help of a pencil. Put a dot mark close to the north pole of the magnet. A compass is placed there in such a way that its south pole rests on the dot marked. Again a dot is marked near the north pole of compass needle. Now replace the compass so that its south pole rests on the second dot marked. In this way, if the same process is

repeated again and again, the magnetic compass reaches the south pole of the bar magnet. Join all the dots obtained. A curved line obtained in this way is called magnetic lines of force. Other lines are plotted in the same way to get the entire picture of magnetic field.

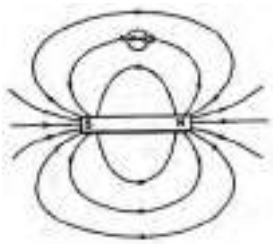


Fig 7.4 A way of plotting magnetic lines of force.

While plotting magnetic lines of force, such points are obtained where the compass does not show any specific direction. Such points are called neutral points. In the above figure (a) and (b) 'X' points are the neutral points. At the neutral points, the earth's magnetic field and magnetic field due to a magnet are exactly equal and opposite. Resultant field is zero in these points.

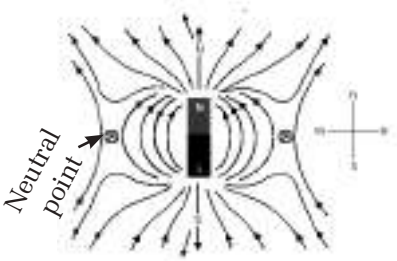


Fig 7.5 neutral point

Terrestrial Magnetism

Earth also has magnetism. It can also be considered as a huge magnet. So, it has its own magnetic field. It has magnetic lines of force in its magnetic field. A magnetic compass always remains parallel to the direction of earth's magnetic lines of force. If a bar magnet is suspended freely with the help of a thread, it remains parallel to the earth's magnetic lines of force. If the earth's magnetic lines of force are followed with the help of a compass, it reaches the earth's magnetic south pole.

The earth's magnetic north pole lies towards the earth's geographical south pole and its magnetic south pole lies towards the geographical north pole. Earth's magnetic south pole is at about the side of north Canada and its north pole is at the side of Antarctica.

Do you know?

If an iron rod is buried in the grounds painting geographical north south direction for 3, 4 days, it gains magnetism.

Angle of Declination

Earth's magnetic poles and geographical poles do not coincide (lie at the same point). So imaginary lines that join geographical north south

and magnetic north south intersect each other at a place. Thus, the angle formed by the intersection of these two imaginary lines is called angle of declination. Its value differs from place to place. θ represents the angle of declination in the given figure.

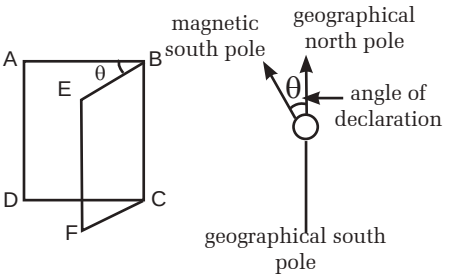


Fig 7.6 Angle of declination

One should know the value of angle of declination to find the correct direction. It is useful for flying aero planes, sailing ships to find the exact direction.

Angle of Dip

A dip needle is freely moveable magnetic needle placed pointing north-south direction on a vertical plane. The angle made by a dip needle with the horizontal line in the magnetic meridian is called angle of dip. The N pole of dip needle points downward in the northen hemisphere and vice versa.

Angle of dip also varies at different places on the earth. Its value is zero at the earth's magnetic equator because effect of north and south poles of terrestrial magnet is equal at this place. Thus a compass needle becomes parallel with the horizon at earth's magnetic equator.

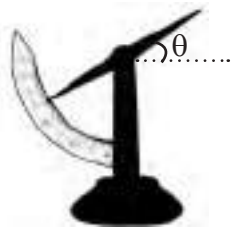


Fig 7.7 Angle of dip

On moving towards the north or south pole from the equator, the angle of dip gradually increases. Its value is 90° at the earth's magnetic poles.

Do you know?

The angle of dip at Kathmandu is 42°.

Points to remember

1. According to Ohm's Law, the current flowing in a conductor is directly proportional to the potential difference between two points of the conductor. ($V = I R$)
2. The property of a conductor due to which it resists the flow of current through it is called resistance. Its unit is ohm (Ω).
3. Electrical resistance of a wire depends on its length, temperature, thickness and the nature of the material of the wire.

4. The reciprocal of the resistivity is called conductivity.
5. The magnetic field of a strong magnet is larger and that of weak one is smaller.
6. The imaginary lines of force drawn from north pole to south pole in magnetic field of a magnet are called magnetic lines of force.
7. The earth has magnetism. It is accepted as a huge magnet.
8. The angle between the geographical meridian and the magnetic meridian at a place is called angle of declination.
9. The angle made by a dip needle with horizontal is called angle of dip. Its value is 0° at the equator and 90° at the poles.

Exercise

A. Tick (√) the right answer in the following multiple choice questions.

1. In which unit is potential difference measured?
   i) Volt ii) Ampere iii) Ohm iv) Watt
2. On which factor does the resistance of a conducting wire depend?
   ii) Length of wire ii) Thickness of wire
   iii) Temperature iv) All of the above.
3. What is the value of angle of dip at the magnetic poles of the earth?
   i) 0° ii) 45° iii) 90° iv) 180°.
4. Which of the following instruments is used to measure the angle of dip?
   i) Ammeter ii) Voltmeter iii) Galvanometer iv) Dip needle
5. What is the potential difference when 5 Ampere current flows in a conducting wire of resistance 2Ω?
   i) 0.4V ii) 2.5V iii) 5V iv) 10V.

B. Answer the following questions:

1. What is an electrical resistance? On which factors does it depend?
2. What do you mean by 1Ω resistance?
3. What is meant by semiconductor? Give two examples of it.
4. State Ohm's Law and prove V = I R.

5. Define terrestrial magnetism. Give two examples that provide evidence for the presence of terrestrial magnetism.
6. What is a magnetic line of force? Mention its feature.
7. What is angle of dip? What is its value at the earth's magnetic poles? Why?
8. Draw a diagram showing magnetic lines of force when the north pole of a bar magnet points towards the earth's geographical north pole.
9. Write the differences between electromotive force and potential difference.
10. In an electric circuit, voltmeter is connected parallel to a load and ammeter is connected in series, why?
11. What is a neutral point? A freely suspended magnet points geographical north-south direction, why?

C. Solve the following mathematical problems.

1. What is the current that flows in a circuit when 10V battery is connected to the bulb of resistance 40Ω. *[Ans: 0.25A]*
2. If 15A current flows in an electric motor having 4KV potential difference, find the electrical resistance of the conductor. *[Ans: 266.67Ω]*

Project Work

Take a white sheet of paper and polish it with wax. Warm the paper on fire gently. Put a bar magnet on the table in such a way that its south pole points geographical north. Put the paper polished with wax on the magnet so that the magnet remains at the centre of the white paper. Now, put some iron dust on the paper. How do the magnetic lines of force appear? Observe.

Vocabulary

Ammeter : An instrument that measures current

Voltmeter : An instrument that measures voltage or potential difference

Magnetic lines of force : The imaginary lines that passe towards the south pole of a magnet emerging from its north pole.

Dip needle : A freely moveable magnetic needle kept on a vertical plane.

Magnetic Field : The region around a magnet upto which magnetic force can be experienced.

Unit

8

Classification of Elements

Till now, 118 elements have been discovered, as 92 natural and 26 artificial. Gold, silver, carbon, hydrogen, oxygen, helium, etc are some elements found in our surroundings. The smallest particle of an element is called atom.

An atom is made up of electron, proton and neutron. Gold, silver, copper, steel, etc elements are metals whereas carbon, hydrogen, oxygen, chlorine, etc elements are non metals. Due to the number of electrons present in this atom and its situation, there is difference in their characters. During chemical reactions, as an electron transfers to other atom or sharing nature also brings difference in characters. In this chapter, we will study about the structure of atoms in element, their electronic configuration, valency, radical, ion, etc.

Element and Compound

We know that, hydrogen and oxygen combine to form water whereas carbon and oxygen combine to form carbon dioxide gas. The elements like hydrogen, oxygen, carbon can be broken into simple matter than this. This matter is called element. They are pure matters. According to the physical and chemical properties, elements are distinguished into three types as metal, metalloids and non metal. The smallest particle of an element is called atom. Atoms are made up of electron, proton and neutron.

Do you know?

Element phosphorous when comes in contact with the air, burns itself. Sometimes we see fire burning itself in the hilly region, which is found to be called fire ghost (rankebhoot). The burning of fire in this way is due to the contact of phosphorous present in the bones of dead organisms and its compound with oxygen.

The substance formed after the chemical reaction between two or more than two elements is called compound.

The smallest particle of an element or a compound that keeps its property constant is called molecule. Two or more than two types of molecules combine to form compound. Water, carbon dioxide, salt, soda, etc are the examples of compound. Every compound has its own properties. Those properties are different from the properties of element present in the compound. For example, the physical and chemical properties of water

are different from the properties of oxygen and hydrogen.

Hydrogen + Oxygen ⟶ Water

(gas) + (gas) ⟶ (liquid)

Structure of Atoms and Electronic configuration

An atom is made up of electron, proton and neutron. Protons and neutrons are present in the nucleus of atom whereas electrons move around the nucleus. The centre of atom is called nucleus, in which proton and neutron are present. The path where an electron moves around the nucleus is called track or shell. Shell is also called as orbit in other word. Different shapes of sub shell combine to form a shell. Some of that sub shells are spherical and some are dumb bell shaped.

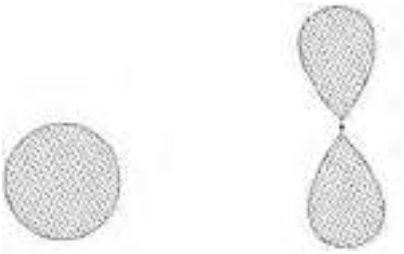


Fig 8.1: shapes of sub shells

Do you know?

IN 1913 A.D Neil Bohr said that the shells where electron moves are circular like bangle. This scientist gave many facts about the structure of atom. Similarly in 1917 A.D Rutherford found that nucleus is present in the centre of an atom. Rutherford got noble prize in chemistry in 1908 .D

Now, we will study about the sub shells present in the shell of atom and the maximum numbers of electrons that can fit in them.

Shells	K	L		M			N			
Sub shells	s	s	p	s	p	d	s	p	d	f
No. of electrons	2	2	6	2	6	10	2	6	10	14

Electronic configuration of atom can be done by two ways. According to the first method electrons are kept only at shells whereas according to the second method, electrons are also kept in sub shells. Shells are also indicated by number. Example:

Shell	K	L	M	N
Number	1	2	3	4

While doing electronic configuration on the basis of shell, the maximum

numbers of electron that can fit first shell (K) is 2 electrons, second shell (L) is 8, third shell (M) is 18, and fourth shell (N) is 32 electrons. For this following formula is used.

First shell or K = $2 \times 1^2 = 2 \times 1 = 2$

Second shell or L = $2 \times 2^2 = 2 \times 4 = 8$

Third shell or M = $2 \times 3^2 = 2 \times 9 = 18$

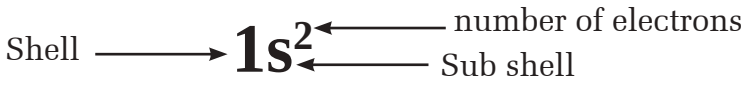
Fourth shell or N = $2 \times 4^2 = 2 \times 16 = 32$

While writing the electronic configuration on the basis of sub shell, the maximum number of electrons that a sub shell can hold are given below:

Sub shell	S	p	d	f
No. of electrons	2	6	10	14

The order of electrons in the sub shell while writing the electronic configuration is given below.

1s 2s 2p 3s 3p 4s 3d 4p 5s……..



The number in front of the symbol indicates orbit or shell, sub orbit or sub shell by the symbol and number above the symbol (superscript) indicates numbers of electrons.

Valence electron and Valency

When an atom takes part in chemical reaction, the arrangement of electrons suffers a change. As the electrons are exchanged between atoms or sharing takes place during chemical reaction atoms combine to form molecule. All electrons present in the atoms do not take part in this process. Generally, the electron present only at the last shell or the outer most shell of an atom takes part in chemical reaction. The outer shell of atom is called valence shell.

The inner part except the valence shell of atom is called core. The rest of electron, neutron and proton except valence electron are present in the core.

Electronic configuration of sodium

$1s^{2,}\ 2s^2 2p^{6,}$ $3s^1$

Core Valence shell

Third shell in the above example is valence shell. The electrons present in the valence shell are called valence electron. These valence electrons are the probable electrons that can take part in the chemical reaction.

The combining capacity of an atom is called valency.

The combining capacity of an atom depends upon the number of electrons present at the valence shell. During chemical reaction the exchange of electron or sharing of electrons between the atoms takes place.

The electron ic configuration and valency of some elements on the basis of shell and sub shell are given in the table below.

Atomic number	Name of element	Electronic configuration					Valency
		On the basis of shell				On the basis of sub shell	
		K	L	M	N		
1	Hydrogen	1				$1s^1$	1
2	Helium	2				$1s^2$	0
3	Lithium	2	1			$1s^2,2s^1$	1
4	Berilium	2	2			$1s^2,2s^2$	2
5	Boron	2	3			$1s^2,2s^2 2p^1$	3
6	Carbon	2	4			$1s^2,2s^2 2p^2$	4
7	Nitrogen	2	5			$1s^2,2s^2 2p^3$	3
8	Oxygen	2	6			$1s^2,2s^2 2p^4$	2
9	Fluorine	2	7			$1s^2,2s^2 2p^5$	1
10	Neon	2	8			$1s^2,2s^2 2p^6$	0
11	Sodium	2	8	1		$1s^2,2s^2 2p^6,3s^1$	1
12	Magnesium	2	8	2		$1s^2,2s^2 2p^6,3s^2$	2
13	Aluminium	2	8	3		$1s^2,2s^2 2p^6,3s^2 3p^1$	3
14	Silicon	2	8	4		$1s^2,2s^2 2p^6,3s^2 3p^2$	4
15	Phosphorous	2	8	5		$1s^2,2s^2 2p^6,3s^2 3p^3$	3, 5

Atomic number	Name of element	Electronic configuration					Valency
		On the basis of shell				On the basis of sub shell	
		K	L	M	N		
16	Sulphur	2	8	6		$1s^2,2s^2 2p^6,3s^2 3p^4$	2, 6
17	Chlorine	2	8	7		$1s^2,2s^2 2p^6,3s^2 3p^5$	1
18	Argon	2	8	8		$1s^2,2s^2 2p^6,3s^2 3p^6$	0
19	Potassium	2	8	8	1	$1s^2,2s^2 2p^6,3s^2 3p^6,4s^1$	1
20	Calcium	2	8	8	2	$1s^2,2s^2 2p^6,3s^2 3p^6,4s^2$	2

According to the valency of element its chemical reactivity is also different. The element with 0 valency is neutral. Their outer shell is complete due to which they cannot take, give or share electron and cannot take part in chemical reaction. Therefore, these types of elements are called noble element. For example, helium, neon, argon, etc are noble elements.

Except noble elements, in case of other elements if the valency is more, it is less reactive and if valency is less then it is more reactive. For example, sodium is more reactive than magnesium.

Valency of some elements is more than one. During the process of chemical reaction, only the electrons of outer shell take part. If the electrons present in the shell other than valence shell also take part in reaction, it possesses another valency also. For example: valencies of some elements are given below;

Name of the element	Symbol of element	valency
Iron	Fe	2 and 3
Copper	Cu	1 and 2
Silver	Ag	1 and 2
Gold	Au	1 and 3
Lead	Pb	2 and 4
Mercury	Hg	1 and 2

Radical

During the process of electronic configuration, any atom or group of atom gives electrons, takes electrons or shares electrons with each other. By doing so, an atom or a group of atoms becomes charged. This kind of charged atom or group of atoms is called radical. During the process of chemical reaction it acts as a unit. The formula of some radicals and their valencies are given in the table below.

Radicals with valency 1		Radicals with valency 2		Radicals with valency 3	
Radical	Symbol	Radical	Symbol	Radical	Symbol
Bicarbonate	HCO_3^-	Carbonate	CO_3^{--}	Phosphate	PO_4^{---}
Hydroxide	OH^-	Sulphate	SO_4^{--}		
Ammonium	NH_4^+	Sulphite	SO_3^{--}		
Nitrate	NO_3^-				
Nitrite	NO_2^-				
Chlorate	ClO_3^-				

Ion

Do you know?
There is no role of nucleus in chemical reaction. But if there is no change in nucleus after nuclear reaction then organisms would not have emerged. The heat and light that we are getting from sun, all these are gained from nuclear reaction. During nuclear reaction, due to the numbers of proton and neutron in nucleus, increasing or decreasing, new element is formed. During this process, along with more heat and light, other harmful rays are also come out.

We know that the number of positively charged proton and the number of negatively charged electrons are equal. Due to this, an atom is neutral. When an atom gives electron to other or take from other, it becomes charged. This kind of charged atom is called ion, example: Na^+, Mg^{++}, Ca^{++}, Al^{+++}, O^{--}, N^{---}, Cl^-, etc. When atoms give electrons present in it to other it becomes positively charged whereas when atom takes electron from other it becomes negatively charged.

Octet and Duplet

While making chemical bond, an atom makes 8 electrons in its valence shell by exchanging or sharing electrons. In this way, the state when there is 8 electrons in the valence shell is called octet. The rule of making octet in valence shell and obtaining stable state in chemical form is called octet rule except K shell.

In all the shell octet rule is applied.

As in K shell, only two electrons can make the shell complete, the rule of making its outer shell with 2 electrons are called duplet. When atoms

reach duplet and octet state it becomes inactive. Because of a chemical reaction, duplet or octet state. To be clear about octet and duplet, let's study the table below.

Element	No. of electron	Electronic configuration	Valency indicator shell	Valency indicator number of electrons	Valency	Remark
He	2	$1s^2$	$1s^2$	2	0	Duplet
Ne	10	$1s^2,2s^22p^6$	$2s^22p^6$	8	0	Octet
Ar	18	$1s^2$, $2s^22p^6,3s^23p^6$	$3s^23p^6$	8	0	Octet

The reason of not reacting of the above gases with other atoms is their octet or duplet state which has already been completed. As the valence shell is complete their electron cannot be transferred or shared. Therefore, they are called noble gases.

Chemical Bond

During chemical reaction, when the valence electrons are taken or given or shared, an attracting force is created in between them. Due to that attracting force, atoms are grouped together to form molecule of a compound. In this way, the energy that keeps the atoms bonded with each other in molecule is called chemical bond. Chemical bonds are mainly of three types.

a) Electrovalent or Ionic bond

b) Covalent bond

c) Co-ordinate covalent bond

Among these three bonds, let's study here only about electrovalent and covalent bond. About co-ordinate covalent bond we will study in higher classes.

a) Electrovalent bond

Except noble gases other elements take part in chemical reaction making bond with each other. Some elements give or take valence electron. The bond made from this way of giving or taking electron from one atom to other is called electrovalent bond. As ions are generated in this, it is called ionic bond. The compounds having ionic bond are called ionic compound. How is ionic bond formed in common salt or sodium chloride? Let's study now.

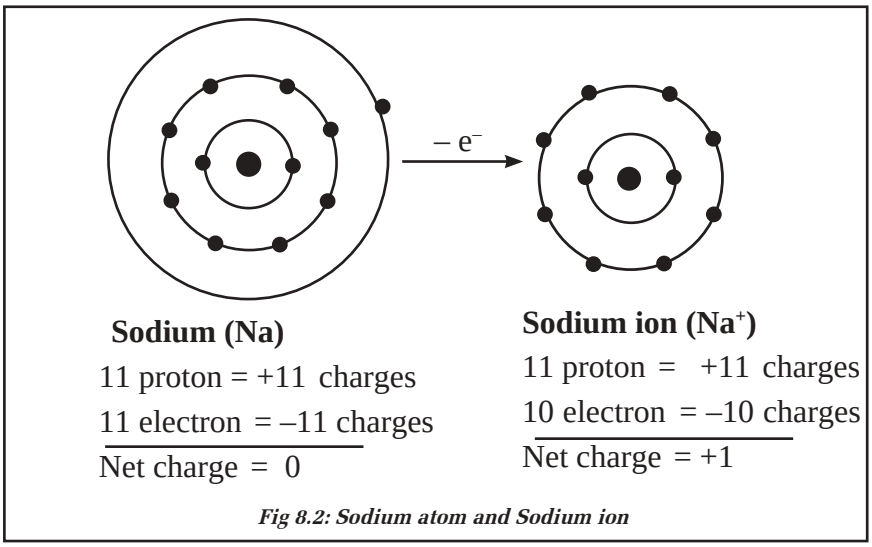


Fig 8.2: Sodium atom and Sodium ion

Among 11 electrons of a sodium atom, one electron lies in its outermost shell of atom. Therefore sodium is more reactive metal. During the compound formation with other element, the electron present at the outermost shell of sodium is given to another atom and sodium ion is formed. In this way, there will be 8 electrons in the valence shell of sodium ion. Its electronic configuration becomes like the electronic configuration of neon (Ne). As the number of electron is one less than the number of proton, positive charge is generated.

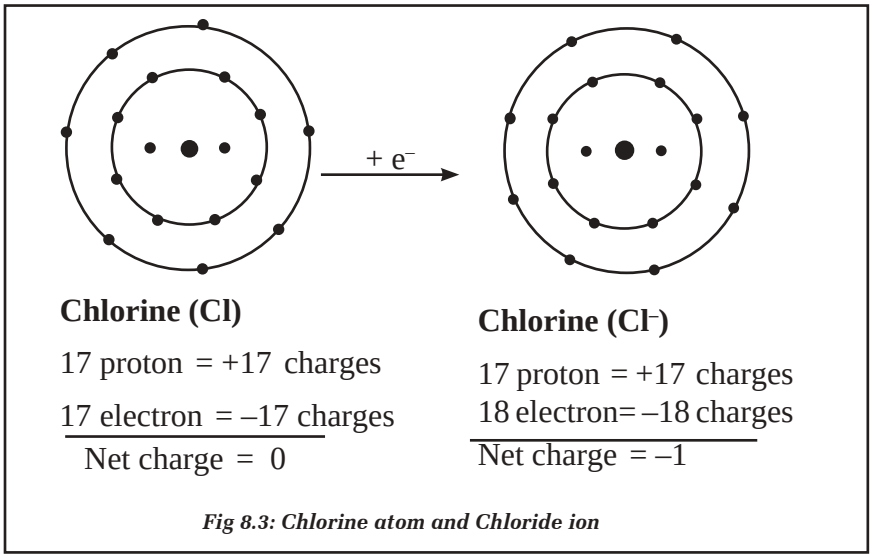


Fig 8.3: Chlorine atom and Chloride ion

Out of 17 electrons of a chlorine atom, 7 electrons are at the outer shell. Like the electronic configuration of argon, chlorine tries to gain one electron from other atoms to make 8 electrons in the valence shell to obtain octet. After taking one electron, chlorine ion ($Cl^{-)}$ is formed.

Therefore, when sodium and chlorine atoms take part in the chemical reaction, Na gives an electron to chlorine and sodium ion ($Na^{+)}$ and chlorine ion (Cl^{-}) are formed. Attraction energy is generated between those two ions because of their opposite charges. In this way, electrovalent bond is formed in between the atoms of NaCl.

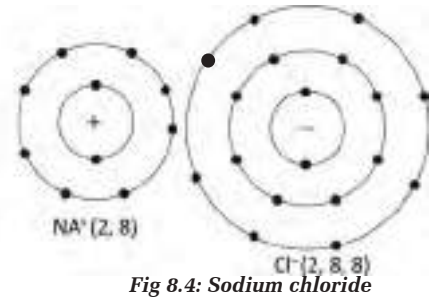


Fig 8.4: Sodium chloride

Generally, when a reaction takes place between metal and non metal, electrovalent bond is formed. Ionic compound is at the state of crystalline solid. They have high melting point but are brittle. Also, they are more soluble in water. They conduct electricity in the melting state or liquid state.

Magnesium oxide (MgO), potassium chloride (KCl), calcium chloride ($CaCl_{2),}$ sodium bromide (NaBr) etc are examples of electrovalent compounds.

b) Covalent bond

In the condition where atoms cannot give or take electron, how will compound be formed? Let's think for a while. At the stage when exchange of electron between atoms cannot take place, two or more atoms share electron with each other and complete octet or duplet in their outer shell. The bond formed by sharing electrons in this way is called covalent bond. Now, let's study how covalent bond is formed in the molecule of water. For an example:

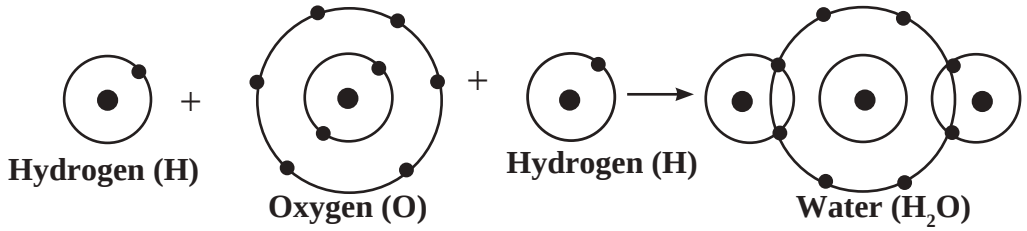


Fig 8.5: molecule of water

To complete the octet in the outer shell, oxygen atom needs two electrons whereas to complete the duplet hydrogen atom needs one electron. In this condition, with the two atoms of hydrogen, one atom of oxygen shares electron and completes the valence shell. In this way, when oxygen is formed, oxygen makes covalent bond with two hydrogen atoms. Generally, when metal and non metal combine to form compound, covalent bond is formed between elements.

The compound formed by sharing electrons between two or more than two atoms of the elements is called covalent bond.

Covalent compound is in solid, liquid or gaseous state. In solid, compounds are soft and have low melting point. Generally, compounds are insoluble in water. Covalent compounds cannot conduct electricity.

Water (H_2O), Ammonia (NH_3), carbon dioxide (CO_2), hydrochloric acid (HCl) etc are examples of covalent compounds.

Molecular Formula

A molecule is formed by the fusion of two or more than two atoms. Some molecules are made from the element of one atom. Example: molecule of hydrogen whereas some molecule are formed from the combination of two or more than two atoms of element. Molecule of water (H_2O) is formed by the combination of atoms of hydrogen and oxygen.

Symbol is also used to denote molecules. By not keeping its different symbol, group of symbol (formula) is made from the symbol and numbers of atoms. Thus, the group of symbols of atoms to represent one molecule is called molecular formula.

For example: let's see the molecular formula of NH_3. This molecular formula is made by the combination of symbols of nitrogen and hydrogen. As it is made from only one atom of nitrogen and 3 atoms of hydrogen, there is no any number mentioned below nitrogen whereas 3 is kept below hydrogen. In this way, molecular formula is made from the symbol of elements and

their number. While writing molecular formula you should have good idea about the symbols of element, valency of element and radical, etc.

Method of writing molecular formula

Here, from valency criss cross method, we can write molecular formula of any molecule of compound. Let's study the method of writing molecular formula.

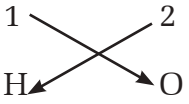
How is the molecular formula of water written?

1. First of all write the name of molecule, like water.
2. From which element or radical that molecule is made, write the symbol of element or radical.

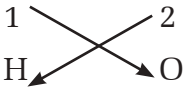
   H O
3. Above the symbols, write the valency of respective element or radical.

   1 2

   H O
4. Exchange the valency between element or radical and indicate it with arrow.

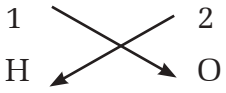


5. After exchanging the valency between element or radical, write the symbol and valency together. Write the valency down at the right side of symbol. If radical is made from more than one element keep the group of radical's symbol in bracket and write valency down at the right side outside the bracket.



H_2O_1

6. If valency of any element or radical is 1, as it is not be written remove. If both the valencies can be divided by any number, remove the divisible and write the molecular formula keeping the remainder.



H_2O

Now let us practice to write the molecular formula as given below.

Sodium carbonate 1 2 Na CO_3 Na_2 $(CO_3)_1$ Na_2CO_3	Calcium sulphate 2 2 Ca SO_4 Ca_2 $(SO_4)_2$ $CaSO_4$
Magnesium hydroxide 2 1 Mg OH Mg_1 $(OH)_2$ $Mg(OH)_2$	Ammonium carbonate 1 2 NH_4 CO_3 $(NH_4)_2$ $(CO_3)_1$ $(NH_4)_2CO_3$

Some compounds and their molecular formula

S.n.	Name of a compound	Molecular formula
1	Ammonia	NH_3
2	Hydrochloric acid	HCl
3	Potassium carbonate	K_2CO_3
4	Ammonium sulphate	$(NH_4)_2SO_4$
5	Ferric oxide	Fe_2O_3
6	Silver nitrate	$AgNO_3$
7	Calcium carbonate	$CaCO_3$
8	Magnesium chloride	$MgCl_2$
9	Calcium hydroxide	$Ca(OH)_2$
10	Sulphuric acid	H_2SO_4

What can be known after observing the molecular formula of a compound?

The following things can be known after studying molecular formula of any compound:

1. The name and symbol of element present in molecules
2. Number of atoms present in molecules
3. Valency of element or radical

For example, let's see the molecular formula of water H_2O.

1. Water is made from the elements hydrogen and oxygen.
2. In one molecule of water there are two atoms of hydrogen and one atom of oxygen.
3. Valency of hydrogen is 1 and that of oxygen is 2.

Things to remember

1. The pure matter which cannot be broken into simple matters is called element. They are made up of one type of atom.
2. Compound is made from the chemical reaction between two or more than two elements.
3. The method of arranging electrons around the nucleus is called electronic configuration. The electronic configuration of atoms is done on the basis of shell and sub shell.
4. Sub shells are four types as s, p, d and f. In s sub shell 2, p sub shell 6, d sub shell 10 and f sub shell 14 electrons can be filled.
5. The outermost shell of an atom is called valence shell and electrons present in that is called valence electron.
6. The number of electrons that can take part during the chemical reaction is called valency.
7. The method of arranging 8 electrons in outer shell of the atoms by exchanging or sharing of electrons of atoms is called octet rule.
8. During chemical reaction, due to the exchange of electrons between metal and non metal force of attraction is developed, it is called electrovalent or ionic bond.
9. During the chemical reaction, the bond is formed due to the sharing of electrons between metal/non metal and the shell of atom overlap with each other is called covalent bond.
10. The atoms or group of atoms of molecule with positive charge or negative charge is called radical.

Exercise

a) Put the correct sign (√) in the correct answer of the following multiple choice questions.

1. Among these which is the example of compound?

   a) sulphur b) iron c) ammonia d) mercury

2. How much is the valency of an element having 1s2,2s2sp6,3s2 electronic configuration.

   a) 1 b) 2 c) 3 d) 4

3. Among these, which is noble gas?

   a) Ar b) H c) N d) O

4. Among these, which is the molecular formula of ammonium sulphate?

   a) NH_4SO_4 b) $(NH_4)2SO_4$ c) $(NH_4)3SO_4$ d) $NH_4(SO_4)_2$

5. Among these which radical has valency ?

   a) NH_4 b) CO_3 c) OH d) ClO_3

b) Answer the following questions:

1. What are elements? Write with example.
2. What is compound? Write any two differences between molecule and atom.
3. How is chemical bond formed? Write any two differences between electrovalent bond and covalent bond.
4. Find the valency of the elements given below using electronic configuration on the basis of sub shell.

   a) carbon b) sulphur c) magnesium

   d) potassium e) fluorine

5. What is ment by radical? Write any five examples with their valencies.
6. Give a description of valence electron. Find the number of valence electrons of oxygen, aluminium, chlorine and calcium.
7. What is octet rule? In which shell duplet rule is applied, why?
8. How is electrovalent bond formed? Describe with an example.
9. How is covalent bond formed in water? Clarify with a diagram.

10. Write three differences between electrovalent bond and covalent bond.

11. If there is mistake in the molecular formulae given below, correct them.

a) Ca_2Cl_2 b) MgOH c) Cu_2SO_4 d) $K(NO_3)_2$

e) NH_4Cl_2 f) $NaSO_4$ g) Ca_2CO_3 h) $CaHCO_3$

12. Write the molecular formula of the compounds given below:

a) Sodium hydrogen carbonate b) calcium hydroxide

c) silver nitrate d) ammonium sulphate

e) Magnesium carbonate f) Ferric oxide

Project work

Prepare a model of covalent compounds (water and ammonia) with the help of mud or seed of amala, stick and sticking gum. While preparing model, take help of your teacher to correct the angles of bond. (Note: The angle of bond in water is approximately 104 and angle in bond of ammonia is 107)

Glossary

Conductor : which can conduct heat and electricity

Insulator : Which cannot conduct heat and electricity

Semi-conductor: which can conduct some amount of heat and electricity

Oxide: compound made from the combination of any element and oxygen

s, p, d, f: sharp, principal, diffuse, fundamental respectively

duplet: the state like in helium where there is two electron in the valence shell

Atomic weight: sum of number of proton and neutron in atom (the weight of electron is negligible)

Molecular weight: sum of atomic weight of all elements present in molecule.

Unit

9

Chemical Reaction

How does change take place in a substance? Do you know? When a substance gives energy or liberates energy one or more than one changes occur. For example, formation of ice while cooling water, release of energy and heat from food, conversion of milk into curd, etc. Except nuclear reaction, all types of changes taking place in the substances can be divided into two parts as physical change and chemical change. Physical change means not the change in its actual properties but in its state, structure, colour, etc whereas chemical change means the change in its molecular structure as well as its state. In this change the properties of substance completely change and new substance is formed with new properties. In this unit we will study about the chemical reaction.

Chemical reaction

The process of displacement, association or dissociation between the atoms and molecules of substances during the chemical change is called chemical reaction. The chemical change is expressed through equation. The method of representing substances involved in chemical reaction in symbol and molecular formula is called chemical equation.

The substances which are involved in a chemical reaction are called reactants whereas the substances obtained as a result of the chemical reaction are called products. The elements or compounds on which chemical reaction takes place, that is placed on the left side of an arrow and the element of compounds which are formed as a result of chemical reaction, those are placed on the right side of an arrow. The direction of arrow distinguishes reactants and products.

For example

Hydrogen + Oxygen $\longrightarrow$ Water

Reactants $\xrightarrow{\text{Chemical reaction}}$ Products

$H_2 + O_2$ H_2O

(Reactants) $\longrightarrow$ (Product)

Here, hydrogen and oxygen are reactants whereas water is a product. To denote the state of matter, s,l,g or aq is written inside the bracket. Where's'

represent solid,'*l*' represents liquid, 'g' represents gas and 'aq' represents the solution formed in water.

Example:

Zinc + Hydrochloric acid ⟶ Zinc chloride + Hydrogen

$Zn\ (s) + 2HCl\ (aq) \longrightarrow ZnCl_2\ (aq) + H_2\ (g)$

Do you know?
The molecules of H, N, O, F, Cl, Br, I gases are diatomic. Therefore, when these molecules are written separately, they are written as H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2, etc.

Balanced Chemical Equation

The method of representing substances involved in chemical reaction through symbols and formula is called chemical equation. The chemical equation in which the number of atoms of each element of reactant and the number of atoms of same element in product are equal is called balanced chemical equation.

Method of writing balanced chemical equation

Mass is neither be created nor be destroyed during the chemical reaction. On the basis of this principle, chemical equation is balanced. The total mass of reactant is equal to the total mass of product.

The chemical equation in which the number of atoms of each element of reactant and the number of atoms of same element in product are equal is called balanced chemical equation.

While balancing chemical equation, the following point should be considered.

a) The symbol and molecular formula of each matter participating in chemical reaction should be correct.

b) At first chemical equation should be expressed in word equation.

c) While balancing the chemical equation, the subscript present in the molecular formula should not be changed.

d) According to this method suitable coefficient is placed just in front of the symbol and molecular formula and the coefficient is selected in such a way that the number of atoms at both sides are equal.

This method of balancing chemical equation is called hit and trial method.

Let us see the given chemical equation for example

Aluminium + Hydrochloric acid ⟶ Aluminium chloride + Hydrogen

The given word equation is written as follows in chemical equation.

$Al + HCl \longrightarrow AlCl_3 + H_2$

By counting each atom present in the equation, find out which element is not balanced.

Atom	Reactant side	Product side
Numbers of aluminium	1	1
Numbers of hydrogen	1	2
Numbers of chlorine	1	3

Here, number of aluminium in left and right side is 1/1. The number of H in left is 1 and 2 in right whereas the number of chlorine is 1 in left and 3 in right. To make the number of H_2 and Cl_2 in left and right side equal, we should multiply Al by 2, HCl by 6, $AlCl_3$ by 2 and H_2 by 3. After that, chemical equation is written as follow.

$2Al + 6\ HCl \longrightarrow 2AlCl_3 + H_2$

Now, the number of atoms in the above chemical equation has become as follow.

Atom	Reactant side	Product side
Numbers of aluminium	2	2
Numbers of hydrogen	6	6
Numbers of chlorine	6	6

This type of chemical equation is called balance equation.

Some examples of balanced chemical reaction are given below.

Potassium + Chlorine ⟶ Potassium Chloride

$2K + Cl_2 \longrightarrow 2KCl$

Sodium + Oxygen ⟶ Sodium oxide

$4Na + O_2 \longrightarrow 2Na_2O$

Aluminium + Nitrogen ⟶ Aluminium nitride

$2Al + N_2 \longrightarrow 2AlN$

Sodium + Chlorine ⟶ Sodium chloride

$2Na + Cl_2 \xrightarrow{heat} 2NaCl$

Hydrogen peroxide $\longrightarrow$ Water + Oxygen

$2H_2O_2 \xrightarrow{heat} 2H_2O + O_2$

Calcium carbonate $\longrightarrow$ Calcium oxide + Carbon dioxide

$CaCO_3 \xrightarrow{heat} CaO + CO_2\,(g)$

Potassium chlorate $\longrightarrow$ Potassium chloride + Oxygen

$2KClO_3 \xrightarrow{heat} 2KCl + 3O_2$

Zinc + Hydrochloric acid $\longrightarrow$ Zinc chloride + Hydrogen

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

Potassium + Hydrochloric acid $\longrightarrow$ Potassium chloride + Hydrogen

$2K + 2HCl \longrightarrow 2KCl + H_2$

Calcium + Sulphuric acid $\longrightarrow$ Calcium sulphate + Hydrogen

$Ca + H_2SO_4 \longrightarrow CaSO_4 + H_2$

Sodium chloride + Silver nitrate $\longrightarrow$ Sodium nitrate + Silver chloride

$NaCl + AgNO_3 \longrightarrow NaNO_3 + AgCl$

Sodium hydroxide + Hydrochloric acid $\longrightarrow$ Sodium chloride + Water

$NaOH + HCl \longrightarrow NaCl + H_2O$

Potassium hydroxide + Nitric acid $\longrightarrow$ Potassium nitrate + water

$KOH + HNO_3 \longrightarrow KNO_3 + H_2O$

Information obtained from balanced chemical equation

a) Name and molecular formula of reactant and product

b) Number of molecules of reactant and product

c) Ratio of molecular weight of reactants and products

d) Type of chemical reaction

Exothermic and Endothermic Reaction

Due to the change in heat, chemical reactions take place. Therefore, on the basis of gaining heat from outside or generating heat during the chemical reaction can be divided into two parts. The reaction that absorbs heat during the chemical reaction is called endothermic reaction whereas the reaction that evolves heat is called exothermic reaction.

Some examples of exothermic reaction

$C + O_2 \longrightarrow 3CO_2 + Heat$

$Zn + 2HCl \longrightarrow ZnCl_2 + H_2 + Heat$

Some examples of endothermic reaction

$N_2 + O_2 + Heat \longrightarrow 2NO$

$2NaCl + Heat \longrightarrow 2Na + Cl_2$

Catalyst

The chemical substance that increases or decreases the rate of chemical reaction is called catalyst. These substances are not expensed or also changed during the time of chemical reaction. The substances which increase the rate of chemical reaction, they are called positive catalyst. Similarly, the substances that decrease the rate of chemical reaction are called negative catalyst. Example:

$$2KClO_3 \xrightarrow{MnO_2} 2KCl + 3O_2$$

Here, MnO_2 acts as positive catalyst.

$$2H_2O_2 \xrightarrow{C_3H_5(OH)_3} 2H_2O + O_2$$

Here, $C_3H_5(OH)_3$ acts as negative catalyst.

Characteristics of Catalyst

a) There is no any change in their mass and chemical structure at the end of chemical reaction.

b) They do not start the reaction, but they increase or decrease the rate of reaction that has been started.

Things to remember

1. There will be no change in the real properties of matter but changes only in state, structure, colour, etc. take place in the physical change.
2. The change in molecular structure of matter as well as its properties is called chemical reaction.
3. The substances taking part in chemical reaction are called reactants whereas the substances obtained as the result of chemical reaction are called products.
4. The equation where the number of atoms of each element taking part as reactant and the number of atoms of the product is written by making equal is called balanced chemical equation.
5. During the time of chemical reaction, the reaction that absorbs heat is called endothermic reaction whereas the reaction that evolves heat is called exothermic reaction.
6. The chemical substance that increases the rate of chemical reaction is called positive catalyst whereas the chemical substance that decreases the rate of chemical reaction is called negative catalyst.

Exercise

A) Put correct sign (√) in the correct answer of the following multiple choice questions:

1. What is the change in molecular structure as well as state of matter called?

   a) Chemical change b) physical change

   c) Biological change d) Thermal change

2. What is the substance that takes part in chemical reaction called?

   a) Product b) Reactant

   c) Chemical substance d) Physical substance

3. What is the substance that is obtained as a result of chemical reaction called?

   a) Product b) Reactant

   c) Chemical substance d) Physical substance

4. What is the reaction that gives heat during the time of chemical reaction called?

a) exothermic reaction b) negative reaction

c) positive reaction d) endothermic reaction

B) Answer the following questions

1. What is chemical reaction? Give an example of each of exothermic and endothermic reaction.
2. What is catalyst? Describe the role of catalyst in the chemical reaction.
3. Balance the following unbalanced chemical equations.

a) $Na + O_2 \longrightarrow Na_2O$

b) $Hg + O_2 \longrightarrow HgO$

c) $Ca + N \longrightarrow Ca_3N_2$

d) $Fe + O_2 \longrightarrow Fe_2O_3$

e) $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$

f) $HCl + NaOH \longrightarrow NaCl + H_2O$

g) $HCl + KOH \longrightarrow KCl + H_2O$

h) $HNO + Ca(OH)_2 \longrightarrow Ca(NO_3)_{2\,+}\, H_2O$

4. Change the following word equations into balanced chemical equations.

a) Sodium + Oxygen → Sodium oxide

b) Potassium + Chlorine → Potassium chloride

c) Hydrogen + Chlorine → Hydrogen chloride

d) Nitrogen + Hydrogen → Ammonia

e) Calcium + Nitrogen → Calcium nitride

f) Calcium carbonate → Carbon dioxide + Calcium oxide

g) Zinc + Hydrochloric acid → Zinc chloride + Hydrogen

h) Ammonia + Nitrogen → Ammonium nitride

5. Complete the following chemical equations and balance them.

a) Na + …….. ⟶ Na_2O

b) Ca + O_2 ⟶ .....

c) …….. + O_2 ⟶ HgO

d) Al + N_2 ⟶ .....

e) Fe + …… ⟶ Fe_2O_3

f) Fe + $CuSO_4$ ⟶ ..... + Cu

g) HCl + …… ⟶ NaCl + H_2O

h) H_2SO_4 + NaOH ⟶ ……. + H_2O

i) ……. + $Ca(OH)_2$ ⟶ $Ca(NO_3)_2$ + H_2O

6. What are formed from the chemical reaction of the substances given below? Write the balanced chemical reaction as well.

a) When carbon burns in air

b) When calcium carbonate is heated

c) When a piece of burning magnesium ribbon is inserted in the jar filled with oxygen gas.

d) When hydrogen peroxide gets dissociated in the presence of manganese dioxide.

e) When chemical reaction between calcium carbonate and hydrochloric acid takes place.

f) When calcium carbonate and hydrochloric acid react with each other.

g) When carbon dioxide is passed through calcium hydroxide.

h) When a piece of burning magnesium ribbon is inserted in the jar filled with nitrogen gas.

i) When a piece of sodium metal is kept in water.

Project work

1. Burn a piece of magnesium ribbon in air. What changes do occur in it? Study and write the chemical reaction involved in it with equation.
2. Put a piece of calcium carbonate in water and observe it to know what happens. After that touch it with hand. What change do you get? Discuss and make conclusion.

Glossary

Physical change:	change in state, structure, colour, etc of substances
Chemical change:	change in molecular structure as well as chemical properties
Reactants:	substances taking part in chemical reaction
Products:	Substances obtained as a result of chemical reaction
Endothermic reaction:	process that absorbs heat during the chemical reaction
Exothermic reaction:	process that evolves heat during the chemical reaction
Negative Catalyst:	substances that decreases the rate of chemical reaction.
Positive Catalyst:	substances that increases the rate of chemical reaction

Unit

10

Solubility

Plants absorb minerals from soil in the form of solution and make different nutrient substances, like protein, vitamin, carbohydrate, fats, etc. Similarly, the nutrients gained from the food reaches to different organs of the body in the form of solution. Therefore solution has big role in the growth and development of organisms.

When we make tea, sugar gets dissolved in it or while cooking vegetable salt gets dissolved in the solution (water of vegetable). Solution has close relation with our life process. In this chapter, we will study about solution, types of solution, solubility, crystallization process, etc.

Solution

You have studied about the mixture in previous classes and have understood some things about solution. Solution is the homogeneous mixture of two or more than two substances. Now let us try to understand more about the solution.

Activity 1:

Make the mixture of following substances with water

Necessary materials

Salt – one spoon	sugar – one spoon	baking soda – one pinch
Surf – one spoon	chalk - one spoon	oil - one spoon
Sand - one spoon	soil - one spoon	sugar candy - one cube

Method

Take a glass or a plastic cup. Put half water in that cup. Add one spoon salt and stir slowly with spoon. Observe whether the salt dissolves or remains in solid state while stirring. After observing, whether solution is prepared or not, note in the copy making table.

Similarly, like above by mixing sugar, baking soda, surf, chalk, oil, sand, soil, milk and sugar candy respectively with water, test whether they dissolve or not.

After performing this activity, observing the properties of mixture, discuss which mixture can be called solution in the classroom.

Mixtures	Homogeneous mixture	Heterogeneous mixture	Mixtures	Homogeneous mixture	Heterogeneous mixture
Water + Salt			Water + Soil		
Water + Surf			Water + Baking soda		
Water + Sand			Water + Chalk		
Water + Sugar			Water + oil		
Water + Soil			Water + Sugar candy		

Homogeneous mixture is prepared after the mixing of matters in solution. In the above activity, those matter that completely disappear in water and particles of dissolved materials was not seen, all of them is solution. If solvent is liquid than mixture will be transparent.

Generally in solution, solvent is liquid and solute is solid or gas. But in liquid-liquid solution, the component of matter whose amount is more is called solvent and that matter whose amount is low is called solute. There are various type of solution. Let us study some examples given below.

Type of solution	Example of solution	Solvent	Solute
1. liquid + solid	Sugar water	Water	Sugar
2. liquid + liquid	Water and alcohol	Water Alcohol	Alcohol (if alcohol is more) Water (if water is more)
3. liquid + gas	Oxygen dissolved in water	Water	Oxygen gas
4. gas + gas	Atmosphere	Nitrogen (found more in amount)	Oxygen (found less in amount)

Unsaturated and Saturated Solution

According to the capacity of dissolving additional amount of solute and the amount of solute dissolved in solvent of a solution, solution is of three types.

a) Unsaturated Solution b) Saturated Solution

c) Super Saturated Solution

Activity 2

Apparatus required

Salt, beaker, glass rod, burner, matchstick, water, jug of water and vessel to heat water or porcelain basin

Procedure

Put two test tubes water in a beaker and add one spoon salt. Stir with the help of a glass rod. What happen to the salt, observe it.

Which solution is the solution, called in that state?

Again, add salt in that solution and stir. Did the added salt dissolve, observe. Continue this process till the salt stops dissolving. When salt stops dissolving, crystals of salt is left in the solution.

What is the solution in that state called, think.

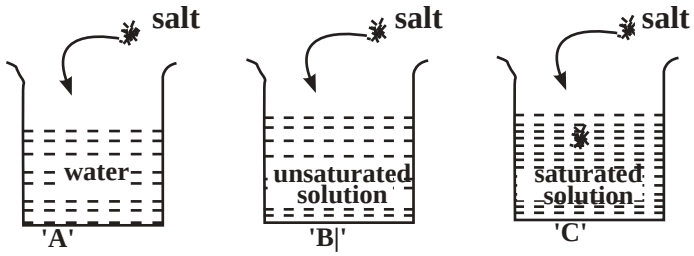


Fig 10.1: Saturated and unsaturated solution

As shown in the figure, in the state of solution (B) all salt dissolved. There is possibility of dissolving more salt. It is called unsaturated solution. In case (C), no more salt can be dissolved at that temperature. Therefore it is saturated solution.

In normal condition at certain temperature, if more solute can be dissolved in any solution then that solution is called unsaturated solution.
In normal condition at certain temperature if more solute cannot be dissolved in any solution then that solution is called saturated solution.

Supersaturated Solution

Activity 3

Like in activity 2, prepare saturated solution of salt and water. Heat that solution in spirit lamp or with the help of any other source. While heating, keep adding salt and stir with a rod. After sometimes salt stops dissolving or not, observe it. Now stop adding salt and cool the solution. This solution so, made is super saturated solution.

In normal state, the solution where more solute has been dissolved than the solute that can dissolve is called supersaturated solution.

Activity 4:

Way of identifying Solution

If three beakers with salt solution are given to identify them as unsaturated solution, saturated solution and super saturated solution, add one pinch of solute in each beaker. (If it is salt water solution than add one pinch salt). Stir with glass rod. In which solution more solute is dissolved, observe it. If solute dissolves than it is unsaturated solution. If the amount of solute that was added remained same but did not dissolve it is saturated solution. If the amount of solute increases than added then it is supersaturated solution.

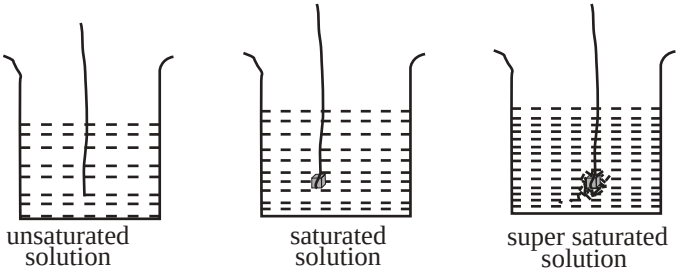


Fig 10.2: Types of solution

Solubility

In a certain temperature, if we keep dissolving sugar in 100gm water, at some moment. Such state comes when more sugar does not dissolve and it becomes saturated solution. The amount of dissolved salt in this state is called solubility.

In certain temperature, the amount of solute needed to make a saturated solution in 100 gm of water is called solubility.

Activity 5

Take three beakers and put 50ml of water in each. Keep on dissolving 5gm of each sugar, salt and copper sulphate separately in each of three beakers. The solution of which water became saturated solution first, observe. Now, which matter become saturated solution secondly and third, observe and discuss in classroom. The capacity of dissolving of different solute is different. Each matter has its own solubility. In the following table, solubility of different matters at 20°C in water is given.

Substance	Solubility	Substance	Solubility
Sodium chloride	35.7	Copper sulphate	20
Sucrose (sugar)	179	Sodium nitrate	88

Mathematically,

$$\text{Solubility} = \frac{\text{Weight of solute (in gm)}}{\text{Weight of solvent (in gm)}} \times 100$$

Example 1:

What is the solubility of sodium nitrate at 20°C, if 17.6gm of sodium forms saturated solution in 20gm of water?

Given,

Weight of sodium nitrate (solute) = 17.6gm

Weight of water (solvent) = 20gm

Solubility = ?

According to the equation of solubility,

$$\text{Solubility} = \frac{\text{Weight of solute (in gm)}}{\text{Weight of solvent (in gm)}} \times 100$$

$$\text{Solubility} = \frac{17.6\,gm}{20\,gm} \times 100 = 88$$

Therefore at 20°C solubility of sodium nitrate is 88.

Solubility has no unit, it is denoted only by number because it is the ratio of same physical quantity expressed in the same unit.

Example 2.

At 20°C, what amount of water is required to make saturated solution of 40gm of sugar? (The solubility of sugar at 20°C is 179.)

Given,

Weight of sugar (w1) = 40 gm

Solubility = 179

Weight of water (w2) = ?

According to formula,

$$\text{Solubility} = \frac{\text{Weight of solute (in gm)}}{\text{Weight of solvent (in gm)}} \times 100$$

Or, $179 = \frac{w_1}{w_2} \times 100$

Or, $w_2 = \frac{40 \times 100}{179} = 22.35\, gm$

Therefore, the weight of water is 22.35 gm.

Example 3.

If 25gm saturated solution is dried, 10gm of salt is left, then what is the solubility of salt at that room temperature.

Given,

Weight of saturated solution (w_1) = 25gm

Weight of Salt residue (w_2) = 10gm

Weight of vapourated water (w_3) = (w_1-w_2)gm

= (25-10)gm = 15gm

Therefore, weight of water = 15gm

According to formula of solubility,

$$\text{Solubility} = \frac{\text{Weight of solute (in gm)}}{\text{Weight of solvent (in gm)}} \times 100$$

Or, Solubility $= \frac{10}{15} \times 100 = 66.66$

Therefore, at given temperature, the solubility of the given salt is 66.66

Relationship between solubility and temperature

If temperature of a solution increased, the solute dissolving capacity of a solution also increases. The amount of solute that can be dissolved in equal volume of solvent is different at different temperature. Therefore, the solubility of solute increases with the increase in temperature.

Observe the solubility table given below.

Solubility of different substances at 20˚C and 100˚C

Solute	20˚C temperature	100˚C temperature
Sodium chloride	35.7	39.1
Copper sulphate	20	76.99
Sucrose	179	48.7
Ammonia gas	89.9	7.4
Oxygen gas	0.0045	0.0033

Generally, the solubility of solid substance increases with the increase in temperature. But the solubility of gas decreases. During summer, as the temperature of water increases the oxygen dissolved in water comes out of water. Therefore, fishes come to the surface of water for oxygen (for respiration).

Solid solute dissolves more in hot water than in cold water, why?

When temperature increases the gap between the molecules of solvent increase and forms a place for the solute to fit. In the region between these molecules, the additional solute fills the gap. Therefore, more solutes dissolve in hot water than in cold water. As a result solubility also increases.

Gas dissolves less in hot water, why? After discussing in class, present the conclusion to the class teacher.

When solution of liquid and gas is heated, the motion of gas becomes more than liquid. The place between the molecules of liquid is unsufficient for the molecules of gas. As a result, solubility decreases. For example, when we open bottle of cold drink, bubbles are seen coming out from the solution. Those bubbles are carbon dioxide gas dissolved in water. If we keep the bottle at sunlight, more carbon dioxide gas comes out. It is clear that the space between the molecules of water is unsufficient for the molecules of carbon dioxide gas in motion. Therefore the solubility of gas is less in hot water than in cold water.

Solubility Curve

The curve drawn on the graph paper showing the solubility of solute at different temperature is called solubility curve. While drawing solubility curve temperature is kept in X-axis and solubility of matter in Y-axis.

Study the solubility curve given in the figure and try to answer the following questions. Discuss with friends and tell the conclusion in class.

1. What is the solubility of potassium nitrate at 80°C? What is the solubility of ammonium chloride at the same temperature?
2. If solution of potassium nitrate at 100°C is cooled down to 50°C, how many gram of crystal of potassium nitrate is obtained?
3. If solution of potassium nitrate and ammonium chloride at 100°C is cooled down to 50°C, which substance forms crystal at first?

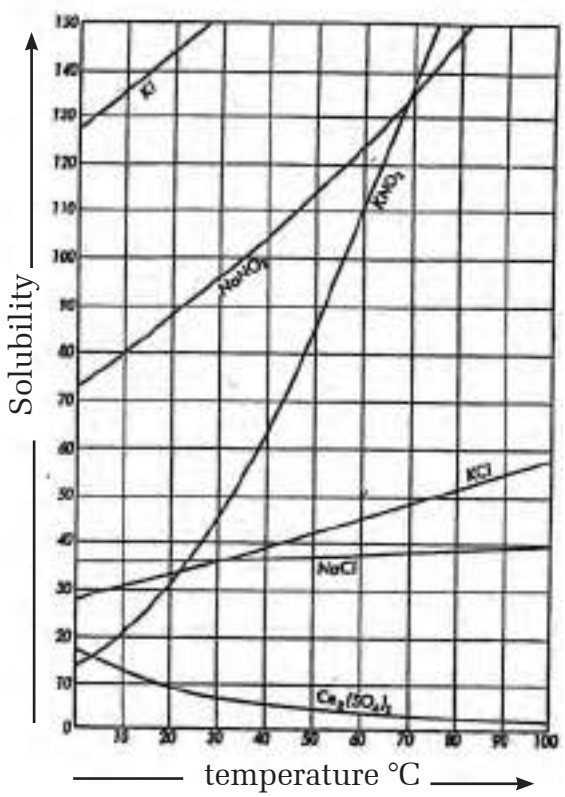


Fig. No 10.3: ***Solubility Curve***

Application of Solubility Curve

1. Solubility of solute can be known at any temperature.
2. We can compare the solubility of different solute at any temperature.
3. We can calculate the amount of crystal obtained by cooling the solution from one temperature to another temperature.
4. During crystallization of the solution of mixture of solutes we can find out the order of formation of crystals of that solute.

Activity 6

In the following chart, solubility of copper sulphate at different temperature is given. Observe this chart and draw a solubility curve in a graph paper. What happens when solution prepared at 50˚C is cooled down to 20˚C? Discuss in classroom

Temperature (˚C)	0	10	20	30	40	50	60	70	80	90	100
Solubility	14	17	20	24	29	34	40	48	57	68	77

Crystallization Process

When super saturated solution of solute is cooled down crystals of solute is formed. The process of forming of crystals in this way is called crystallization. Generally, this process is used to obtain pure substance form impure substances or to differentiate the mixture.

Crystallization process depends upon solubility of solute. Those solute that has low solubility, crystals of that solute is obtained fast. Example, at 20˚C the solubility of sodium chloride and copper sulphate is 35.7 and 20 respectively. When the mixture of these two matter is cooled down after preparing supersaturated solution, the crystals of copper sulphate gets separated at first whereas the sodium chloride remains in the form of solution. To obtain the crystal of sodium chloride, the solution should be cooled down for longer time.

Activity 7

Method of preparing crystals from crystallization method

Take 30ml of water in a porcelain basin or hard glass flask and mix copper sulphate slowly. Each time stir the solution with glass rod. Prepare saturated solution of copper sulphate at the end. Heat the vessel containing saturated solution slowly. After sometime when some amount of water changes into vapour, crystals are seen in the surface of porcelain basin. Now remove the source of heat.

When the solution is cooled down, crystals of copper sulphate will be seen at the base of porcelain or hard glass flask. The crystals separated

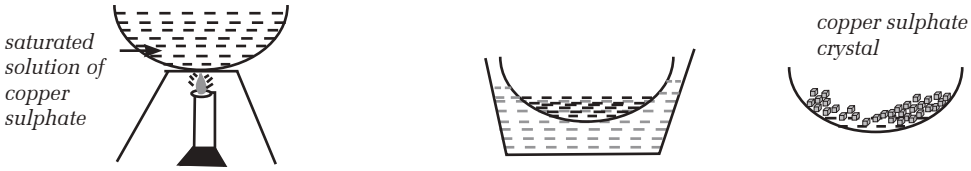


Fig 10.4: Process of crystallization of copper sulphate.

are pure wheras impurities remain in the solute. Take out the crystals and keep it in the filter paper and press to take the water out from crystals. In this way crystals of copper sulphate is made ready.

Pure sugar is known as sugar candy. To prepare the sugar candy, small piece of sugar candy is hanged with the help of thread in the saturated solution of sugar as shown in figure. After some days, big crystal of sugar is prepared. The preparation of sugar candy in this way is also called crystallization process.

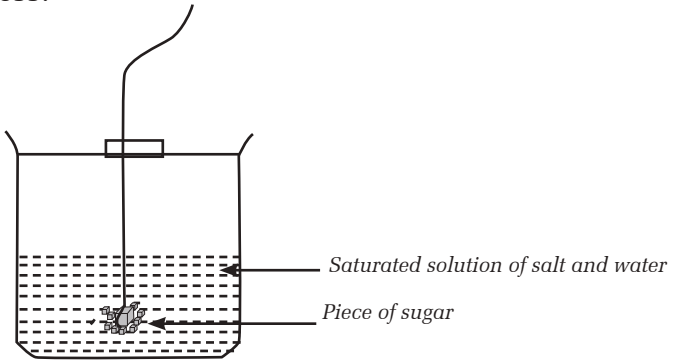


Fig. 10.5: Big crystal of sugar

Things to remember

1. Homogeneous mixture of matters is called solution.
2. Solution can be divided into different types according to the condition of solute and that of solvent. Example: liquid and solid solution (sugar water), liquid solution (water and alcohol), etc.
3. According to the amount of solute in solution and the capacity of solvent to dissolve solute, it can be divided into three types as unsaturated, saturated and super saturated.
4. In normal condition the solution that can dissolve more solute is called unsaturated solution.
5. In normal condition the solution that cannot dissolve more solute is called saturated solution.
6. In normal condition the solution made by dissolving more solute than the solvent can dissolve is called super saturated solution.
7. In normal condition if one piece of crystal of solute is kept in super saturated solution then the solute dissolved in water changes in the form of crystal.

8. In certain temperature, the amount of solute needed to make saturated solution in 100gm of water is called solubility.

9. Equation of solubility. $\text{Solubility} = \frac{\text{Weight of solute (in gm)}}{\text{Weight of solvent (in gm)}} \times 100$

   At high temperature, the solid state solute dissolves more in a solution. Because, the molecules of solvent vibrate and the gap between molecules increases.

10. The curve drawn keeping the solubilities of any matter at different temperature is called solubility curve. While drawing this curve, temperature is kept in the X-axis.

11. Solubility curve is used to find solubility of solute at different temperature, to compare the solubility of two matters, to find the amount of crystal that comes out while cooling a solution.

12. The process of purifying crystal obtained from the solution of solid solute is called crystallization, where pure matter is separated in the form of crystals.

Exercise

A) Put correct sign (√) in the correct answer in the following multiple choice question.

1. Which one of the following mixtures is called solution?

   a) water and kerosene b) water and alcohol

   c) water and oil d) water and milk

2. If a piece of sugar candy is tied in thread and then dipped in the sugar water solution, what type of solution is that?

   a) unsaturated solution b) saturated solution

   c) supersaturated solution d) None of the above

3. What is the solubility of salt if 12gm salt dissolves in 50gm of water to prepare saturated solution at a certain temperature?

   a) 12 b) 24 c) 50 d) 25

4. Among these, which one is not the purpose of solubility curve?

   a) to find solubility b) to compare solubility

   c) to find crystallization rate d) to find atomic weight.

B) Answer the following questions.

1. Define solution and give any five examples.
2. Differentiate saturated and unsaturated solution.
3. What is meant by supersaturated solution? How is this made?
4. Give any two examples of solution where solute is gas and solvent is liquid.
5. How can you differentiate the given solution in beaker as saturated, unsaturated and supersaturated?
6. Define solubility. What is meant by "solubility of copper suphate at 20°C is 20"?
7. Write the equation of solubility. At 25°C, in 500gm water, 240gm potassium chloride dissolve to form saturated solution, find out the solubility of potassium chloride at that temperature.
8. Describe the relation of solubility and temperature. Solute in solid state dissolves more in hot water than in cold water, why?
9. What do you understand by solubility curve? What conclusions can we draw from that curve?
10. In the following table, solubility of lead nitrate is given. Study the table and answer the following questions.

Temperature (°C)	20	40	60	80	100
Solubility	58	74	94	115	140

Draw solubility curve of lead nitrate according to the table given above.

b) At 20°C and 50°C, what are the solubilities of lead nitrate?

c) What happens when the solution of lead nitrate at 50°C is cooled to 30°C?

11. At 20°C, solubility of sugar is 179. How much gram of sugar is needed to prepare saturated solution with 30gm of water?
12. If 15 gm saturated solution prepared at 30°C is cooled down to 10°C, what is the amount of salt obtained?
13. What is meant by crystallization process? Describe how can you prepare crystal of copper sulphate?

Project work

Fill one third part of a glass with water at your home. Keep on dissolving salt in water and stir with a spoon. Then, how many gram of salt is needed to prepare saturated solution is noted down. Similarly in another glass put water and keep on dissolving sugar. Find the amount of sugar needed to prepare saturated solution. Now, compare the solubility of salt and water.

Glossary

Burner:	A device that burns with gas and used for heat in laboratory.
Crystal:	solid with certain geometrical structure
Solute:	matters that gets dissolved in solvent/ example: sugar, salt, etc
Solvent:	matter that dissolves solute. Example: water, alcohol, etc.
Porcelin basin:	small white bowl used for heating/grinding purpose.

Unit 11

Some Gases

The formation of natural or manmade things like plants, animals, food, petrol, drinks, steel etc is impossible without gases. Either the food that we consume or petrol required for vehicle, to obtain these things also, gases play a great role directly or indirectly. Only four elements oxygen, hydrogen, nitrogen and carbon constitute 96.2% of human body weight, among which oxygen, hydrogen and nitrogen are gases. They form different useful substances combined with other elements and those substances have direct relationship with human life. Gases we need are obtained directly from atmosphere or from industrial production. Gases like hydrogen, oxygen and nitrogen are produced in laboratory. In this chapter, we will study about these three gases.

Gases are present in the form of mixture in the atmosphere. The gases present in atmosphere are given in the table below.

Gas in atmosphere	Molecular formula	Percentage on the basis of volume
Nitrogen	N_2	78.08%
Oxygen	O_2	20.95%
Argon	Ar	0.93%
Carbon dioxide	CO_2	0.0360%
Hydrogen	H_2	0.00005%
Ozone	O_3	0.000004%
Other gases (Ne, He, CH_4, N_2O)		0.003945%

Source: www.physicalgeography.net

Hydrogen gas

The lightest gas and the most abundantly found element in the atmosphere is hydrogen. This gas is found in the sun, star and the space in between stars. But, only 0.00005% (by volume) of hydrogen is found as a form of gas in the Earth. Hydrogen is available in the form of compounds by reacting with other elements as it is highly reactive. Example: Acid, hydrocarbon Carbohydrate, etc.

Henry Cavendish introduced hydrogen as 'combustible gas' in 1823 A.D. But later Lavoisier termed it as hydrogen. As the hydrogen forms water when burns with oxygen, it is called hydrogen. The meaning of hydrogen is 'Water forming' or 'water producer'.

Some facts about the hydrogen are given in following table.

Do you know?

Hydrogen is of three types, hydrogen ($_1H^1$) in which one electron and one proton is present whereas neutron is absent. Deuterium ($_1H^2$) in which one electron, one proton and one neutron are present. Tritium ($_1H^3$),in which one electron, one proton and two neutrons are present. Among them, the heaviest one is tritium. Heavy water is formed by deuterium and oxygen. This water is use in molecular plants.

Symbol	Molecular formula	Atomic number	Atomic weight	Electronic configuration
H	H_2	1	1	$1s^1$

Methods of preparation of hydrogen gas

There are three major sources of hydrogen, acid, base and water. Hydrogen gas is prepared from all these three types of substances. We will only discuss about the method of laboratory preparation of hydrogen gas and the method of preparation of hydrogen gas by electrolysis of water.

A) Laboratory Preparation of Hydrogen gas

Active metals like zinc, magnesium etc displace the hydrogen present in an acid and release hydrogen gas. In laboratory, granulated zinc and dilute hydrochloric acid react with eachother to form hydrogen gas.

$$Zn\ (s) + 2HCl\ (aq) \longrightarrow ZnCl_2 + H_2$$

(zinc) + (dil. Hydrochloric acid) ⟶ (zinc chloride) + (hydrogen)

(Note: Reaction slows down by using pure zinc. So, granulated zinc is used. The impurity present in that helps to increase the rate of reaction.)

Method

Zinc is kept inside clean woulfe's bottle and all apparatus are fitted as shown in figure. Dilute hydrochloric acid is poured through thistle funnel in such a way that another end of thistle funnel dipped in acid. Hydrogen gas starts to produce immediately after acid comes in contact with zinc. The gas is collected in a gas jar by displacing the water.

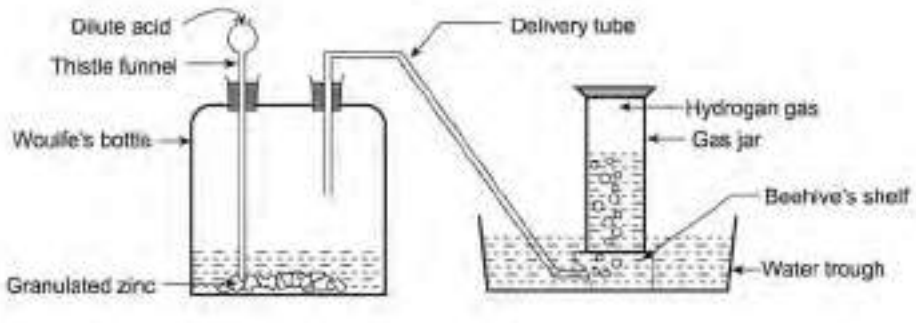


Fig 11.1: Laboratory preparation of Hydrogen gas

Precautions

1. All apparatus should be cleaned.
2. Granulated Zinc should be used.
3. All apparatus should be air tight.
4. Dilute acid should be used because concentrated acid does not give hydrogen gas.
5. Acid should be poured in thistle funnel, so that its another end sinks in the acid.
6. Gas jar should be filled with water completely or bubbles of air should be absent.

Test for hydrogen gas

How can we know that the gas produced in laboratory is Hydrogen gas? Think for a while. The gas burns when taking the burning matchstick closer to the mouth of an upright gas jar. If it produces 'pop' sound while burning then that gas is hydrogen. Other gases do not produce 'pop' sound.

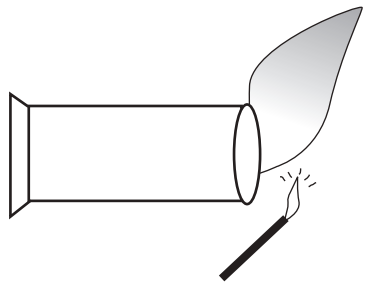


Fig 11.2: Test for Hydrogen gas

B) Production of hydrogen gas by electrolysis of water

Industrial production of hydrogen is done from water. Since water is found abundant in the Earth and a molecule of water is composed of two atoms of hydrogen, industrial production of hydrogen have been done from water.

Acidulated water is kept into a voltameter and electricity is passed through it. By doing so, a molecule of water dissociates into hydrogen and oxygen ions. Hydrgen ion moves towards cathode and oxygen ion moves towards anode and collected in the form of gas.

The collected gase is filled in a cylinder.

$2H_2O \rightleftharpoons 2H_2 + O_2$

By this method, 100% pure hydrogen is prepared. The production of hydrogen is done by this method where electricity is cheap.

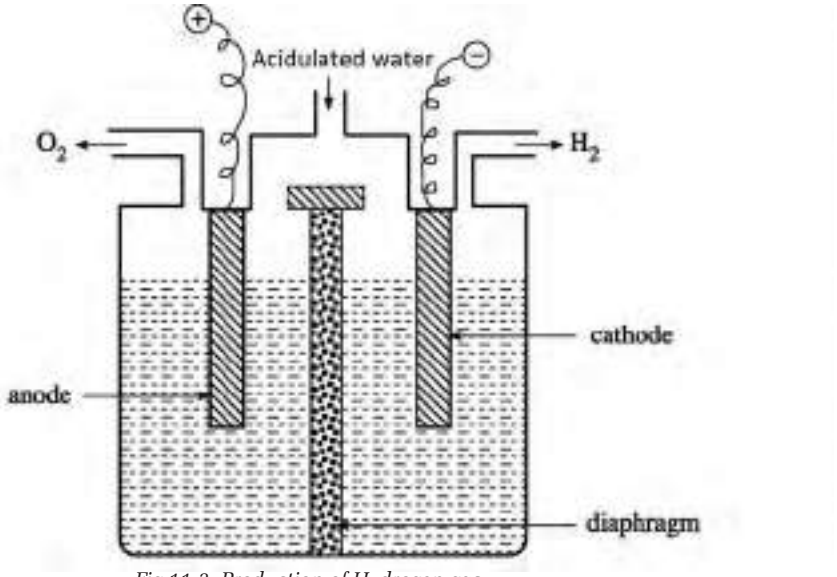


Fig 11.3: Production of Hydrogen gas

Properties of hydrogen gas

Physical properties

1. Hydrogen gas is colourless, odourless and tasteless.
2. Hydrogen gas is lighter than air.
3. Hydrogen gas is insoluble in water.
4. Hydrogen gas shows no effect in litmus. So, it is neutral gases.
5. Hydrogen gas is converted into liquid at -253°C and into solid at -259°C.

Chemical Properties

1. Hydrogen burns with air or oxygen to form water.

$$2H_2 + O_2 \xrightarrow{\text{Heat}} 2H_2O$$

2. Generally, in high temperature hydrogen quickly reacts with non metal.

$$C + 2H_2 \xrightarrow{\text{Heat}} CH_4 \text{ (methane)}$$

$$S + H_2 \xrightarrow{\text{Heat}} H_2S$$

3. Then metals like sodium, potassium, calcium are burnt in vessel with hydrogen unstable hydrides are formed.

$$2Na + H_2 \longrightarrow 2NaH \text{ (sodium hydride)}$$

$$2K + H_2 \longrightarrow 2KH \text{ (potassium hydride)}$$

$$Ca + H_2 \longrightarrow CaH_2 \text{ (calcium hydride)}$$

4. When dry hydrogen is passed through hot oxide of metal, metal and water are formed.

$$Fe_2O_3 + 3H_2 \longrightarrow 2Fe + 3H_2O$$

$$CuO + H_2 \longrightarrow Cu + H_2O$$

$$PbO + H_2 \longrightarrow Pb + H_2O$$

This process is chosen to extract metal from oxide of metal. This process is called reduction reaction. As hydrogen removes the oxygen present in the metallic oxide to form water, this process is called reduction reaction.

Uses of Hydrogen gas

1. To extract metal from metallic oxide, hydrogen gas is used.
2. Hydrogen gas is used to prepare ammonia gas.
3. Hydrogen gas is used to prepare vanaspati ghee.

   Hydrogen is passed through vanaspati oil in the presence of heat and catalyst. By doing so, oil is converted into ghee, which is called vanas pati ghee.

   $$\text{Vanaspati oil} + H_2 \xrightarrow[250°C]{\text{8 to 10 atm}} \text{vanaspati ghee.}$$

   This reaction is called hydrogenation.
4. Hydrogen gas is used as fuel in rockets. Large amount of energy is re

leased during the reaction between hydrogen and oxygen and that helps to launch the rocket.

5. Approximately upto 3000°C temperature is releasedwhen hydrogen burns in the presence of oxygen. The flame which comes when oxygen and hydrogen burns is called oxyhydrogen flame which is used to cut and join metals and that process is called welding.

Oxygen gas

Oxygen gas is the necessary gas for plants and animal to be alive. Oxygen destroys the harmful bacteria resent inside our body. In atmosphere, 21% (by volume) oxygen gas is present. In different substances like water, carbohydrate, limestone, silica, wood, etc oxygen is present in the form of compounds. In 49% of Earth's surface, this gas is found in the form of oxides.

A British scientist Joseph Priestley prepared the oxygen gas for the first time by heating red oxide of mercury in 1774 AD. Later on, Lavoisier gave the name Oxygen. The same scientist found that oxygen constitutes one fifth part of the atmosphere.

Do you know?

Ozone is the blue coloured gas formed by the combination of 3 atoms of oxygen. This gas is deep blue in its liquid state. Ozone is being formed during the use of electrical devices or electrolysis of water or lightening. Ozone present in atmosphere prevents from reaching different harmful radiations from sun upto the surface of the Earth which prevents from cancer and damage of gene.

Some facts about oxygen are given below:

Symbol	Molecular formula	Atomic number	Atomic weight	Electronic configuration
O	O_2	8	16	$1s^2,2s^22p^4$

Methods of Preparation of Oxygen gas

1. Laboratory preparation of oxygen gas

a) By using heat

When salt containing oxygen is heated, oxygen gas is liberated. In laboratory, potassium chlorate (KClO3) is heated with manganese dioxide (MnO2) to prepare oxygen. Manganese dioxide is only a catalyst here, which increases the rate of chemical reaction.

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

Method

The mixture of 4 parts of potassium chlorate and one part of manganese dioxide is kept inside a hard glass test tube and apparatus are arranged as given in the diagram. The mixture present in test tube liberates oxygen gas, when heated approximately at 250°C. This released gas is collected in an inverted gas jar.

Precautions

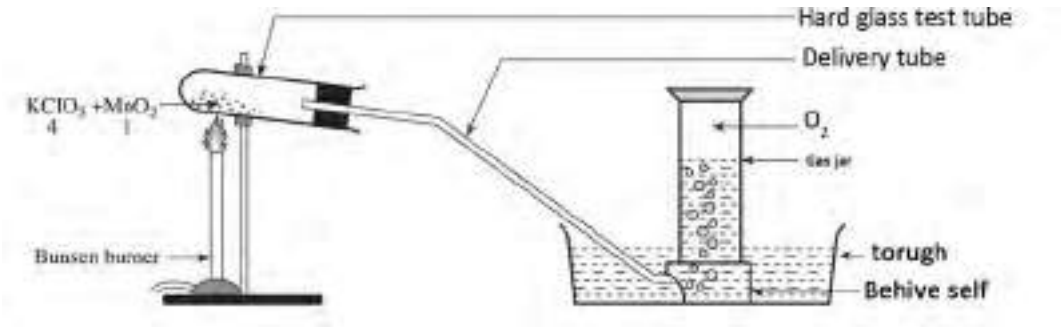


Fig 11.4: Process of preparation of oxygen gas

1. Hard glass test tube should be slanted as shown in diagram. It does not allow to mix the water forming during the chemical reaction with reactants.
2. Apparatus should be air tight.
3. Gas jar should be completely filled with water or air bubbles should be absent.

b) **Without using heat**

In laboratory, oxygen gas is prepared by mixing hydrogen peroxide (H_2O_2) with manganese dioxide (MnO_2). In this process, manganese di oxide acts as a catalyst.

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

Method

Put some manganese dioxide and water in a conical flask and all the apparatus are fitted as shown in given diagram. Hydrogen peroxide is slowly poured in the conical flask through thistle funnel. Oxygen gas is released immediately after hydrogen peroxide and manganese dioxide get contact. Oxygen gas is collected by downward displacement of water in a gas jar.

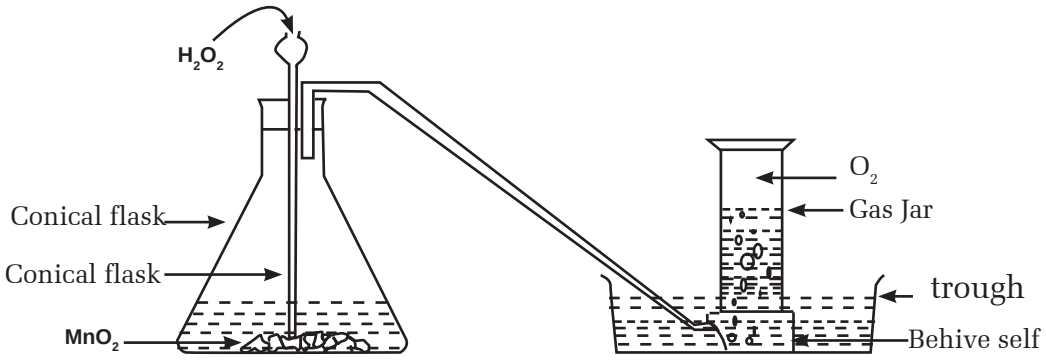


Fig 11.5 Laboratory preparation of oxygen gas without using heat.

Precautions

1. All apparatus should be fitted air tightly.
2. The end of the thistle funnel should be dipped inside hydrogen peroxide.
3. Pure manganese dioxide should be used.

Test of gas

How to know that the gas prepared in laboratory is oxygen gas? Let's think for a while. When burning match stick is inserted inside the gas jar containing oxygen gas, if it burns more brightly then that gas is oxygen. It happened so because oxygen gas helps others to burn.

2. **Manufacture of Oxygen gas**

Oxygen is present enough in water and air. So, those two sources are used for manufacture of oxygen gas.

A) **From electrolysis of water**

When electrolysis of water is done, oxygen gas is produced.

$2H_2O \rightleftharpoons 2H_2 + O_2$

(Note: Please see hydrogen gas for this process)

B) **From liquid air**

Air is converted into liquid state by applying high pressure. More amount of nitrogen and oxygen are present in liquid air. As, the boiling point of liquid nitrogen is -196°C and that of liquid oxygen is -183°C, when liquid air is heated nitrogen will be escape out first whereas oxygen will remain in liquid state. The oxygen in that state is heated up to -183°C and liquid oxygen is converted into gas. Oxygen gas and nitrogen gas prepared in this way are directly filled in separate cylinders. In this way, manufacture of oxygen gas from liquid air is done. Both nitrogen and oxygen gases can be prepared by this method.

Properties of Oxygen

Physical Properties

1. Oxygen gas is colourless, odourless and tasteless.
2. Oxygen gas is slightly heavier than air.
3. Oxygen gas is slightly soluble in water.
4. Oxygen gas is neutral. So, it does not show any effects on litmus.
5. Oxygen gas reamins in liquid state at -183°C and in solid state at -219°C.

Chemical Properties

1. When metals are burnt in the presence of oxygen, metallic oxides are formed. But gold (Au) and platinum (Pt) do not form oxide.

   $4Na + O_2 \longrightarrow 2Na_2O$ (sodium oxide)

$4K + O_2 \longrightarrow 2K_2O$ (potassium oxide)

$2Mg + O_2 \longrightarrow 2MgO$ (magnesium oxide)

2. When non metals burn in the presence of oxygen, oxides of non metals are formed.

   $2H_2 + O_2 \longrightarrow 2H_2O$ (water)

   $C + O_2 \longrightarrow CO_2$ (carbon dioxide)

3. All hydrocarbons burn in the presence of oxygen and convert into CO_2, water and energy.

   $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + energy$

   $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O + energy$

4. The oxygen mixed in the blood reacts with glucose in the presence of biocatalyst inside the cell and liberates energy.

   $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + energy$

   This reaction takes place inside our body during the respiration process.

Uses of Oxygen gas

1. Inside the body, oxygen gas helps to produce energy reacting with glucose.
2. Oxygen is used for cutting or welding metals. This work is done by oxy-acetylene flame or oxy-hydrogen flame.
3. In hospital, with the help of oxygen filled in cylinder, patients suffering from pneumonia or having problem in respiration can perform artificial respiration.
4. Oxygen gas cylinder is used to work in mines, to go in high altitude, to study about space, to work inside water.

During the production of steel, to remove impurities present in iron like carbon or any other non-metals, oxygen is used.

Nitrogen gas

Nitrogen gas does not react with other elements or compounds at normal state. Comparatively, it is neutral gas. But nitrogen has big importance in plants, animal and industrial areas. Nitrogen is present in the protein, enzymes, RNA, DNA found in plants and animals. In atmosphere 79% (by

volume) nitrogen is present. Nitrogen is present in the form of compound in some stones and minerals.

Daniel Rutherford discovered nitrogen in 1772. In 1790, Chaptal gave the name nitrogen.

Some facts about nitrogen is given below.

Symbol	Molecular formula	Atomic number	Atomic weight	Electronic configuration
N	N_2	7	14	$1s^2,2s^22p^3$

Methods of Preparation of Nitrogen gas

Nitrogen gas can be formed by different ways. This gas can be produced by passing hot air in copper, burning phosphorous in oxygen, liquid air as well as by the reaction between ammonium chloride and sodium nitrate.

Here, we will study only how nitrogen is produced in laboratory and industries.

A) **Laboratory Preparation of Nitrogen gas**

Nitrogen gas is prepared by heating the mixture of sodium nitrite ($NaNO_2$) and ammonium chloride (NH_4Cl).

$$NaNO_2 + NH_4Cl \longrightarrow NaCl + N_2 + 2H_2O$$

Procedure

Mixture of 5gm of sodium nitrate and 4 gm of ammonium chloride is kept in a clean round bottom flask. Then, 50ml water is added to make solution. The apparatus are arranged as given in the figure. The mixture is heated slowly. By doing this, nitrogen gas is liberated and is collected in the gas Jar by displacing the water.

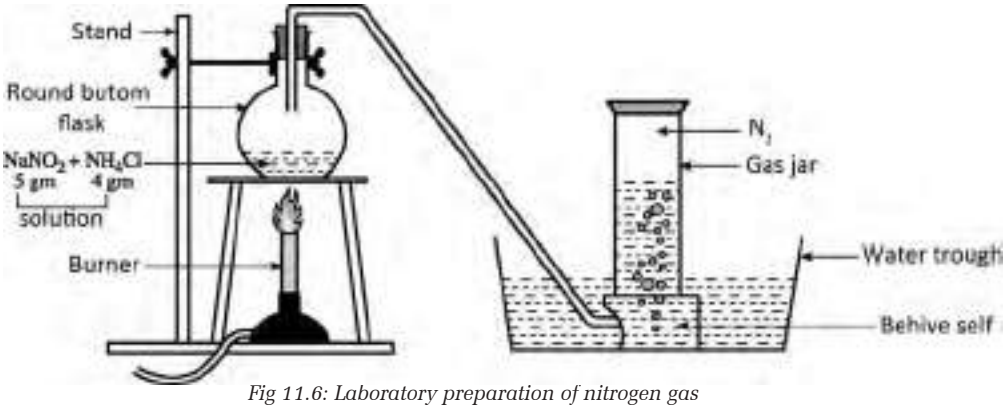


Fig 11.6: Laboratory preparation of nitrogen gas

Precautions

1. As solid ammonium chloride is volatile in low temperature, we should make solution before heating.
2. The apparatus should be air tight.
3. The mixture should be heated slowly.

Test of gas

How can we know that the gas collected in jar is nitrogen? Discuss with teacher, perform the test.

When burning magnesium ribbon is inserted inside the gas jar containing nitrogen gas, it keeps on burning and at the end it converts into yellow powder. When some drop of water is added to yellow powder, if the smell of ammonia is noticed, then the gas collected in the jar is nitrogen.

Manufacture of Nitrogen gas.

(This chapter is given in the manufacture of oxygen gas from liquid air.)

Properties of Nitrogen gas

Physical Properties

1. Nitrogen gas is colouless, odourless and tasteless.
2. Nitrogen gas is lighter than air.
3. Some volume of nitrogen gas dissolves in oxygen.
4. Nitrogen gas is neutral. Therefore, it shows no change in litmus.
5. Nitrogen is neither combustible nor support in combustion.
6. Nitrogen gas remains in liquid state at -196°C and converts into solid state at -210°C.

Chemical Properties

Nitrogen does not easily react with other elements. But also at certain condition it reacts with different matters. Some chemical properties are given below:

1. At 2000° C to 3000°C, in the presence of electric spark nitrogen reacts with oxygen to form nitrogen oxide.

$N_2 + O_2 \longrightarrow$ 2NO (nitrogen oxide)

2. At approximately 450 and 500 atmospheric pressure as well as in the presence of catalyst (Fe/Mo) nitrogen reacts with hydrogen to form ammonia.

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

3. When metals like magnesium, aluminium, calcium is burnt and kept in the container with nitrogen gas it burns continuously and forms re spective nitrides.

$3Mg + N_2 \longrightarrow Mg_3N_2$ (magnesium nitride)

$3Ca + N_2 \longrightarrow Ca_3N_2$ (calcium nitride)

Uses of nitrogen gas

1. Use of nitrogen is more in the production of ammonia, nitric acid which is used for the industrial manufacture of chemical fertilizers.
2. Nitrogen gas is filled in the packet to protect the packet food from being damaged.
3. Nitrogen gas is filled in the bulb for preventing burning of tungsten wire inside the electric bulb.
4. As liquid nitrogen has -196.5°C temperature it is used as refrigerant.

Things to remember

1. When hydrogen burns in the presence of oxygen, water is formed.
2. By the use of hydrogen, vanaspati oil is converted into vanaspati ghee. This process is called hydrogenation.
3. Hydrogen is combustible gas. It gives 'pop' sound while burning.
4. When salt with oxygen and oxides of metal is heated, oxygen gas is liberated.
5. Manufacture of oxygen can be done from liquid air.
6. Some volume of oxygen gas dissolve in water, that oxygen is used in the respiration by aquatic animals.
7. Oxygen gas reacts with glucose to produce energy in body.
8. Oxy-acetylene flame and oxy-hydrogen flame is used in cutting and welding metals.

9. Nitrogen gas is formed by heating the mixture of sodium nitrate and ammonium chloride.

10. Nitrogen gas is used in the preparation of chemical fertilizer and in the filament of electric bulb.

Exercise

A) Put the correct sign (√) in the correct answer in the following multiple choice questions.

1. Among these, which gas is completely insoluble in water?

   a) nitrogen b) hydrogen c) ammonia d) oxygen

2. What is the process of preparing vanaspati ghee from vanaspati oil called?

   a) hydrogenation b) reduction

   c) oxidation d) carbonation

3. Among these, which substance is heated to produce oxygen gas in laboratory?

   a) $KClO_3$ b) $CaCO_3$ c) H_2O_2 d) Fe_2O_3

4. Which compound is formed when magnesium is burnt with oxygen?

   a) magnesium nitrate b) magnesium nitrite

   c) magnesium oxide d) magnesium nitride

B) Answer the following questions

1. How is hydrogen gas prepared in laboratory? Explain along with chemical equation.

2. Draw a well labeled diagram of apparatus filled for laboratory preparation of hydrogen gas. Also, write the procedure in few stpes.

3. What are the physical properties of hydrogen gas? Write any four properties.

4. What do you mean by hydrogenation? Write its importance in our daily life.

5. Write any four uses of hydrogen.

6. What substances are formed when hydrogen reacts with the following matter? Write balanced chemical equation.

   a) sodium b) oxygen c) nitrogen d) ferric oxide

7. Explain with diagram about the method of preparing oxygen gas in laboratory without using heat.
8. Write the manufacturing process of oxygen gas from liquid air.
9. Write any four physical properties of oxygen gas.
10. If you are asked to identify whether the given gas in a gas jar is oxygen or not, write how will you identify? Explain it.
11. What happens when metals and non metals burn with oxygen? Write an example of each.
12. Write four important uses of oxygen gas.
13. Draw a well labeled diagram showing the apparatus fitten for laboratory preparation of nitrogen gas. Also, write the balanced chemical equation of the chemical reaction involved in it.

a) $2H_2$ + ... ⟶ $2H_2O$

b) Na + H_2 ⟶ .....

c) ..... ⟶ KCl + $3O_2$

d) ..... + O_2 ⟶ CO_2 + $2H_2O$ + energy

e) $C_6H_{12}O_6$ + O_2 ⟶ ..... + ... + energy

f) ..... ⟶ H_2 + O_2

g) 3Mg + N_2 ⟶ .....

h) $4P + 5O_2$ ⟶ .....

Project work

Collect the local alternative apparatus which can be used to prepare hydrogen, oxygen and nitrogen gases beside the required apparatus given in this chapter for the laboratory preparation of hydrogen, oxygen and nitrogen gases. How can those gases be prepared using these apparatus? By taking help from teacher, prepare these gases.

Glossary

Electrolysis: the method of dissociating the elements present in a compound (electrolyte).

Cathod: conductor connected to the negative pole of a battery

Anode: conductor connected to the positive pole of a battery

Hydrogenation: the process of adding sufficient hydrogen to the unsaturated hydrocarbon in the presence of catalyst.

Biocatalyst: the substance present inside the body which acts as a catalyst.

Slake lime: the solution of lime (CaO) and water or $Ca(OH)_2$

Unit

12

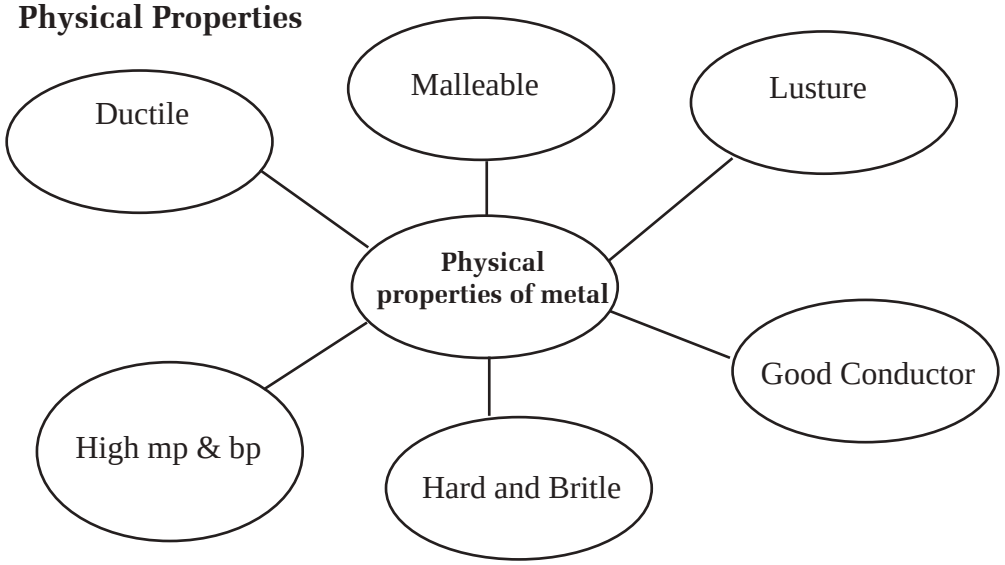
METAL

The things around us have been made from different matters such as; wood, plastic, glass, copper, iron, gold, silver, etc. These matters are either elements or compounds. Pure matters (which are called elements) can be divided into three groups as metal, metalloid and non-metal. Metals have been used in utensils, vehicles, aeroplanes, train electrical equipments. Without these objects our life cannot move easily. If there was no iron found in blood and metal magnesium in chlorophyll of plants then no one would have been alive in this earth. If in our body there were no enough metal zinc then what would happen? Because of the zinc, nose has the power of smelling. If there was no power of smelling it would be hard to live. How are the properties of these important metals? Can non-metal do the work of metal? What are the differences in metal and non-metal? What are the roles of metals in our life? About all this we will study in this chapter.

General properties of metal

You studied about some metals and non-metals in previous classes. In this chapter (through different activities) we will study properties of metal. Let's study the properties of metal dividing into two types as physical and chemical.

a) **Physical Properties**



Let's study the physical properties of metals mentioned above from the following activities.

Activity 1: Hardness of metal

Take a piece of wood, a piece of copper, an iron nail, bowl made up of aluminium, sulphur, coal, etc substances in hand chronologically and check hardness and softness by touching them. Try to break them and write the result according to the given table in a copy.

Substances	Hard or soft	Can be broken or not	Conclusion
Nail of iron	Hard	Can not	
Piece of coal			
Piece of copper			
Bowl of aluminium			
Sulphur			

From the above activities it is clear is that metals are hard. They cannot be easily broken. But all metals are not hard, example: sodium and potassium. These metals are soft and can be easily cut with knife. In normal temperature mercury is the metal found in liquid state.

Activity 2: Lustre Property of Metal

Take a sheet of zinc, a pot of copper, jewellery made up of gold, coal, paper, phosphorous, etc and observe which of them shine and which do not. Scratch those substances with nail of iron one by one. Now write your result in copy according to the table below.

Substances	Shines or does not shine	Conclusion
Coal		
Copper		
Sulphur		
Sheet of zinc		
Jewellery of gold		
Paper		

Metals shine, which is called metallic luster. Due to the presence of independent electron they shine. Non metal do not shine.

Activity 3: MALLEABILITY

Heat the above substances one by one slowly with a hammer. Observe nicely what changes occur in which materials and fill the table below according to that. Do this activity under the supervision of teacher.

Substances	Metals can be converted into sheet by beating	Non metals cannot be converted into sheet

Though metals are hard when hit by hammer by heating, the hit place will become widened and in the end is converted into sheet. Due to this property metals are used to make different materials. This property is called malleability.

Activity 4: DUCTILITY

Have you seen making long wires from the above discussed metals or others? Make report and discuss in class between friends. Now fill the conclusion in the table given below.

Substances	Can change the metal into small wires by stretching	Wire cannot be made from non metals

Wire is made from metal by slowly stretching. By doing this, not any difference is seen in the properties of metal. While stretching metal, the positive charged ions and necessary amount of electrons are being pulled slowly and are changed in the form of long wire. The properties of metal of making wire are called ductility.

Do you know?

Nowadays, in this world the most used metal in the form of semiconductor is graphin. They are light in weight and transparent. But is 100 times stronger than steel. Graphin was built in the laboratory for the first time in 2003 A.D.

Activity 5: GOOD CONDUCTORS

Take one dry cell, wire and small bulb and join it as shown in the figure below.

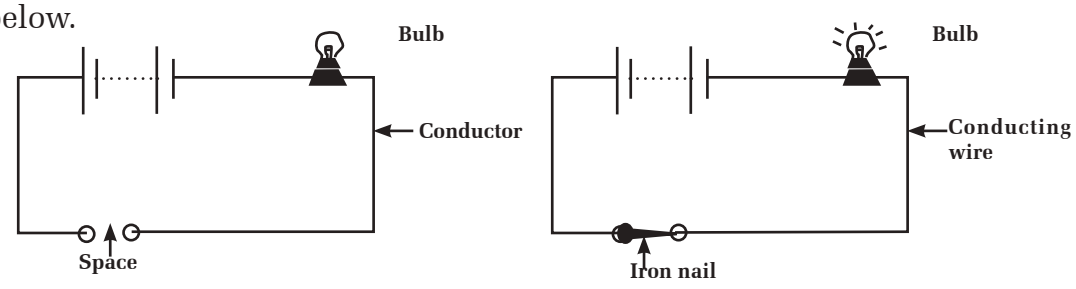


Fig 12.1: Conductivity of metal

Join materials like paper, sulphur, copper, iron, aluminium, wood, etc one by one in the empty place of electric circuit with wire. While joining, which material did the bulb light? Observe and fill the table below. While joining discuss with friends regarding the materials which allow electricity to glow the bulb, they are metals and metals conduct electricity.

Materials that conduct electricity	
Materials that cannot conduct electricity	

Activity 6: GOOD CONDUCTOR OF HEAT

Take one candle and match stick, light a candle. Heat the spoons made up of steel and aluminium, iron nail, pencil, piece of wood, etc materials one by one holding them at one end.

Substances	Conducts heat/does not conduct	Conclusion

As there is strong attracting force between atoms of metals, they are strong and hard. Therefore, the melting point and boiling point of metals are high. Melting points of some metals are given below:

Metals	Melting Point	Boiling Point
Mg	650˚C	1107 ˚C
Al	660˚C	2467 ˚C
Fe	1535˚C	2750 ˚C
Cu	1083˚C	2567 ˚C

But the melting and boiling point of sodium and potassium are very low than other metals.

Metals	Melting Point	Boiling Point
Na	97.79˚C	882.94˚C
K	63.5˚C	759˚C

If we mix metals with each other in the molten state, a homogenous mixture is formed with different properties rather than a chemical change which is called alloy. Example: brass.

Do you know?

Brass is an alloy of copper and zinc. Brass is harder, stronger and less active than copper and zinc. Physical properties of alloys are like metals. All metals cannot make alloy. To form an alloy homogenous mixture of mixed metals should be formed.

Activity 7: Sound producing (sonorous) property

Take a cooker and a rod. Hit the cooker with rod. Listen to the sound produced. Discuss in classroom. Similarity between this sound and sound bicycle bell or the bell that is rung before the class starts or after the class ends. The tingling sound that comes after hitting metal is called sonorous.

Chemical properties of metals

Divide the students of your class into few groups and do the following activities in the supervision of science teacher to study how the metals react with air, acid and solution of other metals.

Activity 8

Materials required: a piece of magnesium, tong, spirit lamp, litmus paper, water, one test tube, white paper

Put a white paper under burner and light the burner. With the help of tong light magnesium holding it from one side, If any matter is formed from the burning metal, collect it in a test tube. Observe the colour and smell of the matter collected in a test tube and then shake the test tube adding a little water. What happens when litmus paper is dipped in the solution of matter? observe and discuss in the class.

When metals burn in the air (oxygen), oxides are formed and these oxides are basic. Example:

$4Al + 3O_2 \longrightarrow 2Al_2O_3$ (aluminium oxide)

$2Mg + O_2 \xrightarrow{heat} 2MgO$ (Magnesium oxide)

$2Cu + O_2 \xrightarrow{heat}$ 2Cuo (copper oxide)

Activity 9

Collect one piece of each of magnesium, aluminium, copper and iron, four test tubes, 10ml dilute hydrochloric acid. Put 2ml of dilute hydrochloric acid in each test tube and put the collected piece of metals in the test tube with acid chronologically. Observe which metals react with acid. When active metal reacts with dilute hydrochloric acid, salt and hydrogen gas are formed.

$Mg + 2HCl \longrightarrow MgCl_2 + H_2$

$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$

$2Fe + 6HCl \longrightarrow 2FeCl_3 + 3H_2$

Do you know?

We have seen rust in iron. If iron gets rusted its outer part is covered with brown substance. Does copper get rust? Copper is shining, red, brown metal but if we leave it in the contact of air and water for some days. One type of green substance starts to deposit. These green substances are compounds like sulphate, hydroxide and carbonates of copper

Activity 10

Take 20ml of saturated solution of each of copper sulphate and ferrous sulphate, two beakers or glasses, an iron nail, a piece of clean copper wire and a long thread.

Keep copper sulphate solution in one beaker and ferrous sulphate solution in another beaker. Now dip iron nail in the copper sulphate solution and copper wire in the ferrous sulphate solution with the help of thread. After sometimes take out both the metals from solution. Observe it and discuss in the class. Why is the iron nail looking like copper? What is the reason for no any change in copper wire? Discuss these questions with your teacher, find the reason and present along with correct chemical reaction.

The more active metal displaces the less active metal (from solution of less active metallic compound).

A (metal) + B (metallic solution) B (metal) + A (metallic solution)

On the basis of above observation, find out which is more active between iron and copper?

Differences between metals and non metals

On the basis of above activities we can study the differences between metal and non metal as following point.

S.n.	Property	Metal	Non-metal
1.	Hardness	Hard and cannot be broken	Soft and can be broken
2.	Malleability	Can be made sheet by beating	Cannot be made sheet by beating
3.	Ductility	Long wires can be made	Long wire cannot be made
4.	Electric conductor	Good conductor of electricity	Bad conductor of electricity
5.	Conductor of heat	Good conductor of heat	Bad conductor of heat
6.	Boiling and melting point	Both are high	Less comparatively

Role of Metals in Organisms

Mainly 6 non metals C, H, N, O, P and S are found in the body of organisms. In addition to these non-metals, metals like Na, K, Ca, Zn, Mg, Fe, Cu are also present in the body of organisms. These metal and non-metals are present in the form of different compound. From these elements, substances like protein, nucleic acid, lipids, etc are being formed. These elements are called biological inorganic elements. Blood contains iron. It had been known in 17^{th} century. Respectively, important role of other elements is being found in organisms. Among the above 6 main non-metal elements like Na, Mg, K, Ca are in high amount and elements like Mn, Fe, Co, Cu, Zn, Mo are in less amount. Besides these, other remained elements are present in very less amount.

Zinc in Enzyme

In the body of organisms though zinc is found in very less amount it is very important element. In human body, zinc is present in approximately 300 enzymes. In a body of an adult person approximately 2-3 gm of zinc is present. In all parts of body, cell, tissue, bone, serum, etc zinc is present. 90% zinc of body is found in prostate gland and semen. Similarly high concentration of zinc is also present in retina. The concentration of zinc decreases in eye with respect to age and at last the eye gets blurred. In our body, zinc is found in the form of compound.

Role of zinc in human body

1. For development of embryo/ for development of height, weight and bone of small children and adults.
2. To increase the reproductive capacity of males and for routine menstruation cycle in females.
3. To increase the immunity of a body. Example to be protected from pneumonia, diarrhea, dysentery and other infection.
4. To taste and smell
5. To treat disease anorexia (loss of appetite)
6. Fast renewal of cell of skin, to heal wound, abscess
7. To treat psoriasis and neurodermitis.

Importance of Sodium and Potassium Ions

Among the metals found inside our body sodium and potassium metals have more importance. These metals are present inside and outside of cell in the form of ions. As ions have charge nervous system can only work in

the presence of ions of metals. Due to the exchange of sodium and potassium ions important processes are running in the body. Sodium ions present outside the cell enters the cell and potassium ions come out of the cell. This process occurs together, which is called sodium potassium pump (Na^+/ K^+ pump).

Do you know?

Na+ and K+ ions help the heart to beat 60-100 times in one minute. If due to any reason the heart beat is less than 60 then we can understand there is some problem in heart. In this situation to make the heart beat, inside the right side of the body one small battery is kept, which is called pacemaker. Two wires from the pacemaker is taken to heart and it makes the heart beat in an artificial way, due to this blood can pump blood in the necessary amount to the different parts of body.

This process is very important process of body. Due to this reason neurons present in the nervous system transmit message with brain, which controls heart beat of heart, control body temperature, keep the muscles healthy, controls PH of the solution inside the cell, etc.

If sodium and potassium pump is not run continuously in the body, problems like migraine, spasm, paralysis, etc. are seen. Therefore, it is necessary for the presence of ions of sodium and potassium metal in the correct amount in the body.

Harmful effects of Mercury and Lead

Mercury

The poisonous effect of mercury is called hydrargyria or mercurialism. Due to only one drop of mercury, it blocks the blood vessels and even death can occur. The compounds of mercury affect brain. Along with this, it weakens the power of seeing, hearing and talking.

Similarly, it also harms the kidneys and lungs. Mercury also affects the fetus in the womb. The compounds of mercury easily pass the placenta and show adverse effect in the growth and development of a child. It also has adverse effect in the development of brain of the children.

Lead

Lead damages almost all organs of the body. Lead flows in different organs similarly as useful metals do. It affects the brain the most. Its effect is seen fast in children. Problems like head ache and stomach ache, change in habit, anaemia, not developed brain, etc. Due to the presence of lead in the blood, blood cannot take oxygen and symptoms of anaemia are seen. Lead is collected more in bone, due to which, it prevents from the

formation of blood cells and absorption of calcium and makes the bone weak. Therefore, we should be away from substances that have metals like mercury and lead.

Things to remember

1. Metals are substances that have physical properties like lusturous, hard, non-brittle, sonorous, malleable, ductile, conduct heat and electricity, high melting point and boiling point. Example: aluminium, iron, copper, zinc, etc.
2. Non metals are substances that have physical properties like non lusturous, soft, in solid state, brittle, non sonorous, non malleable, non ductile, non conductor of heat and electricity, low melting and boiling point. Example: carbon, sulphur, phosphorous, etc.
3. Metals burn in the presence of oxygen and form metallic oxides.

   $2Mg + O_2 \longrightarrow 2MgO$
4. Metals react with dilute acid producing salt and hydrogen gas.

   $Zn + 2\ dil.\ HCl \longrightarrow ZnCl_2 + H_2$
5. Cu, Ag, Au and Pb do not react with dilute acid.
6. Active metals displace the less active metals from the solution of compounds of less active metals. But less active metals cannot displace the active metals from the solution of compounds of active metals.

   $Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$

   $Cu + FeSO_4 \longrightarrow$ no reaction
7. Besides C, H, N, O, P and S there is a big role of biological inorganic elements for the organisms to live. Example: Na, K, Zn, Ca, Fe, Mo, Cu, etc.
8. Zinc is present in approximately 300 enzymes in the human body. Zinc metal is found in cell, tissue, bone, serum, etc and also present in high concentration in prostate gland and semen.
9. Mercury and lead are harmful for our body. Therefore to prevent these substances to enter our body we should control environmental pollution.

Exercise

A) Put correct sign (√) in the correct answer of the following multiple choice questions.

1. Among the following which property is absent in metal?

   a) conductor of heat b) hard

   c) brittle d) ductile

2. Among the following, which metal is found in liquid state at normal temperature?

   a) lead b) mercury c) bromine d) platinum

3. Among the following, which metal is harmful for our body?

   a) Pb b) Ca c) Zn d) Fe

4. Metals can conduct electricity. Among the following, which is the main reason for this property of metal?

   a) free electrons present in the metal

   b) capacity of metal to gain electron

   c) valence outer shell of metal atom

   d) movement of metal atoms

B) Answer the following questions.

1. What are physical properties of metals? Describe any two with example.
2. Write any five differences between metal and non-metal.
3. Iodine shines like metals but is not metal, what is its basis?
4. "Metals are conductor of electricity" how can you prove this statement? Describe.
5. Justify the statement that 'metals have high melting and boiling point'.
6. Write any three chemical properties of metal with an example of each.
7. Copper can be coated on the surface of iron but not on silver, justify with reason.
8. Mention any three diseases caused by the deficiency of zinc in human body.
9. What is the role of sodium and potassium ions in human body, describe.
10. Write adverse effects that can be caused by mercury and lead in human body.

Project work

Collect different objects from your surroundings and differentiate them into metals and non metals. Discuss about the properties that considered for this purpose. You can take the help of teacher to use the properties of metal.

Glossary

Alloy: Homogenous mixture of two or more than two metals. Example: brass.

Tong: One type of equipment used to hold any objects in laboratory.

Lipids: Oily substances like oil, ghee, wax, etc.

Enzyme: catalyst that increases the living processes inside the body.

Prostate gland: gland between urinary bladder and male reproductive organ

Semen: sperm

Unit

13 Carbon and its compounds

The word 'carbon' has come from latin language, whose meaning is 'charcoal'. Humans are well known from charcoal and soot from ancient times. These substances are types of carbon. Similarly, human knew about coal and coke also from very long time ago. Afterwards, humans found that diamond and graphite are made from carbon. These substances can be found in natural form. From 20 years other different substances of carbon have been found, scientists have claimed this world will take a new turn by the use of these.

Carbon is an irregular non metallic element, which makes covalent bond with other four carbons and also can easily make covalent bond with other elements. Due to this property of carbon there are crore carbon compounds in the world till today. What are the properties of carbon? We will study about this subject matter in this chapter.

Do you know?
Element, phosphorous burns itself in contact with the air. Sometimes we see fire in the villages burn itself which is called fire ghost. The fire burnt itself means that the phosphorous compounds present in bones of dead animals converting into pure phosphorous through different reaction and burnt in contact with oxygen.

Carbon in common materials

Carbon is basic component for the structure of every living substance. Different compounds of carbon are found everywhere in our body from head to feet. Is carbon compound present or absent in the clothes we wear, tables of classroom and chairs? Let's think for a while. Carbon is found in plants and animals and all the substances made from them.

Generally, carbon is black in colour and easily burns in air. While burning of carbon sooty flame or smoke as well as heat and light also be found. If block sooty flame or smoke comes out after we burn any substance and if the solid matter left is black then we know that matter contains carbon.

Activity 1

Collect some materials like piece of wood (or stick), sugar, vegetable oil, ghee, kerosene, tong, spatula, burner, matchstick and do the following activities:

1. First, burn a piece of wood by holding it with a tong and observe it.
2. Burn by adding vegetable oil, ghee, kerosene one by one with spatula and observe.
3. Heat little sugar putting in a spoon and observe carefully. What happened to the sugar and what changes occurred in colour? At what colour of sugar it smells sweet! In this state sugar converts into caramel. And at the end, what changes are seen in the sugar? The black matter with bad smell left after heating sugar is called sugar charcoal.

After doing the above activities discuss in classroom and conclude what happens when the substances with carbon burn.

Then, in which matters is carbon present?

Carbon is the sixth element among the most abundantly found elements in the world.

Sources of Carbon

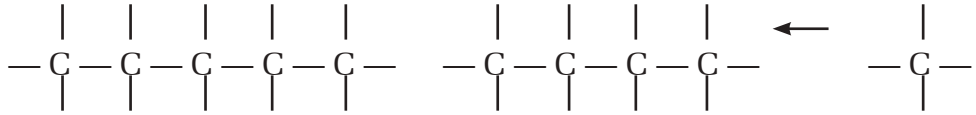
Carbon in the form of element	Carbon in compound form		Carbon in gas form
	Inorganic compound	Organic compound	
Coal Coke Charcoal Dimond Graphite Graphit	Carbonates, Bicarbonates, Carbides (like: CaC_2, SiC), minerals, stones, etc.	Carbohydrates, Protein, Oily substances (Oil, ghee), petrol, urine, vitamin, medicine, silk, paper, soap, etc	Carbon dioxide, carbon mono oxide, hydrocarbon gases (like: methane, ethane, LPG, etc)

How is it possible to produce these many substances from carbon?

Nature of carbon

Among the six electrons present in the carbon molecule four electrons remain in valence shell. Therefore the valency of carbon is 4. Carbon shares four electrons to make octet and makes four covalent bonds. One carbon makes covalent bond with another carbon or other elements. There is strange property of making covalent bond of one carbon with another carbon.

Usually, when elements make covalent with similar elements they share electrons with only one or two elements. Example: two atoms of oxygen in O_2 and 3 atoms in O_3. But one carbon makes 4 different covalent bond with four carbon. In this way, long chain is formed from one carbon with another. Like in polyethene many carbons one after another make long and large compounds. This property of carbon is called catenation. Example:

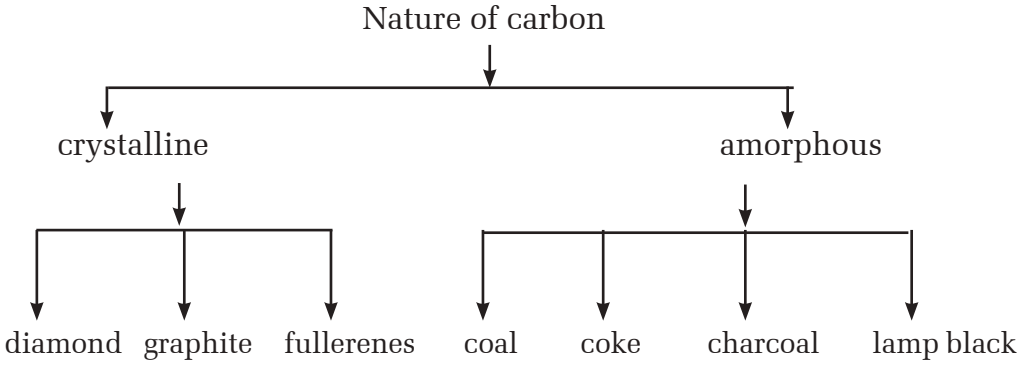


The property of making long chain compounds by making covalent bond with same molecule is called catenation.

Due to its 4 valency and catenation property, it is possible to make these many compounds. Therefore in chemistry, there is different category to study about the compounds of carbon, which is called organic chemistry.

In the given tablethere are some matters which have only carbon element, example: coal, diamond, graphite, etc. This carbon has different forms. The different forms of one element are called allotropes and the phenomenon is called allotrophy.

Allotropes mean different matters made form same elements, which have the same type of chemical properties whereas physical properties are different.



Graphite is also called black lead.

The reason of difference in the physical properties of allotropes is due to the difference in the bonds formed by carbon and the position of carbon atom.

Do you know?

If we collect soot coming out from the lamp burning by oil, lamp black is formed. From ancient times, human used lamp black in the form of ink and Egyptians knew it in the form of lamp black.

Physical properties of carbon

The physical properties of different allotropes of carbon are different.

1. Carbon is an element found in solid state. Diamonds and graphite are crystalline whereas coal and charcoal are in amorphous state.
2. It is insoluble in water.
3. At very high temperature, it is an element that can changes directly from solid to gas state.
4. It is black in colour but diamond is colourless and transparent.
5. Carbon are non lustrous but diamond is lustrous.
6. Carbon is bad conductor of electricity and heat but graphite is conductor.
7. Its density is different according to allotropes. Its density varies from 1.5 to 3.5.

Diamond

In diamond each carbon makes covalent bond with other four carbons, due to which diamond is very strong. Diamond is used to cut glass and marble. In X-ray diamond is transparent. Diamond does not react with any chemical but at 850°C temperature, it burns. Diamond is used in the form of valuable stone.

Do you know?

In an adult person's body 18.5% (according to weight) carbon is present.

Graphite

In the structure of graphite, six carbons are present in hexagonal shape and each carbon makes covalent bond with other three carbon. Numerous numbers of these types of hexagons are spread two dimensionally. Therefore in one piece of graphite, hexagons are piled up one upon another. Therefore, one layer of graphite easily slips with another layer. Due to this, graphite is used in the form of lubricant.

In the lead of pencil mixture of graphite and clay have been used. As they can conduct electricity it is used in the form of electrode.

Chemical properties of carbon

1. **Combustion:** Carbon burns in the presence of oxygen and forms carbon dioxide. But in case of limited oxygen, it gives carbon monoxide.

$$C + O_2 \xrightarrow{\text{Excess oxygen}} CO_2 + \text{Heat and Light energy}$$

$$2C + O_2 \xrightarrow{\text{Less oxygen}} 2CO + \text{Heat and Light energy}$$

2. Reducing Property

a) Carbon helps to remove metal from less active metallic oxides.

$$ZnO + C \longrightarrow Zn + CO$$

$$PbO + C \longrightarrow Pb + CO$$

b) Carbon reacts with SiO_2 and CaO to form carbides.

$$SiO_2 + 3C \longrightarrow SiC + 2CO$$

$$2CaO + 6C \longrightarrow 2CaC_2 + 2CO$$

Do you know?

SiC (silicon carbide) is man made substance, which is hard like diamond.

3. Reaction with Steam

When carbon is passed in the steam of water of approximately 1000˚C temperature carbon monoxide and hydrogen gas is formed which is called water gas.

$$C + H_20 \xrightarrow{1000^\circ C} CO + H_2$$

steam — water gas

Organic and inorganic compounds

Organic Compounds

Compounds that have carbon and if mostly carbon makes covalent bond with carbon or hydrogen, those compounds are called organic compounds. In organic compound except with hydrogen carbon also makes covalent bond with other elements oxygen, nitrogen, halogens, sulphur and phosphorous (note: though carbon is present in CO_2, CO, HCO_3^-, CO_3^{--} but they are not organic compounds).

Generally, organic compounds are made from seven element s like carbon, hydrogen, oxygen, nitrogen, halogens, sulphur and phosphorous. In some organic compounds metals also make bonding. Examples of some organic compounds are methane, methanol, chloroform, urea, insulin, protein, oil, etc.

Inorganic Compounds

Inorganic compounds can be made from the 118 elements found in the periodic table. But in most of them carbon is absent. In such compounds electrovalent, covalent or both bonds are present.

Examples of inorganic compounds are acid, base, salt, CO_2, CO gas, etc.

Differences between organic and inorganic compounds

SN	Differences based on	Organic compounds	Inorganic compounds
1.	State	Present in gas, liquid and solid state	Mainly found in solid state, some liquid and some are in gas state
2.	Colour and odour	Many of them have colour and odour (smell in flowers and sour fruits is due to organic compounds)	Many of the compounds are colourless and odourless. (note: some compounds of metals have colour and ammonia and their compounds have odour)
3.	Solubility	Are not soluble in water but soluble in organic solvents. (oil is not soluble in water but soluble in other)	Soluble in water but insoluble in organic solvents. (salt dissolves in water but insoluble in other)
4.	Combustion	Easily burns (example: petrol, LPG, oil, etc)	Does not burn easily.

5.	Melting and boiling point	Low, petroleum jelly (Vaseline) melts at 37° C.	High
6.	Ionization	Absent	Present
7.	Bond	Covalent	In most of them electrovalent bond is present.

Things to remember

1. Crbon makes covalent bond with carbon and makes long chain compounds from one carbon with another. This property is called catenation.
2. Different elements made from only carbon element is called allotropes. Their chemical properties are similar but physical properties are different. This phenomenon is called allotropy.
3. Diamond is colourless but shining matter transparent, hard, bad conductor of electricity, insoluble in all solvents.
4. Graphite is black, opaque but shining matter, which is slippery and easily breakable. Graphite is good conductor of electricity.
5. Carbon burns in the presence of oxygen forming carbon dioxide gas. If the amount of oxygen is low carbon monoxide gas forms.
6. Carbon reacts with steam at 100°C making water gas. ($CO + H_2$)
7. Organic compounds are made up of carbon and usually covalent bond is formed between carbon and hydrogen.

Exercise

A) **Put correct sign (√) in the correct answer of the following multiple choice questions.**

1. Among these which is colourless and transparent allotropes of carbon?

   a) Diamond b) charcoal c) graphite d) coal

2. Which gas can be obtained from the chemical reaction between Zn and C?

   a) Carbondioxide b) Carbonmonoxide

   b) Nitrogen oxide d) Carbon trioxide

3. Which one of the following mixtures of gases in called water gas?

   a) $CO_2 + H_2$ b) $CO_2 + O_2$ c) $CO + O_2$ d) $CO + H_2$

4. Among these which is inorganic compound?

a) ethyl alcohol b) acetic acid

c) carbon dioxide d) methan gas

Answer the following questions

1. Write any five physical properties of carbon and any five sources of carbon.
2. How is it proved that carbon is present in sugar? Write in short.
3. What is meant by catenation? Describe with an example.
4. What is meant by allotropy? Write names of any three allotropes of carbon.
5. Write major four differences between diamond and graphite.
6. Write any three chemical properties of carbon along with balanced chemical equation.
7. What do you understand by organic compounds? Give any five examples.
8. What do you understand by inorganic compounds? Give three examples of compound containing carbon.
9. Write any five differences between organic and inorganic compounds.

Project work

Note the result after examining in home that carbon is present in rice, maize, paper, torn cloth, plastic. On the basis of your observation prepare a report.

Glossary

Soot: black substance of smoke collected on the sheet by burning kerosene or other substance

Caramel: sweet smelling matter made from melting sugar

LPG: gas used to cook food (liquefied petroleum gas)

Unit 14

Water

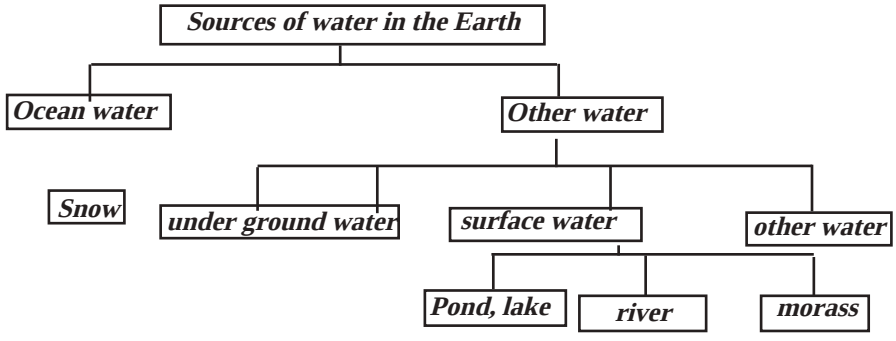
Water is not only important to human beings but also to other animals as well as plants. We have to drink water daily. Water is necessary for all chemical reactions inside the body. Water is necessary parts of a body, to throw out waste materials from the body. Similarly, plants need water to prepare food during photosynthesis, to conduct matters absorbed by root to different parts. What is the property of water having these many importance? Water is found in adequate amount in the earth. Almost among 4 parts of earth, 3 parts is covered by water. Though there is presence of many amount of water but also there is scarcity of water in our daily life, why? Out of total volume of the water in earth, 97% of water is in the ocean. As this water is salty, it cannot be used to drink. What may be the sources of clean drinking water? We can use different ways to change the non-usable water achieved from any sources into usable water.

In this unit, we are studying about sources of water, properties, use and ways to remove hardness of water.

Do you know?
The water of dead sea is so salty, that no any living organisms can be alive but in this water no one has died because of drowning. Humans can easily float as dead sea is made up of 33.7% solution of salt water.

Sources of water

The source from where water is achieved to fulfill the need of humans, that source is called water source. The place from where water is brought for agriculture, to use in industries, for daily use, for different functions, to keep the environment clean and healthy, that are called sources of water. Let's study the chart below to know the sources of water.



On the basis of the place water resources are mainly of two types:

1. **Surface water resources**

a) **Ocean**

Among the resources of water in earth, 97% of water is in ocean, which is salty. This water cannot be used in daily life. It can be used to produce electricity. But for this purpose tides and waves are necessary.

b) **River, waterfall, pond, lake**

The river, waterfall, pond, etc found in the surface of the earth are the surface sources of water. The water obtained from those resources is used in different activities and techniques. Water is needed for agriculture, to use in factories and industries, to produce electricity and to perform daily home activities.

2. **Under ground water resources**

The water absorbed by the soil during rainfall which is collected under the stones inside the ground, is called under ground water. The place where water is collected in preached stones, sand and slit is called acquifer. In this acquifer hundred times more water is being collected than in sea, river, waterfall, pond, lake, etc. The surface of water inside the ground is called water table. As the rainfall is slowly being absorbed by soil stones there is no leaves, insect, dust, etc, but germs, minerals and gases are mixed. This water is not stationery and slowly flows through different routes like waterfall or origin, it reaches to the surface.

Do you know?
Ogallala aquifer is one of the largest aquifer in the world. This is spread for 450,000 square kilometer. This aquifer touches 8 nations of the United States of America.

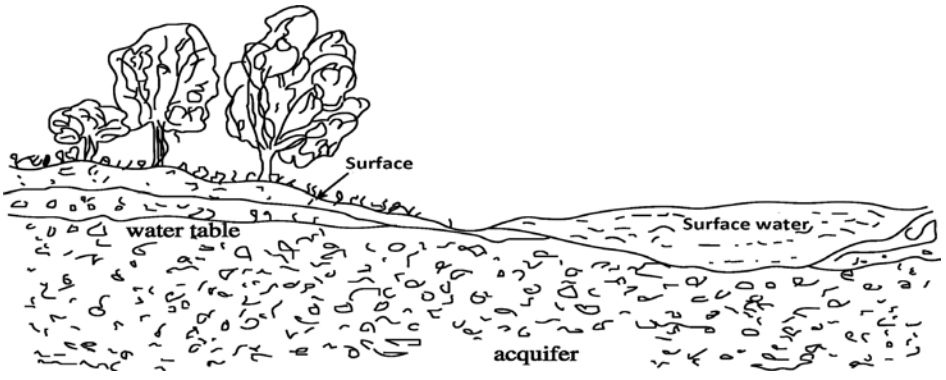


Fig 14.1: Ground water

Properties of water

Physical properties of Water

Among the substances present in the earth, only water is that substance which is present in solid, liquid and gas state. Water is present in the solid state at mountain, glacier etc, in liquid state at stream and river and in gas state at the atmosphere.

1. Pure water is tasteless, odourless and colourless.
2. Water can dissolve many types of substances so it is called universal solvent.
3. Water freezes at 0° C temperature.
4. Pure water is neutral. So it does not show any effect in litmus.
5. Pure water does not conduct electricity.
6. Molecules of water can attract to one another (cohesive property) and also they can be attracted to other substances.

Do you know?

When water freezes, air gaps are formed in between the molecules of water, due to this reason, ice is lighter, density is low and floats on water.

Activity 1

Take a leaf of karkalo. Put one drop water on it. What is the shape of water? Observe and find out the reason. Water is seen spherical in shape. This is because cohesive force is high between the molecules of water as well as less adhesive force between molecule of leaf and water.

Do you know?

Due to the property surface tension, elastic membrane is formed on the surface of water. So, the insect Water strider can walk on the surface of water.

Activity 2

Put little water in one beaker. Put a capillary tube as shown in figure in the next page and observe.

What may be the reason for rising the water in a capillary tune, discuss in class and find out the reason with the help of your teacher and present the reason in your classroom.

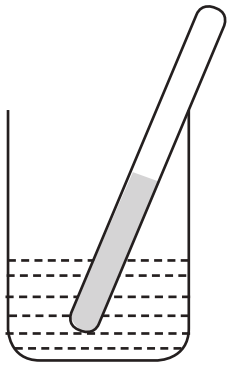
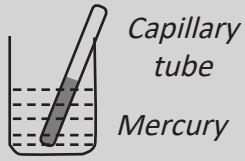


Fig 14.2: Cohesion and Adhesion

Do you know?

If we keep capillary tube in the vessel with mercury, then the level of mercury in the vessel is low than the mercury inside the capillary tube. This is because the attracting force among mercury becomes strong.



Chemical Properties of Water

1. Pure water does not conduct electricity. But if water is impure with any dissolved solute then conducts electricity. Water has high capacity to conduct electricity than other liquid substances.
2. Metals like lithium, sodium, potassium, calcium, etc displace the hydrogen from water and form hydroxide of metal.

$$2Li + 2H_2O \longrightarrow 2LiOH + H_2$$

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

$$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$$

3. When we dissolve acid, base and soluble salts in water, their aqueous solution is formed and breaks down into ions.

$$HCl \longrightarrow H^+ + Cl^-$$

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

$$NaCl \longrightarrow Na^+ + Cl^-$$

Solvent Property of water

Ionic compounds like NaCl (sodium chloride), KNO_3 (Potassium nitrate) $CaCl_2$ (calcium chloride) dissolve in water breaking into ion. But water cannot dissolve ionic compounds like AgCl (silver chloride), $BaSO_4$ (barium sulphate), CaF_2 (calicium fluoride). The cohesive property between the ions of these compounds is strong, so do not dissolve in water.

Some covalent compounds dissolve in water. HCl (Hydrochloric acid), alcohol, glucose, urea, etc dissolve in water. Other covalent compounds CCl4 (carbon tetrachloride), CH4 (methane), etc do not dissolve in water.

Uses of Water

Among the water that can be consumed, 70% of water consumption is in agriculture. To produce enough crop for the growing population water is used in large amount in irrigation. The water used in irrigation is achieved from ground water, stream, river, waterfall, pond, etc.

Do you know?
Water jet cutter (water flown with high force) can cut wood, rubber, etc.

1. Water is used in the industry to produce different materials, clean metals, purification of oil, to cut minerals (jet cutting), to make chemical solution for chemical reaction.
2. Water is used to generate hydro electricity.
3. For daily use like cleanliness, cooking food, drinking, gardening, etc approximately 4% water is needed.
4. Water is also used for entertainments. But this water is not consumed, like rafting, swimming, degrading stones.
5. Sometimes, water is used to make greenery. Artificial ponds are made for fish farming.
6. Water is necessary for plants to prepare food or for photosynthesis process.

Types of Water

Activity 3

Collect water from different resources and keep it in different beakers. In each beaker, put one pinch surf and stir with a glass rod. Observe it. In which beaker is the foam produced? And in which beaker is the foam not produced? Discuss in the classroom.

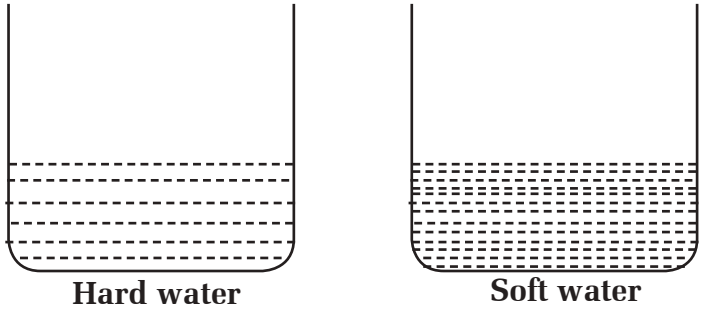


Fig 14.3: test of soft and hard water

Compounds of different metals are mixed in water. Those compounds make the water hard. Mainly compounds of calcium and magnesium make the water hard. The pure water where those compounds are not dissolved is called soft water. In hard water soaps do not give foam whereas in soft water soaps give foam. On the basis of compounds of presence of calcium and magnesium, water is divided into two types.

1. Hard water

If in any water soluble compounds of calcium and magnesium like calcium sulphate, calcium chloride, calcium bicarbonate, magenesium sulphate, magnesium chloride, magnesium bicarbonate, etc. are present. Soaps do not give foam. Such type of water is called hard water. Well water, river water, ground water, etc are examples of hard water. There are two types of hardness of water.

a) **Temporary Hardness of water**

If bicarbonates of calcium and magnesium are dissolved in water then that hardness of water is called temporary hardness. This type of hardness gets removed while boiling the water.

b) **Permanent Hardness of Water**

If chloride and sulphate salts of calcium and magnesium are dissolved in water then that type of hardness of water is called permanent hardness.

2. Soft Water

If water soluble salts of calcium and magnesium which brings the hardness of water like calcium sulphate, Calcium chloride, calcium bicarbonate, magnesium chloride, magnesium bicarbonate, etc are not dissolved in water, it is called soft water. Soap gives foam properly in soft water. Rain water is its best example of this type of water.

Methods of removing hardness of water

On the basis of the nature of hardness of water, there are different methods to remove hardness of water. Here, we will study the method of removing temporary and permanent hardness of water.

1. **Method of removing temporary hardness of water**

a) **Boiling:**

While boiling water the dissolved bicarbonate converts into insoluble carbonate. These insoluble compounds are separated from filter method. The water achieved in this way is soft water.

$Ca(HCO_3)_2 \longrightarrow CaCO_3 + H_2O + CO_2$

Calcium bicarbonate — Calcium carbonate

$Mg(HCO_3)_2 \longrightarrow MgCO_3 + H_2O + CO_2$

Magnesium bicarbonate — Magnesium carbonate

b) By Clark's method

Certain weight of calcium hydroxide [$Ca(OH)_2$] is mixed in hard water according to the amount of water. The soluble bicarbonates of calcium and magnesium convert into insoluble carbonate, which settles at the base of vessel.

$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 + 2H_2O$

Insoluble carbonate

$Mg(HCO_3)_2 + Ca(OH)_2 \longrightarrow MgCO_3 + CaCO_3 + 2H_2O$

In this method, if amount of $Ca(OH)_2$ in water is more it reacts with carbon dioxide present in air and again forms bicarbonate. Therefore it should be kept in correct amount.

2. Methods of removing Permanent hardness

a) By the Addition of Washing Soda

When washing soda ($Na_2CO_3.10H_2O$) is mixed in water with permanent hardness Ca^{++} and Mg^{++} ion present in hard water react with carbonate to form insoluble carbonates. It is separated using filter method and soft water is obtained.

$$CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2NaCl$$

$$CaSO_4 + Na_2CO_3 \longrightarrow CaCO_3 + Na_2SO_4$$

$$MgCl_2 + Na_2CO_3 \longrightarrow MgCO_3 + 2NaCl$$

$$MgSO_4 + Na_2CO_3 \longrightarrow MgCO_3 + Na_2SO_4$$

We can remove the permanent hardness of water by using washing soda.

b) Permutit process

Zeolite is used to remove hardness of water from permutit process. Zeolite is of two types as natural and artificial. The method of removing hardness by using artificial zeolite is called permutit process. Generally, artificial zeolite is used to remove the hardness of water.

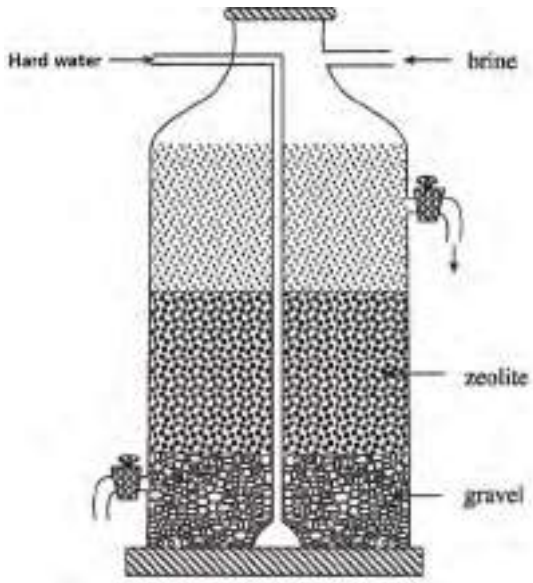


Fig 14.4: Permutit Process

Sodium zeolit (Na_2Z) is kept above the pieces of stone and hard water is slowly sent upwards from the base. Ca^{++} and Mg^{++} ions present in water displace the sodium present in ziolite. In this way, Ca^{++} and Mg^{++} ions get separated from hard water and soft water is formed.

$$Ca^{++} + Na_2Z \longrightarrow CaZ + 2Na^{+}$$

Sodium zeolite

$$Mg^{++} + Na_2Z \longrightarrow MgZ + 2Na^{+}$$

Sodium zeolite

[Note: $Z = Al_2Si_2O_8.9H_2O$]

When zeolite stops functioning, brine (strong solution of NaCl) is added from the top and it starts to function again. By this method, both temporary and permanent hardness of water can be removed.

How do both hardness disappear? Discuss in your classroom.

Things to remember

1. On the basis of place from where water can be obtained, there are two major sources of water: Surface water and Underground water.
2. The water obtained from the resources like stream, waterfall, river, pond, lake etc are use to irrigate, to generate electricity, for cleanliness, to run industries, etc.
3. As, the most of the substances get dissolved in water, it is called universal solvent.
4. Water has cohesive property as well as adhesive property.
5. Active metals react with water and form hydrogen and hydroxide.
   Eg: $2Na + 2H_2O \longrightarrow 2NaOH + H_2$
6. Water consumption in agriculture is 70%, 20% in industries and 4% in daily life. Water is also consumed for entertainment and cleaning environment.
7. If bicarbonate salts of calcium and magnesium are dissolved in the water then hardness of such water is temporary.
8. If chloride and sulphate salts of calcium and magnesium are dissolved in water then it has permanent hardness.
9. To remove the hardness of water means to convert the soluble compounds of calcium and magnesium into insoluble compounds.

10. To remove temporary hardness of water, boiling method and Clark method can be used.

11. To remove permanent hardness of water the soluble salt is reacted with washing soda ($Na_2CO_3.10H_2O$) or sodium zeolite (Na_2Z)

Exercise

A) Put correct sign (√) in correct answer in the following multiple choice questions.

1. Among the properties below, which one is not the property of water?

   a) odourless b) tasteless c) neutral d) opaque

2. Which salt among the following brings temporary hardness in water?

   a) calcium sulphate b) magnesium chloride

   c) magnesium bicarbonate d) sodium bicarbonate

3. Which one among the following salts brings permanent hardness in water?

   a) calcium bicarbonate b) magnesium chloride

   c) magnesium bicarbonate d) sodium bicarbonate

4. When we heat water with temporary hardness which compound among the following will be formed?

   a) calcium carbonate b) calcium sulphate

   c) calcium carbonate d) calcium bicarbonate

5. If we put sodium metal in water which compound among the following will be formed?

   a) sodium hydroxide b) sodium hydride

   c) sodium oxide d) sodium chloride

B) Answer the following questions.

1. What are the sources of water in the Earth? Write the process of by which under ground water comes to the surface.
2. Write four physical and two chemical properties of water.
3. What activities do you perform to exhibit the cohesive and adhesive properties of water? Write the process of the activities in points.

4. Describe any four uses of water.
5. What do you mean by hardness of water? Write the name and molecular formula of salts that bring temporary and permanent hardness in water.
6. Mentioning any two methods of removing temporary hardness of water. Write the balanced chemical reaction involved in the process.
7. Mention any two methods of removing permanent hardness of water. What happens when we put washing soda in water with temporary hardness?
8. Write methods that can be used to remove both temporary and permanent hardness of water and describe with diagram how permanent hardness can be removed from that method.

Project work

1. Collect sample of water from any three sources around your house. Is the water hard or soft? Test and find out. Present your conclusion in the classroom along with reason.
2. Observing the sources of water around your house or school. Find out for what purpose the water is being used. Draw the table given below and fill it. Present your findings in the classroom.

Sources of water	Use of water

Glossary:

Acquifer: stones (having gappings present under the ground, sand, silt, where water is being collected.

Cohesive property: Attraction property between the molecules of same matter.

Adhesive property: property where molecules of one atom attract to molecules of another atom

Unit 15

Chemical fertilizers used in Agriculture

You may have seen farmers using different chemicals in soil during farming. All those elements are required minerals for the growth and development of the plants. In this unit, we will learn about the fertilizers used in agriculture, organic fertilizer, chemical fertilizer, types of fertilizers containing nitrogen, phosphorous, potassium, effects on the growth of the plants due to deficiency of those fertilizers and their uses.

Fertilizers

If we observe world's population then population is being increasing rapidly whereas if the sources produced from agriculture are observed, it is not increasing in the same ratio. In this way, while surfacely observing, recent agricultural production is not sufficient to satisfy the needs of the growing population. It is required to increase the production. For what it is quite necessary to know about the condition of soil and the nutrients required for the plants. Plants need two types of nutrients. Nutrients containing nitrogen, phosphorous and potash are required in higher amount whereas nutrients like boron, magnesium, iron, zinc, sulphur, etc are sufficient even in little amount. These types of elements or compounds if added, the fertility of the soil increases. Plants absorb these elements or compounds in the form of fertilizers from soil. Therefore the extra required chemical compounds or elements added in the soil to increase the fertility of soil are called fertilizers. When the same type of crops are cultivated for a long period of time in the same farm, the minerals required for the plant get reduced in soil and the fertility gets deteriorated. By fulfilling this deficiency to maintain the fertility of soil, minerals are added which are called fertilizers.

Types of Fertilizers

a) Organic fertilizers b) Inorganic fertilizers

Organic Fertilizers

The fertilizers formed by the decomposition of excreta excreted by

animals, leaves of trees, plants, agricultural waste, dead bodies of animals, hay, stack etc. are called organic fertilizers. When the oxygen level is less in the air, excessive smell may come or methane gas may be produced during the process of decomposition of living things, If the production of methane increases, due to the influence of green house effect atmospheric temperature also increases as well as environment pollution occurs. Therefore, to reduce production of methane while preparing compost manure, the materials are cut into small pieces and churning it at interval of time allows the flow of oxygen so that materials get decomposed rapidly and also does not affect the environment. This method of preparation of fertilizer is called aerobic method. Fertilizer can also be made in the absence of oxygen flow. This method is called anaerobic method. Similarly, fertilizers can also be prepared by mechanical method. These fertilizers are divided into following two types:

a) Green Organic Fertilizer

The fertilizers prepared by cutting plants and decomposing them under the soil are called green organic fertilizers. While preparing this fertilizer, by dumping specially pulses, crops under the soil provide the required amount of nitrate for plants.

b) Animal Organic Fertilizer

The fertilizers prepared by dumping dead animals into a pit which are decomposed by bacteria and fungi are called organic fertilizers obtained from animal. But inorganic nutrients like nitrogen, potash and phosphorous cannot be found in the fertilizers obtained by this method.

Advantages of Organic Fertilizers

a) It stores water in soil as well as increases fertility of soil.

b) It protects from soil erosion as well as controls environment pollution.

c) It does not affect soil even after long time.

d) It makes vegetables and fruits tasty, nutritional and healthy.

Disadvantages of Organic Fertilizers

a) As this fertilizer is in large amount, the collection and transportation of it is difficult.

b) It is not soluble in water.

c) It does not contain special types of nutrients.

Inorganic fertilizers

The fertilizers prepared by mixing different types of chemical substances are called inorganic fertilizers. Specially, nutrients like nitrogen, potash and phosphorous are present in these fertilizers. The fertilizer prepared by mixing these three types of chemicals is called NPK fertilizer. This fertilizer is also called complete fertilizer. This fertilizer provides required nutrients for growth and development of plants. It helps to increase crop production by protecting plants from diseases.

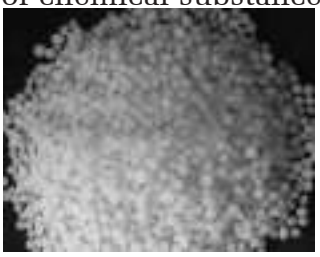


Fig 15.1: Urea

Advantages of Inorganic Fertilizers

a) Inorganic fertilizers are easy to collect, transport from one place to another and to use.

b) Inorganic fertilizers are soluble in water so plants absorb properly.

c) Special types of nutrients are present in inorganic fertilizers.

d) Inorganic fertilizers increase the fertility of soil.

Do you know?

Calcium hydroxide [$Ca(OH)_2$] should be used in soil to remove acidity of the soil whereas calcium sulphate, calcium chloride, sulphuric acid, hydrochloric acid, urea can be used to remove basicity of the soil.

Disadvantage of Inorganic Fertilizer

a) Inorganic fertilizer is non-biodegradable so it pollutes the environment.

b) It increases acidity or basicity of the soil.

S.n	Organic fertilizers	S.n	Inorganic fertilizers
1.	The natural substances obtained from dissociation of animal's excreta and remnants of plants are called organic fertilizers	1.	These are Inorganic compounds.
2.	They are not nutrition specific	2	They are nutrition specific
3.	They protect the soil structure	3.	They do not protect the soil structure.

4.	These fertilizers are less soluble in water, so plants absorb them slowly.	4.	As these fertilizers are highly soluble in water, plants absorb them rapidly.
5.	They provide a lot of organic compounds to the soil.	5.	They do not provide organic compounds to the soil.
6.	They make the soil loose.	6.	They do not make the soil loose.

Some examples of chemical fertilizers

Nitrogen containing fertilizers	**Phosophorous containing fertilizers**	**Potassium containing fertilizers**
a) Ammonium sulphate [$(NH_4)_2SO_4$]	a) Ammonium phosphate [$(NH_4)_3PO_4$]	a) Potassium chloride (KCl)
b) Ammonium nitrate [NH_4NO_3]	b) Calcium super phosphate [$Ca(H_2PO_4)2CaSO_4$]	b) Potassium sulphate [K_2SO_4]
c) Urea [NH_2-CO-NH_2]	c) Triple super phosphate[$3Ca(H_2PO_4)_2$	c) Potassium nitrate [KNO_3]
	d) Amophous [$NH_4(H_2PO_4)$]	d) Potassium carbonate[K_2CO_3]
	e) Bone meal	

Importance and Effects of Chemical Fertilizers

Importance of Nitrogen	**Effects due deficiency of nitrogen**
a) Helps in fast growth of the plants. b) High synthesis of chlorophyll. c) Helps to increase production. d) Increases the amount of protein, protoplasm and chlorophyll.	a) Deficiency in production b) Leaves become yellow c) The size of flower fruit and seed of a plant become small.
Importance of Phosphorous	**Effects due to deficiency of phosphorous**
a) Helps in formation and development of roots. b) Crops and seeds mature fast. c) Helps to prevent from diseases. d) Makes the granule healthy.	a) Root of plant cannot be developed. b) Cell-division becomes passive.

Importance of Potassium	Effects due to deficiency of potassium
a) Makes the stems and roots of plants strong. b) It increases the immunity power of the plants. c) It helps to develop flowers of a plant. d) It helps to synthesize starch, protein along with other materials in plant.	a) The rate of protein synthesis becomes slow as well as cell division becomes diminished. b) The leaf of plants as well as small plants dry or die.

Considering factors while using chemical fertilizers

a) Acidity or basicity of the soil should be identified before using chemical fertilizers.

b) Chemical fertilizers are used covering the nose and the mouth properly.

c) We should not let chemical fertilizers to mix in the sources of water.

d) Chemical fertilizers should not be over used than required amount.

Do you know?
NPK is the macronutrients of chemical fertilizers but micronutrients like magnesium, iron, zinc, sulphur etc also have importance.

Use of chemical fertilizers and its impact on environment

Although the productivity increases by using chemical fertilizers in the farm, it results adverse effects on environment. As for example, these chemicals present in the soil reach the source of water by various means and the numbers of weeds and alga are increased in such area where that water is available. Due to the same growth, dissolved oxygen present in water gets used up and due to the deficiency of oxygen, death of aquatic organisms occurs. Along with this, while the harmful chemicals present in these fertilizers get deposited in different types of edible things like vegetables, fruits etc, our health gets affected adversely.

Things to remember

1. The required elements or compounds which are added in the soil to increase the fertility of the soil are called fertilizers.
2. The fertilizers obtained from remaining of dead plants and animals are called organic fertilizers.
3. The fertilizers which are prepared by mixing different types of chemical substances are called chemical fertilizers.

4. The fertilizer prepared by cutting plants and decomposing them under ground is called green organic fertilizer.
5. The fertilizer prepared by dumping animals after death and decomposing them through bacteria and fungi is called organic fertilizer obtained from animal.
6. The fertilizer formed by mixing three types of nutrients including nitrogen, potassium and phosphorous is called NPK fertilizer
7. Ammonium sulphate, ammonium nitrate, urea and ammonium phosphate are the sources of nitrogen.
8. Calcium super phosphate, triple sugar phosphate, amophous are the sources of phosphorous.
9. Potassium chloride, potassium sulphate, potassium nitrate and potassium carbonate are the sources of potassium.

Exercise

A) Put correct sign (√) in a correct answer in the following multiple choice questions.

1. What does organic fertilizer refer to?
   a) Insecticides b) Fertilizer obtained from mineral
   c) Green fertilizer d) Fertilizer obtained from organic substances
2. What does inorganic fertilizer refer to?
   a) Insecticides b) Fertilizer obtained from mineral
   c) Green fertilizer d) Fertilizer obtained from organic substances
3. Which mixture of chemicals are found in complete fertilizer?
   a) nitrogen, potash and phosphorous b) nitrogen and phosphorous
   c) potash and phosphorous d) potash and nitrogen
4. Among following, which one is the source of nitrogen?
   a) potassium carbonate b) amophous
   c) calcium super phosphate d) Ammonium phosphate
5. Which one is the source of potash among the following?
   a) potassium carbonate b) amophous
   c) calcium super phosphate d) Ammonium phosphate
6. Which one is the source of phosphorous among the following?
   a) potassium carbonate b) amophous
   c) calcium super phosphate d) Ammonium phosphate

B) Write the answers to the following questions

1. What is called chemical fertilizer?
2. What is called organic fertilizer?
3. What is the mixture found in NPK fertilizer? How is this fertilizer prepared?
4. Write three differences between inorganic fertilizer and organic fertilizer.
5. Mention the method of preparation of organic fertilizer stepwise.
6. Show three sources of each of nitrogen, phosphorous and potassium fertilizer in table.
7. Write the effects seen in the plants if nitrogen gets deficient.
8. Write down the effects seen in the plants due to deficiency of phophorous and also write the measures that should be implemented to control those effects.
9. What is the importance of potassium in plant? Write in points.
10. Show the relationship between inorganic fertilizer and organic fertilizer.
11. Mention the precautions to be taken while using chemical fertilizers. Write in points.

Project work

1. Find the causes of using chemical fertilizers by asking farmers involved in farming from your village or town/city. Prepare a report explaining the advantages and disadvantages of using fertilizers. Present that report in classroom and discuss.
2. Observe and collect the fertilizers used in the school's garden. And, discuss in a classroom about the nutrients found in those fertilizers.

Glossary

Organic fertilizer: Fertilizer obtained by the decomposition of remaining part of dead plants and animals.

Inorganic fertilizer: Fertilizer prepared by mixing different types of minerals.

Chemical fertilizer: Fertilizer formed by mixing nitrogen, potash and phosphorous.

Unit

16 Classification of Plants and Animals

Can you tell the names of plants and animals found in the garden around your home or forest? Think for a while! What is the basis for telling their names? Among them, there can be many unknown plants and animals. Are the features of all the organisms same? We can find many kinds of organisms in our surroundings. Their appearance, morphology, habit and habitat are different. There are different basic facts for the classification of organisms. The organisms are classified according to their characteristics, physical features, feeding process, reproduction and development etc. The organisms with similar nature and character are kept under one group. In this way, the process of dividing the living organisms according to their similar and dissimilar nature into different group and sub-group is called classification of living beings.

In the previous classes, we studied two kingdom system of classification for the division of organisms. In this chapter, we are going to study the five kingdom system of classification.

The concept of this system was introduced by American taxonomic, Robert H. Whitaker in 1969A.D.

The reason for the five kingdom classification system to be more useful and scientific system is found to be proved by the following facts.

- Prokaryotes and Eukaryotes have been kept separately.
- Unicellular organisms are also kept separately. For example; Kingdom Monera and Protista
- The plants that posses chlorophyll and do not posses chlorophyll are kept in different groups. For example; Fungi and Algae
- As this system of classification is based on the history of the gradual development of the organisms, we are clear about their life style.

On this basis, the organisms are classified as follow:

1. **Kingdom: Monera**

   Unicellular prokaryotic microorganisms fall under this kingdom. In their cell Deoxyribonucleic acid is present in the form of the nucleus. They may be autotrophic or parasite. Bacteria, Azotobacter, Blue Green Algae, etc are the examples of this kingdom.

2. **Kingdom: Protista**

   In this kingdom, unicellular eukaryotic organisms are kept. Nucleus is absent in their cell. Amoeba, Paramecium, Euglena, etc are the examples.

3. **Kingdom: Fungi**

   In this kingdom, both unicellular and multicellular organisms without chlorophyll are kept. Thalloid are present in their body. They absorb the food from decaying and decomposing things. Fungus, Yeast, etc are the examples of this kingdom.

4. **Kingdom: Plantae**

   In this kingdom Plantae, Flowering and non-flowering plants are kept.

Flowering and non-flowering plants

Many types of plants are found in this category. Under this unicellular, multicellular, chlorophyll containing plants are kept. In their bodycell, cellwall is made up of cellulose. These are autotrophs. Among these plants, some are flowering and some non-flowering plants like spirogyra, marchantia, moss and fern are non-flowering. But pine, mustard, rice, mango, orange, etc are flowering plants. Kingdom Plantae is divided into three main division:

1. Algae 2. Bryophyta 3. Trachaeophyta

1. Algae

a) These plants may be unicellular or multicellular.

b) Due to the presence of chlorophyll, these plants can prepare their own food.

c) They store food in the form of starch.

d) Their cell wall is made up of cellulose.

e) Reproduction is sexual or asexual.

f) These plants are found in pond, river, ocean and moist places.

Example: Chlamydomonas, Volvox, Spirogyra, Ulothrix, Fucus. etc.

Activity 1:

Observation of Algae

a) Collect water from pond or well along with the slippery green things in a bottle.

b) With the help of needle put one drop of water along with the green thing from the bottle on a slide.

c) Observe the slide under microscope.

d) Sketch the diagram of the plant after the observation.

2. Division: Bryophyta

a) Under the division bryophyte multicellular plants are found.

b) Some plants have rhizoid, stem and simple leaf.

c) They are autotrophs.

d) As water is needed for fertilization, they are called amphibian plants.

e) Alternation of generation is found in their life cycle.

f) They are found in the moist and cool places.

Example: Marchantia, moss, riccia, etc.

3. Division: Tracheophyta

Developed plants are found under this division. They have well developed vascular bundle (xylem and phloem). These plants grow into tall trees. The three sub-division of tracheophyta are as follows:

a) Pteridophyta b) Gymnosperm

c) Angiosperm

1. Sub-division: Pteridophyta

Fig. 16.1: Fern

These plants lack seed but root, stem and leaf is clearly distinguishable.

a) In this plant complex cell like xylem and phloem are well developed.

b) On the ventral side of leaf, brown spots are found which is called sorus.

c) Spore germinates into gametophyte.

d) In their life cycle alternation of generation is found.

Example: Fern, Lycopodium, Selaginella, etc.

2. Sub-division: Gymnosperm

a) In these plants, there is absence of true flower and fruit.

b) Instead of being inside the fruit, the seed is naked.

c) Their leaves are long and narrow,

d) They have unisexual flower.

e) The flower lacks ovary, therefore there is no fruit.

f) Pollination takes place by wind.

g) These plants are found in land.

Example: Cycus, Pinus, etc.

Fig. 16.2: Pine

Fig. 16.3: Cycus

3. Sub-division: Angiosperm

a) The plants belonging to the sub division Angiosperm have true flower and fruit.

b) The seed is present inside the fruit of the plant.

c) Some plants are bisexual and some are unisexual.

d) Flower is well developed. Both ovary and ovule are present in the flower.

e) Pollination occurs by wind, water, insects and animals.

f) Some plants are found in water and some in land.

Example: Orange, maize, banana, paddy, soyabean, plants found in water such as water hyacinth, lemna, pistia, etc.

On the basis of cotyledon found in the seed, Angiosperms are classified into two classes.

i. Monocotyledon

ii. Dicotyledon

Class: Monocotyledon

a) The plants belonging to this class have only one cotyledon in their seed.

b) Root is fibrous.

c) Hollow stem is present.

d) Vascular tissue is scattered in the stem.

Parallel venation is present in the leaf.

e) They are found in water and land.

Example: Paddy, maize, wheat, sugarcane, banana, bamboo, etc.

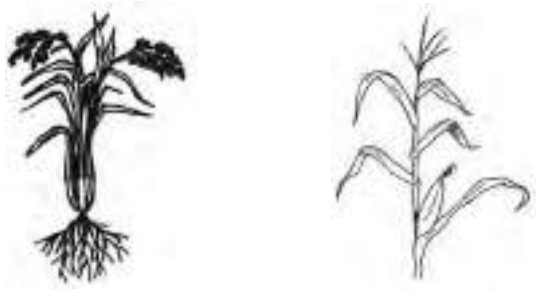


Fig 16.4: Paddy and Maize

Class: Dicotyledon

a) The seed of this plant contains two cotyledons.

b) They have tap root

c) Stem is compact and strong.

d) Reticulate venation is found in their leaf.

e) Vascular tissues are found surrounding the stem in the form of ring.

Example: Soyabean, mustard, pea, orange, mango, gram, bean, pumpkin, etc.

Fig 16.5: Pea and Mustard

Activity 2:

Observation of root, stem and leaf

On the way to school from home, root any two small plants along with their roots. Collect big leaves of any two plants. Observe all the collected plants forming a group in a classroom. By the comparative study of root, stem and leaf of all the collected plants, discuss in a group and distinguish the plants which fall under class monocotyledon and dicotyledon separately.

5. Kingdom – Animalia

Vertebrate and Invertebrate animals fall under Animalia kingdom.

Vertebrate and Invertebrate Animals

Many types of animals are found here. These animals are different from each other in their physical structure, shape, size, etc. Some animals have internal skeleton where as the body of some animals is covered with hard shell. Some animals have simple body structure whereas in some animals all the system are developed. The animals with backbone are kept in one group and the animals which lack backbone are kept in another group. The multicellular animals which lack the backbone are called invertebrate

whereas the animals which posses the backbone are called invertebrates. In this lesson we will study eight phyla under invertebrate:

1. Phylum: Porifera

The animals belonging to this phylum are multicellular. The covering of their body is of two layers. Therefore, the animal of this group is called diploblastic. Small pores are present all over the body surface, which is called ostia. A larger pore is also present which is called osculum. The water enters into the body through ostia and leaves the body through osculum. It absorbs the food present in the water. It respires through the body surface where as its other systems are not developed. They are found attached to some substance in water. Example: *Spongilla*, *Sycon*, *Leucosolenia*.

Fig 16.6: Sponge

Fig 16.7: Hydra

2. Phylum: Coelenterata

Animals belonging to this phylum are multicellular as well as diploblastic. Hollow canal (coeleteron) is present inside the body. Tentacles are present around the mouth. They move with the help of tentacles. They respire through body surface. They reproduce by both sexual and asexual means. These animals are found in lake, pond as well as ocean. Example: Hydra, Coral, Jellyfish, etc.

Fig 16.8: Jelly fish

3. Phylum: Platyhelminthes

Animals belonging to this class are called flat worms. Their body is flat like leaves or long shape like ribbon. The body is covered by three germ cell layers. So these types of animals are called triploblastic animals.

Fig 16.9: Tapeworm and Liverfluke

Mouth is present in the anterior part of body and around the mouth, hook is present. With the help of hook, they are attached with host cell. They have sucker, with the help of which they suck blood, food. Some are endoparasitic whereas some are free living. They are hermaphrodite. In them, reproduction takes place by both sexually and asexually and also has the capacity of regeneration. Example: Liverfluke, tapeworm, etc.

4. Nemathelminthes

The body of animals belonging to this phylum is long and round and is pointed at both the ends. Their mouth, anus and hook have been developed. Body can be divided into two equal halves, which is called bilaterally symmetrical. They are unisexual. Reproduction takes place by sexual means. They are generally parasite where as some are free living.

Fig. 16.10: Ascaris

Example: *Ascaris*, hookworm, pinworm, etc.

5. Phylum: Annelida

The body of animals belonging to this phylum is elongate, cylindrical and segmented. The layer that covers the body is moist. They respire through skin. Brain, tissue, excretory and blood circulatory organs are developed. Body is bilaterally symmetrical. Some animals are hermaphrodite whereas some are unisexual. They are found in moist soil, water whereas some are found in parasitic form.

Example: Earthworm, leech, nereis, etc.

Fig. 16.11: Earthworm, Leech

6. Phylum: Arthropoda

The body of animals belonging to this phylum is covered by hard shell. The legs are made by jointed appendages. Body is divisible into head, thorax and abdomen. One pair of compound eyes and antennae are present in the head. Male and female are separate. Insects have two pairs of wings. They respire by skin, gills or trachea. They are found all over land, air, water, etc.

Example: Scorpion, butterfly, centipede, etc.

Fig. 16.12: Scorpion and Butterfly

Activity 3:

Collection of insects

Make a group of friends of class. Take materials instructed by teacher. Go to the nearby open ground. Collect the insects, bettle, earthworm, dragonflies found with the help of skipping net according to need. Discuss about the collected insects in classroom. After the observation and study of insects, write name, classification and characteristics in copy.

7. Phylum: Mollusca

The body of animals belonging to this phylum is soft. Body of some animals is covered with hard shell made up of calcium. Tentacles are present in head. Whenever they touch any object, they hide their body immediately into the hard shell. They are unisexual. Body is assymetrical. Their digestive, blood circulatory system and nervous system are developed. They are found in land and water. Example: slug, snail, octopus, cuttle fish, unio, etc.

Fig. 16.13: Snail and Octopus

8. Phylum: Echinodermata

The body of animals belonging to this phylum is covered with hard shell which is spiky. Animals are star shaped, elongated, round shaped. They are triplobalstic and radially symmetrical. Digestive system is developed. Mouth and anus are present. They move with the help of tube feet. They are unisexual. They reproduce by sexual means. They are usually found in ocean. Example: Starfish, sea-urchin, sea-cucumber, etc.

Fig. 16.14: Starfish

Vertebrates: Animals with backbone are called vertebrates. All vertebrates are kept under phylum chordata. Animals such as fish, frog, dog, cat, lion, whale, bat, etc belong to chordata. Although, some characters of all these animals are different, some characters are found similar.

Features of phylum Chordata

In some stage of their life notochord is developed. At embryonic stage gills are developed on the outer part of neck. The empty part inside the vertebrae is filled with tube shaped nerve. Skeleton is covered with muscle. Closed blood circulatory system has been developed.

Phylum chordate is divided into four sub-phylum. Hemichordata, urochordata, cephalochordate and vertebrata are those sub-phyla. We will study only about sub-phylum vertebrata in this chapter.

Sub-Phylum Vertebrata

Animals with backbone in their body belong to this group. Their body is bilaterally symmetrical. The process of respiration occurs through gills or lungs. The temperature of body changes according to the surroundings, which is called poikilothermic animal. Poikilothermic animals are called cold blooded animals. Fish, snake, frog, etc belongs to this group whereas man, bird, etc whose body temperature does not change according to the surrounding are called homiothermic. Homiothermic animals are called warm blooded. Phylum vertebrata is divided into five class. They are;

a) Pisces b) Amphibia

c) Reptilia d) Aves e) Mammalia

Pisces

Their body is flat, elongated and covered with scales. Their body is divided into three parts as head, trunk and tail. On lateral side of head gills are present. It helps to respire. It swims in the water by the help of fins. Heart has two chambers. Male and female both are separate. Fertilization is external whereas some has internal fertilization. They live in water.

Example: All types of fishes, sea horse, rohu, etc.

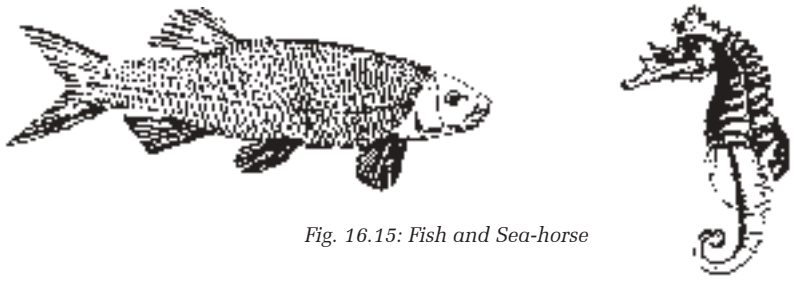


Fig. 16.15: Fish and Sea-horse

Amphibia

Their body is covered with moist skin. Their body can be divided into two parts as head and thorax. They have four limbs. They respire through gills during tadpole stage. But during adult stage they respire through skin. Their heart has three chambers. They are unisexual. They lay egg in water. In them, fertilization is external. They live in both water and land. Example: frog, toad, salamander, etc.

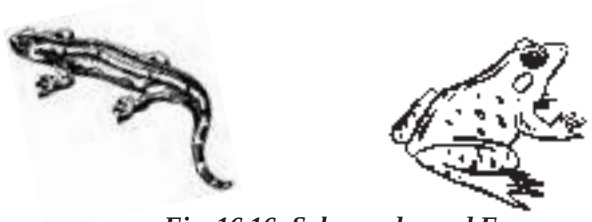


Fig. 16.16: Salamander and Frog

Reptilia

The animals under this class creep on land. Their body is covered with hard shell. The body can be divided into 3 parts as head, thorax and tail. They have two pairs of limbs. They respire through lungs. Their heart has 3 chambers but crocodile has 4 chambers. They are unisexual and fertilization is internal. They lay egg. They live in water and land. Example: Snake, lizard, wall lizard, crocodile, tortoise, etc.

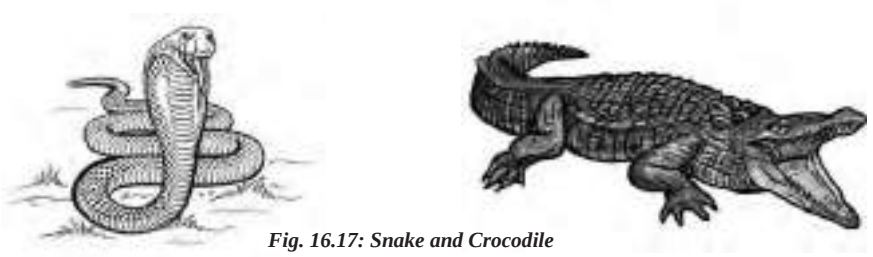


Fig. 16.17: Snake and Crocodile

Aves

The body of animals falling in this class is covered with fur and feather. There is head, neck, thorax and tail in their body. They have two pair of limbs. Fore limbs are modified into wings whereas hind limbs are used for walking . The bone present in their body is hollow, which is called pneumatic bone. They respire through lungs. They lay egg (oviparous). Their fertilization is internal. They are unisexual. Air sac is present in their body. They live on land. Example: Pigeon, danphe, pea-cock, hen, etc.

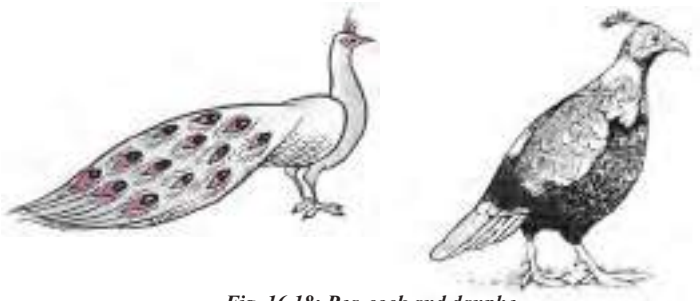


Fig. 16.18: Pea-cock and danphe

Mammalia

Their body is covered with fur. Mammary gland is present in the body. Head, neck, thorax and tail are present in their body. They respire through lungs. Four chambers are present in their heart. They give direct birth (viviparous). They are unisexual and fertilization is internal. These animals are found in both land and water. Example: man, horse, whale, cow, etc.

Kingdom: Animalia Phylum: Chordata

Sub-phylum: Vertebrata Class: Mammalia

Example: Bat

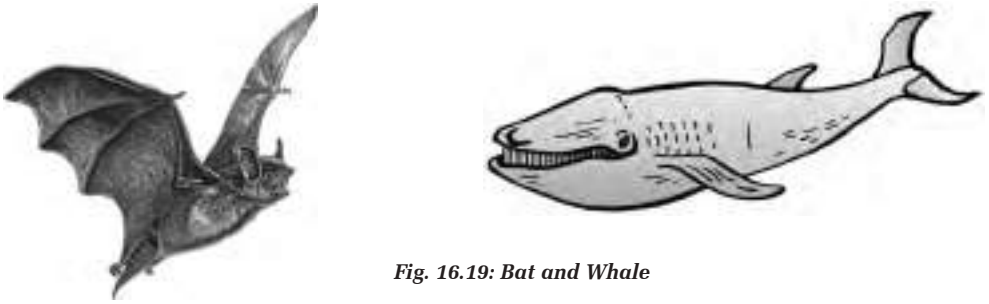


Fig. 16.19: Bat and Whale

Mosquito

Fig. 16.20: Mosquito

Mosquito is one type of harmful insect that belongs to class insect. Mosquito is found everywhere. Specially, during summer and rainy season mosquitoes are found in many places. They do not come out during day time. But during dark, they roam around for finding their food. During night time, they hide in dark places, bushes and branches of trees. Similarly, they stay hiding in the corner of house, bookshelf. Due to the effect of climate change, mosquito has been started to be found above the altitude of mid hilly region. With the increase of temperature, the habitat of mosquito has transfered to the high altitude region. Both male and female mosquitoes survive on feeding the nectar of flower whereas female mosquito also sucks blood of homiothermic animals.

Do you Know?
Due to the effect of climate change, with the increase in temperature, the habitat of mosquito has been found to be changing. Nowadays, in high altitude like Namche bazaar, mosquito has been started to be found.

External features of mosquito

The body of mosquito is divisible into head, thorax and abdomen. In its head a pair of compound eyes and a pair of antennae are present. It has trunk like proboscis. Inside this, there is a needle like sharp organ, which is used to make hole in the animal's body and to suck blood.

Mosquito has a pair of wings.

The wings of female is bigger. Its abdomen is made from nine segments whereas in the last anus is present. The fertilization of mosquito is internal. When the mosquito flies, their wings collapse with eachother and sound is produced. During egg laying time of female mosquito, they suck the blood of vertebrates.

Life cycle of mosquito

Mosquitoes are found in the garden of house, farms, near the drainage, pond as well as lakes. In their life cycle, there are four stages of egg, larva, pupa and adult. Among these, the development of egg, larva and pupa completes in water.

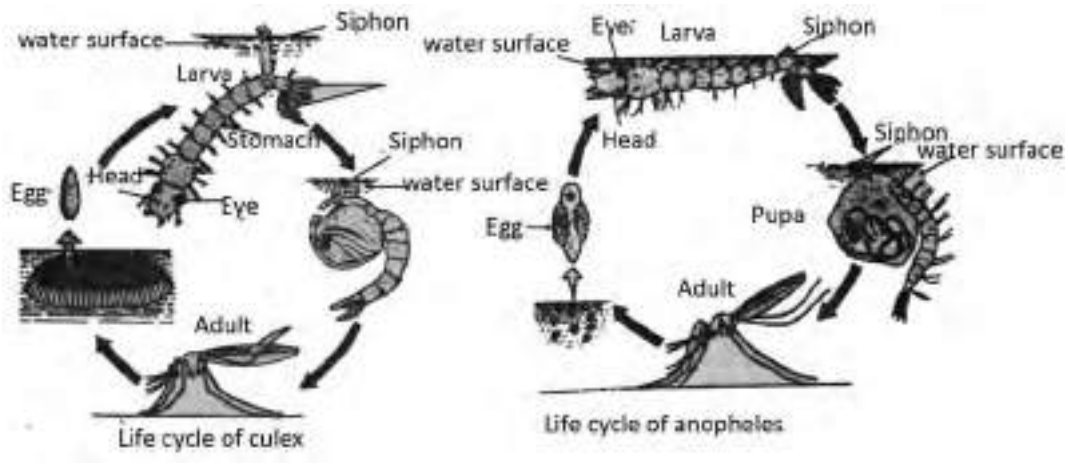


Fig 16.21: Life cycle of mosquito

Egg

The mating of male and female takes place in air. Female mosquito usually lays egg on the stagnant water of pond, ditches of farm and lakes. Some mosquitoes lay egg in clear water whereas some lay egg in dirty water. *Anopheles* type of mosquito lays 40 to 100 eggs at a time. On left and right side of each egg air float is present. Each egg is separate. *Culex* type of mosquito lays 200-400 eggs at a time. These eggs attach with eachother forming a boat shape and floats on water.

Larva

Under favourable environment, in 2-3 days larva comes out from each egg. Larva is small, transparent and like insect. The larva of mosquito is called wriggler. It shows wriggling movement in water.

It feeds on the algae and microorganisms found in water. They are voracious feeder and active. Their body is divisible into head, thorax and abdomen. Thorax is broad and made up of from arrangement of 3 segments. Abdomen is also made up of from arrangement of segments. One pair of compound eyes is present on head. On the lower side of head, mouth is present. With the help of tiny hairs around the mouth the food present in the water is taken to the mouth. Tiny hair like structure is also present in the abdomen. At the end of abdomen four gills and siphon is

present to respire. They stay hanging on the surface of the water. When the water moves slightly, they swim inside the water and after sometimes comes to the surface to respire.

The way of living inside the water of larva is also different. The larva of *Culex* mosquito makes an angle with the surface of water whereas the larva of *Anopheles* mosquito lies parallel to the surface of the water.

Larva stage lasts for approximately two weeks. In this stage, moulting takes place 3-4 times and then it is fully developed.

Pupa

The fully grown larva dips in water and becomes comma shape. Its head and thorax combine to form cephalothorax. Its abdomen is long and segmented. It is covered with transparent layer which is known as puparium. The pupa stage of other insect is inactive. But the pupa of mosquito is active. It swims in water but doesnot feed. It respires with the help of siphon. This stage lasts for approximately 2-7 days.

Adult mosquito

The organs developed in larva stage are totally lost in pupa stage and the pupa changes into fully developed mosquito which is known as imago. Puparium burst and imago comes out. It dries up the wings and get ready to fly, which is called adult mosquito.

Disadvantages of mosquitoes

Mosquito is harmful. It transfers different kinds of diseases to human and animals. Typical types of mosquito transfers and spreads diseases like malaria, filariasis, yellow fever, meningitis, encephalitis, dengue.

Diseases	**Types of mosquito**	**Causative agent**
Malaria	*Anopheles*	*Plasmodium*
Filariasis	*Cules fatigans*	*Wuchereria bancrofti*
Dengue	*Culex* sp, *Aedes* sp	Virus
Encephalitis	*Culex* sp, *Aedes* sp	Virus
Yellow fever	*Aedes*	Virus

Female *Anopheles* mosquito transfers the disease malaria. This is dangerous disease which is caused due to parasit *Plasmodium*. The life cycle of parasite *Plasmodium* completes in two host cells; man and mosquito.

When female *Anopheles* mosquito bites a malarial patient, it also sucks the parasite along with the blood. That parasite multiplies in the stomach of mosquito and develops and travels to salivary gland. When this mosquito bites a healthy person, along with its saliva the parasite also enters into the body of that person. This parasite multiplies its number and develops in the liver of human. The parasite coming out from liver enters into the red blood cell, where they multiply in large number. At the end, the red blood cell burst. In this stage, the symptoms of malarial disease are seen in human.

Prevention of infection

1. Using mosquito nets during sleeping or applying oil in the body as well as mosquito repellant mat can be lighted.
2. Cover the puddles, around house and insecticides should be sprayed in such place.
3. The life cycle of mosquito completes in water therefore kerosene, petrol should be sprayed in lake, pond, ditches/puddles. Due to this pupa and larva of mosquito die.
4. If there is fish-farmed pond near the house, if gambusia fish, trout fish are farmed they feed on the larva and pupa of mosquito.

Activity 6:

Find the solution for removing mosquito

a) Observe the nearby pond or ditches properly during summer.

b) Take the water where larva/pupa of mosquito is present in beaker or glass.

c) Keep the glass or beaker without touching.

d) Observe the larva and pupa hanging at the surface of water.

e) Add one-two drops of kerosene oil in water.

f) What does it affect in larva and pupa? Observe.

g) How useful is this way of controlling mosquito? Discuss in a group and write the conclusion.

h) There are four stages in the life cycle of mosquito viz. egg, larva, pupa and adult.

i) The pupa of mosquito is different than that of other insects. It is active

and swims in water.

j) To be protected from malaria disease, we should be protected from the bite of the mosquito at first.

Types of Mosquito

Mosquito are of many types. Among them, we will study about *Culex* and *Anopheles* mosquito. Now, let's see the differences between these two.

Difference between *Anopheles* and *Culex* mosquito

Stage	Anopheles	Culex
1. Egg	Its egg consists of air float on both sides.	Air float is not present in its egg.
	It lays individual egg at the surface of water.	It lays egg in group at the surface of water, which attaches to each other forming boat shape.
	At one time, it lays 40-100 numbers of eggs.	At one time, it lays 200-400 numbers of eggs.
2. Larva	Its larva lies parallel with the surface of water.	Its larva makes an angle with the surface of water while lying.
3. Pupa	Its pupa is green and the head is small.	Its pupa is colourful and the head is big.
4. Adult	The adult mosquito makes acute angle with the surface of land while sitting.	The adult mosquito sits parallel with the surface of land.
	Its wing is transparent.	Its wing has light or dark like stain.
	Small-small palpi are present near the proboscis.	Proboscis and palpi are of same size.

Things to remember

1. The process of dividing living organisms into different groups and sub groups according to their similar and dissimilar characteristics found in them is called classification.
2. Scientist Robert H. Whitaker has put forward the idea of the five kingdom system including monera, protista, fungi, plantae and animalia.
3. Algae, bryophyte and tracheophyta belongs to the kingdom plantae.

4. Three sub-division; Pteridophyta, gymnosperm and angiosperm belongs to tracheophyta.
5. Two classes monocotyledon and dicotyledon belongs to angiosperm.
6. Animals without backbone are called invertebrates. Eight phyla; porifera, coelenterate, platyhelminthes, nemathelminthes, annelid, arthropoda, mollusca and echinodermata belong to this.
7. All vertebrates are kept under one phylum chordate, where four sub-phyla respectively; hemichordate, urochordatam cephalochordate and vertebrata are found.
8. The life cycle of mosquito completes in four stages: egg, larva, pupa and adult.
9. Mosquito is harmful insect. It spreads different kinds of diseases like filariasis, malaria, jaundice, dengue, etc.

EXERCISE

A] Put the correct (√) sign in the correct answer of the following multiple choice questions.

1. Which scientist is the father of five kingdom classification system?

   a) Carolous Linneus b) James Watt

   c) Gregor Mendel d) Robert H. Whittaker

2. Which of the following plants lacks vascular tissue?

   a) Spirogyra b) Fern c) Paddy d) Mustard

3. In which phylum does the animal with the characteristics of segmented body, elongated and round belongs to?

   a) Platyhelminthes b) Annelida

   c) Arthropoda d) Nematoda

4. In which phylum does the animal with characteristics like multicellular, pores all over the body and sessile belongs to?

   a) Mollusca b) Coelenterata

   c) Porifera d) Protozoa

5. Which class does a bat belong to?

   a) Amphibia b) Aves c) Mammalia d) Pisces

6. Which parasite is the cause of malaria?

   a) *Plasmodium* b) *Antamoeba*

   c) Tapeworm d) *Ascaris*

7. Among the four stages of life cycle of mosquito, which does not occur in water?

   a) Egg b) Larva c) Pupa d) Adult

B] Answer the given questions.

1. What are the kingdoms that belong to the five kingdom classification system?
2. Give any two differences between:

   a) Gymnosperm and Angiosperm

   b) Monocotyledon and Dicotyledon
3. Classify the following plants along with two main characteristics:

   a) Cycus b) Bamboo c) Lemna d) Paddy

   e) Sugarcane f) Pinus g) Mango h) Mustard
4. According to the given characteristic of plants, write their division.

   a) Plants without cover in their seed.

   b) Plants with fruit along with seed.

   c) Plants with only one cotyledon in seed.

   d) Plants with two cotyledon in seed.
5. Classify the following animals along with two main characteristics:

   a) Spongilla b) *Ascaris* c) Bee

   d) Crab d) Starfish
6. Write the name and phylum of animal on the basis of the following characteristics.

   a) Bodyis segmented and its body is covered with moist skin. It is called living plough.

   b) Stay attached to certain place and small pores are found all over the body.

   c) Body is divisible into head, thorax and abdomen and it spreads malaria disease.

d) Body is covered with spiky shell and moves with tube feet.

e) Body is covered with scales and respires through gills.

f) Body is covered with feather and is oviparous. Its beak is blunt.

g) Respires through lungs, is viviparous but flies.

h) Respires through lungs, swims with the help of paddle.

7. Write the difference between jelly fish and star fish.
8. What is mean by vertebrate? Write any four characteristics of it.
9. Write two reasons for keeping sea horse in class pisces.
10. On the basis of two characters differentiate:
    a. Bird and Bat
    b. Horse and Sea-horse
11. Classify along with the important characteristics.

    a) Toad b) Wall lizard c) Crocodile

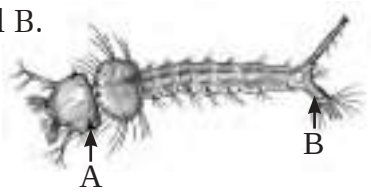
    d) fish e) Duck f) Bat
12. Draw a clean diagram of mosquito and label its different parts.
13. Write two advantages from the study of life cycle of mosquito.
14. How does mosquito transmit malaria, explain.
15. In the figure, one stage of life cycle of mosquito is given. Write the answer of the following questions.

    In the figure write the name of part A and B.

    a) Which mosquito's larva stage is this?

    b) Write two characteristics of it.

    c) Write two solutions to control it.



16. Mentioning the effect of mosquito write what can be done to control it? Write in point.

Project Work

Observe some stages of the life cycle of mosquito by going to nearby

ditches. What did you see on the basis of the things learnt at class? Make a report and discuss in class.

Glossary

Autotrophs:	Living beings with chlorophyll which can prepare their own food.
Heterotrophs:	Living beings that depend upon other living organisms for food due to absence of chlorophyll
Diploblastic:	Living organisms having two layers of cells to cover their body
Triploblastic:	Animals having three layers to cover their body
Symmetrical:	Animals whose body can be divided into two equal parts
Asymmetrical:	Animals whose body cannot be divided into two equal parts
Hermaphrodite:	Living organisms having male and female reproductive organ in one
Unisexual:	Living organism with only one reproductive organ
Parasite:	Animal that depend upon other living organisms
Monoecious:	Organisms having male and female reproductive organ in one
Diocious:	Organisms having male and female reproductive organ separately
Amphibian:	Animals that can live in both land and water
Prokaryotic:	Very simple cell without nucleus
Eukaryotic:	Simple cell with nucleus

The students of class 9 had gone to pond at the ground from school during summer time. They see different types of animals there. Among

Unit 17

Adaptation of Organisms

those animals, some were swimming inside the water whereas some were roaming here and there in land. Similarly, they saw some plants in water and some in land. They start thinking why all plants and animals were not in the same environment. You also think for a while! Why is this happening?

In this chapter we will study about the adaptation of animals and plants found in water and land and also about microorganisms virus, bacteria, protozoa and fungi.

Adaptation

In our surrounding, different types of living organisms are found. Among those living organisms some lives in water whereas some on land. From very big blue whale to very small organism protozoa belongs to aquatic organisms. Among aquatic organisms very living organism can easily be seen with our naked eyes. All these type of organisms have their own type of characteristics to live easily in their own habitat. Due to such characteristics all living beings easily adapt and live in the environment. In this way, the process of organism living and staying in their own environment has been known as adaptation. Here, we are studying about the topic of adaptation of plant and animal found in land and water.

Aquatic Adaptation

In water different types of organism such as: plants, animals, micro-organisms have been adapting. These organisms have the capacity to gain water, light, oxygen and food material living in the water. The animals living in water and plants are classified into two parts; as aquatic animals and hydrophytes respectively.

Hydrophytes

There are three types of aquatic plants present as floating, sub-merged and fixed way.

a) Floating plant: Some aquatic plants remain floating independently do

not touch the soil of the watery area. Example: Pistia, wolfia, lemna, etc.

b) Submerged plant: Some aquatic plants like hydrilla and vallisnaria remain under water but their roots touch the soil.

c) Amphibian plants: Half part of some aquatic plants are inside the water and half part outside the water. But their root is totally fixed into soil. Example: Typha, rumex, sagittaria, ranunculus, etc.

Adaptational characteristics of Aqautic plants

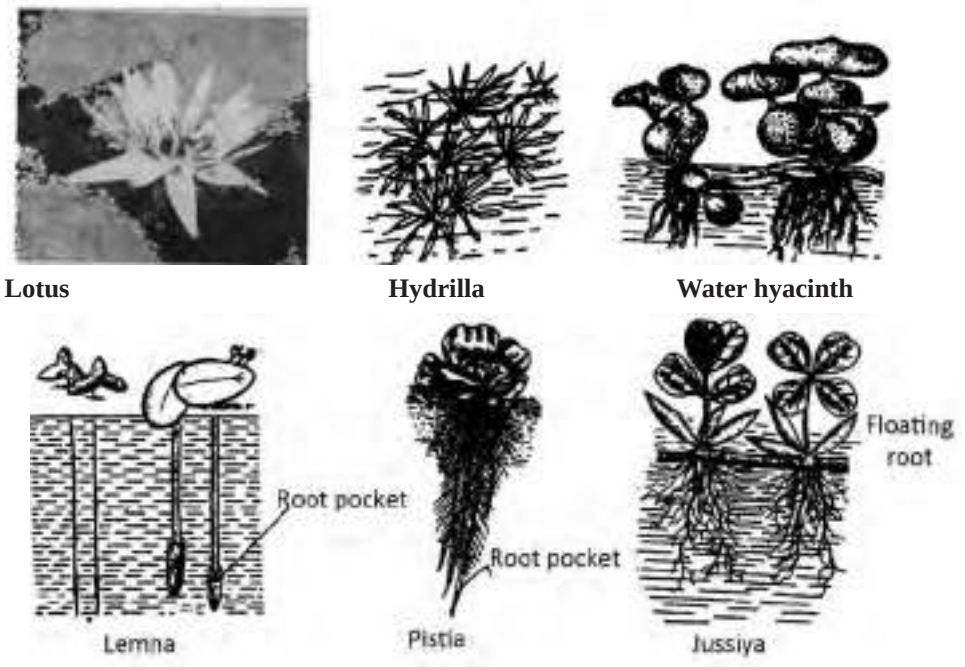


Fig 17.1: Aquatic plants

a) Roots of aquatic plants are less developed or in some plants are also without root.

b) Stems of aquatic plants are long, soft and spongy.

c) To protect from decaying, there is a waxy coating on the surface of their body.

d) In some floating aquatic plants special type of air sacs are present, which help the plant float to on water.

e) Properly not developed xylem and phloem are found in them.

f) The leaves of submerged plant are small and tiny whereas the leaves of floating plants are big and broad.

Adaptational characteristics of Aquatic animals

a) The body of aquatic animals is streamlined. Their head is blunt, the body is slippery and tail is strong.

b) The air sacs are present to help the animals to float in water.

c) Their body temperature increases and decreases according to the environment. Therefore, animals can live in cold and warm environment.

d) Their whole body is covered by water proof scale, due to which their body does not get wet in water.

e) Fish utilizes gills to obtain the oxygen dissolved in water.

f) Fins and tails aid the aquatic animals to swim, keep the body balanced and to change the direction.

Terrestrial Adaptation

Different types of living plants, animals, micro organisms are being adapted.

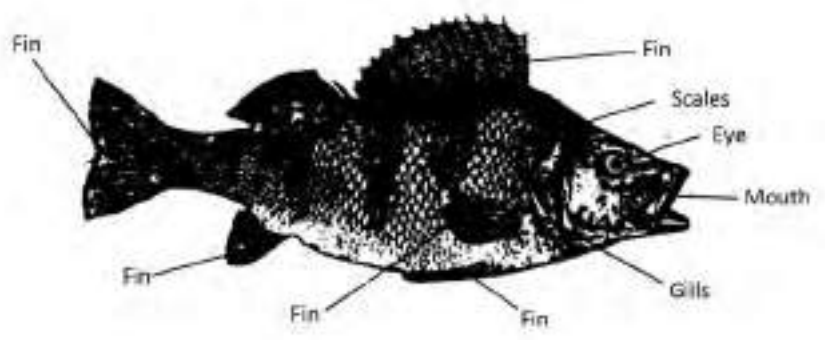


Fig. 17.2: Fish

These living organisms obtain water, light, oxygen and food materials needed to them from the soil and environment. The characteristics of adaptation of terrestrial animals and terrestrial plants are given below.

Adaptational characteristics of Terrestrial plants

a) The roots of terrestrial plants are well developed.

b) In climbers plants tendrils, hook and aerial roots are present for adaptation.

c) The plants living in moist habitat have well developed mechanical tissue and vascular system.

d) The roots of plants present in dry places are long, which can absorb the water from far places.

e) The plants found in dry soil (especially in desert) are stunted. They have thick bark. To lminimize the water loss through transpiration the leaves in these plants are small whereas the leaves of some plants are like of thorns or spines shape.

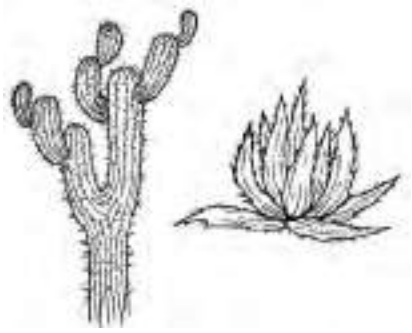


Fig. 17.3: Terrestrial plants

Adaptational characteristics of Terrestrial animals

a) The legs or wings of terrestrial animals are different. They are strong and long which helps fast movement. Some animals have single hoofed (horse, donkey, zebra) whereas some animals have double hoofed (goat, sheep, buffalo).

b) The body of birds is like the shape of aeroplane (streamlined) and covered with feathers. The forelimbs are modified into wings. Their bones are light and hollow and spongy. They have many air sacs. The beaks of birds are different according to their feeding habit.

c) As the nail of the front leg and mouth of the animals living inside hole (borrow) is strong they can easily make their habitat.

d) Some animals climb and jump different places for their food, home and protection. The animals like lizard climbing on the wall has an adhesive pad on their leg. The animals climbing in tree have strong chest muscles as well as the fingers of leg are able to hold the branch of a tree.

e) The animals such as camel living in dry place has a pouch in their body to store water. Their skin is thick as well as tissue storing water is well developed. Food is stored in the hump present in the back.

Bacteria

Bacteria are very microscopic, simple and old organisms. Antonie Van Leeuwenhoek discovered bacteria at first in 1676 A.D. He observed it in a drop of water for the first time with the help of microscope invented by himself and called them small animal. In 1848 A.D. Eherenworg gave name to this small animal as bacteria. Along with this in 1854 Cohn classified bacteria as the form of plant. Louis Pasteur and Robert Koch exhibit that bacteria is responsible for transmitting different types of diseases in plant, animal and human. The science that studies about bacteria is called bacteriology.

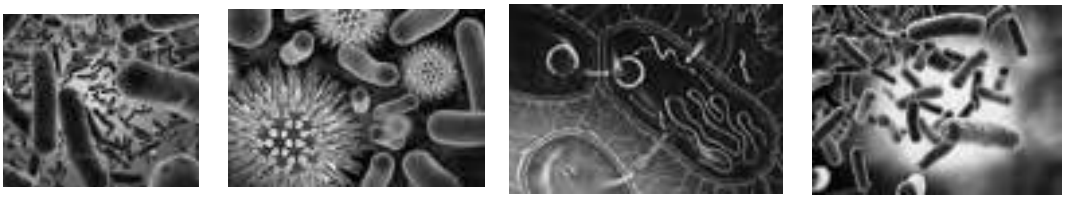


Fig. 17.4: Bacteria

Bacteria are unicellular and microorganisms having definite types of cell wall. Their cells are prokaryotic nature and they synthesize vitamins. Chlorophyll is found in them, but in some bacterial chlorophyll is present. Most of the bacteria live in the form of parasite and transmit diseases.

Bacteria are found everywhere in soil, air and water as well as also in food, fruits, flowers and green vegetables. Some species of bacteria are found in warm weather and some in cold weather.

Bacteria are microorganisms, which are of 0.2 micron to 2 micron diameter. Bacteria are divided into four types as coccus, bacillus, spirillum and filament or mycelia.

Diseases caused by bacteria are bacillary dysentery, diarrhea, cholera, pneumonia, tuberculosis, meningitis, tetanus, leprosy, syphilis, gonorrhea, plague, etc.

Importance of bacteria

a) *Lactobacillus* and *Acidophillus* bacteria help to prepare curd (yogurt) from milk.

b) Bacteria aid in making compost fertilizer. Help to degrade the body of living organism.

c) Some bacteria like *Rhizobium* convert nitrogen present in the free state in the atmosphere into nitrate.

Harmful bacteria for human being

a) Due to different type of bacteria different diseases, in humans are caused such as due to *Diplococcus pneumonia* pneumonia, cholera due to *Vibrio cholera*, typhoid due to *Salmonella* Typhi, etc.

b) Some bacteria like *Pseudomonas* decreases the fertility power of soil.

c) In summer some bacteria spoils the cooked food, fruits, flowers, and green leaves by rotting.

d) Some bacteria cause diseases like spots in plants, weak roots, etc.

Control measures of Bacterial Diseases

The following measures can be applied to control bacteria in plants as well as in animals:

a) Use of seed not infected by bacterial diseases

b) Use of anti-bacterial medicine

c) In case of bacterial contamination use antibiotic medicine

d) People or animal infected with bacterial diseases should use medicine according to the doctor's advice.

Fungi

The group of plants without chlorophyll is called fungi. They cannot make their own food by themselves. They are parasite and saprophytes. They are both unicellular and multi-cellular. Their body is not divided into root, stem and plant. The science that studies about fungi is called mycology. They are found in all types of environment; dead materials, soil, fertilizers, degrading materials, fruits, plants and inside the body of animals. In fungi sexual and asexual reproduction takes place. Asexual reproduction is like fission, budding, fragmentation, sporulation. The enzyme invertase and zymase used for the preparation of alcohol where as to get protein, vitamin and minerals in large amount, mushroom is used as food materials.

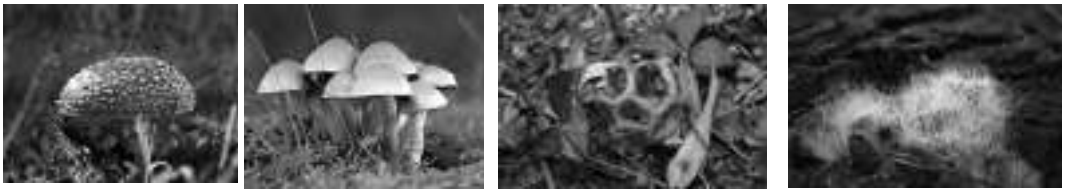


Fig: 17.5: fungi

Importance of Fungi

a) As mushroom has protein, vitamin and minerals, it has importance as nutrient.

b) Different types of antibiotics are produced from species of fungi, such as penicillin.

c) We can get vitamin B complex, vitamin E from yeast. It is also used for making bread.

d) The decaying or decomposing of animals and plants after dead and mixing it in soil increases fertility.

Harmful Activities of Fungi

Fungi have different harmful effect. Some harmful effects are given below:

a) Different species of fungi cause many types of skin diseases and destroys the materials made up of skin, clothes and electrical equipments.

b) It causes high fever and allergy in human.

c) It causes dadhuwa disease in potato and

d) Rhizopus, mucor, etc fungus make the food poisonous.

Control measures of Fungi

To lessen the harmful effects from fungi following control measures can be taken:

a) By keeping different types of food materials like milk, fruit, fish, meat, etc in cool place.

b) By using fungicide for fungi

c) By maintaining personal hygiene to prevent fungal growth in skin

d) By using sugar for fungi

e) By using salt for the fungal growth in fruits and vegetables

Activity 3

Cook bread of wheat or barley. Keep a small piece of that bread after moistening and keep it in safe place for three four days. After that, observe that bread. Did you find any growth of fungi there? If you don't find it, keep it at the same situation for more 3/4 days. Now, again observe it and present the result about the growth of fungi you have seen among the friends in a classroom.

Virus

The name virus has come from latin language virion, which means poison. Viruses are ultramicroscopic, parasites that spread diseases. Viruses show living behavior inside the body of living organisms whereas outside in the non-living things their numbers don't increase. Therefore, virus is called obligatory parasite.

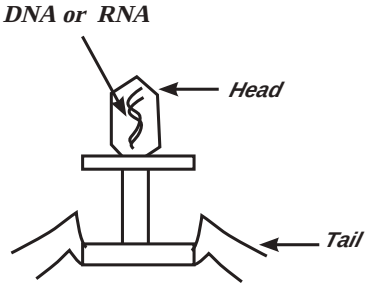
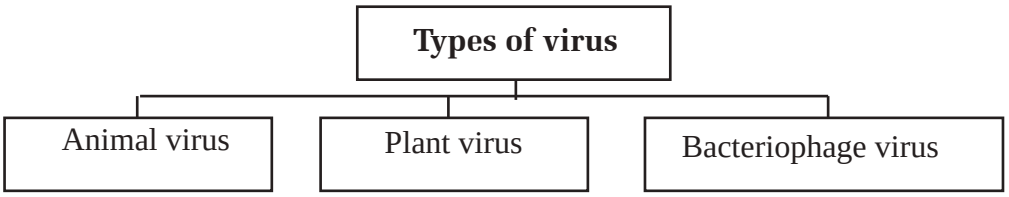


Fig 17.6: Bacteriophage virus

Iwanwisky discovered virus at the first in 1892 A.D. He showed that mosaic disease is caused in tobacco plants by TMV (Tobacco Mosaic Virus). The size of virus is very small from 25nm to 250nm. They are 50 times smaller than bacteria. Virus brings different kinds of diseases. The science that studies about virus is called virology.

Classification of Virus



On the basis of the host of viruses, they are divided into three types as animal virus, plant virus and bacteriophage virus. The virus living in the form of parasite in the animals or attack the body of animals is called animal virus, such as polio, AIDS, measles, cough, chicken pox, etc. The virus living in the form of parasite in the plants or the virus which attacks plant is called plant virus like cynophase, mosaic virus infecting tobacco. On the basis of nucleic acid found in virus, viruses are DNA virus (bacteriophage, small pox virus) and RNA virus (rhino virus, retro virus, polio virus, mosaic virus) etc.

Methods of Transmission of Viral Diseases

There are different ways for the transmission of viral diseases. This happens because particular virus transmits particular type of disease.

a) Transmits, when the leaves of plants are rubbed with eachother

b) Virus transmits, when grafting is done between healthy and unhealthy plants.

c) Virus transmits, when insect like aphid during eating parts of plant.

d) Some viruses such as mosaic virus of wheat transmit from soil.

e) In animals, virus transmits through direct contact while spitting, blowing nose, coughing etc.

f) Transmits from faeces, food and water

g) Virus also transmits while coming in direct contact with the wound or cut part of the patient.

Control measures

a) To control the plant virus, infected part should be burnt.

b) To control the plant virus, insect should be killed.

c) Virus that spreads in human can be controlled by vaccination on time.

Protozoa

Protozoa is unicellular parasite that spreads communicable diseases. They can be seen with the help of microscope. They increase their number after entering the human body. They transmit diseases from infected person to healthy person.

Fig: 17.7: Protozoa

This parasite causes infection from the contact of another person. The protozoa living in the intestine transmits to healthy person through the medium of faeces or direct contact of the infected person. But to transfer the protozoa living in the blood or tissue from infected person to healthy person third medium is necessary. Example: mosquito.

The diseases transmitted from protozoa are amoebiasis, giardiasis, African sleeping sickness, leishmaniasis, toxoplaxmosis, malaria, babesiosis, trichomoniasis, etc.

As these parasites infect from the contact of other person, we should remain away from the sick person. Give attention to personal hygiene. As the diseases can be transmitted through insects like mosquito, we should be away from their contact.

Things to remember

1) The ability of living organism to live in the environment is called adaptation. Due to this reason, they get habitat, food and shelter.
2) The animals and plants found in water are divided into two parts as aquatic animals and aquatic plants respectively.
3) Body structure and colour play important role for the animals to adapt in the environment.
4) The plants found in the land are big and strong, but aquatic plants are small and weak.
5) The plants found in the desert has the ability to store water and prevent water loss through transpiration, therefore can live in dry places.
6) Physical structure of animal as well as the smell present in them, colour, etc has helped them to adapt in their environment.
7) Harmful micro-organisms are called pathogens.

8) Polio, AIDS, measles, cough and cold, chicken pox, etc and virus living in the form of parasite in plants or viruses attacking plants are cynophase, virus in tobacco mosaic virus, virus in cucumber, etc are viral diseases.

9) The diseases transmitted by protozoa are amoebiasis, giardiasis, African sleeping sickness, leismaniasis, toxoplasmosis, malaria, babesiosis, triachomoniasis, etc.

10) The diseases caused by bacteria are bacillary dysentery, diarrhea, cholera, pneumonia, tuberculosis, meningitis, tetanus, leprosy, gonorrhea, tetanus, etc.

Exercise

(A) Put correct (√) sign in the correct answer of the following multiple choice questions.

1. In how many types can aquatic plants be classified?

   (a) 2 (b) 3 (c) 4 (d) 5

2. What has played an important role for the animals to stay adapting in environment?

   (a) Physical structure and colour (b) Body colour

   (c) Eyes (d) Body structure

3. How are the plants on land found?

   (a) Big and strong (b) Big

   (c) Small and weak (d) Weak

4. Which are viral diseases among these?

   (a) Bacillary dysentery and diarrhoea (b) Malaria and babesiosis

   (c) Meningitis and tetanus (d) AIDS and hengue fever

(B) Write the answer to the following questions.

1. What is called the adaptation of living organism?
2. Write any four features of the adaptation of plants and animals found on land.
3. Write any four adaptational features of each of aquatic plants and animals.

4. Prepare table of four diseases caused by bacteria, virus and protozoa.
5. How the diseases spreaded by bacteria transmit from one person to another, explain.
6. How the diseases spreaded by viruses transmit from one person to another, explain.
7. "Virus is both useful and harmful for us", justify this statement.
8. How do the diseases spreaded by protozoa transmit from one person to another? Explain.
9. What solutions can be implemented for being safe from viral and bacterial diseases?
10. Compare the fungal diseases and protozoal diseases.

Project Work

1) After going to the nearest mushroom farm, observe its different parts. Discuss the advantage of mushroom in class.
2) Go to the vegetable garden near to school or home. Observe and note the adaptational features of climber plants present in that vegetable garden. Discuss the adaptational features that you have noted down in classroom.
3) Collect a small fish from the nearby pond, river or market. Among adaptation features of that fish, observe any four organs according to the features such as gills, fins, pointed mouth, scales, etc and prepare report.

Glossary:

Cynophase: Virus that attack plant

Yeast: One type of fungi

Protozoa: Unicellular organism

Sarcodina: Diseases transmitted from protozoa

Adaptation: The ability to adjust in an environment

Unit 18

System

Body of all types of living organisms is made up of cell. Unicellular organisms are made up of only one cell. They perform all functions by one cell. But in multi cellular organisms, to conduct the life process different kinds of system are made by the group of different cell, tissue as well as organ. How do plants transport food? To transport the food and other necessary things in the plants xylem and phloem tissues are present. Similarly, also in the body of animals different kinds of tissues and organs combine to make the system of respiration, digestion, excretion and reproduction, etc. The group of cells of similar shape and size made for performing particular function in the body of plants and animals is called tissue. Similarly, tissues combine to form organ. The group of cells makes their own size and shape according to the nature of work. In this unit, we will study about the relation between cell, tissue and organ and types of plant tissue.

Inter-relationship of cell, tissue, organ and system

Unicellular organisms take food, excrete, respire, etc conduct other activities with the hub of a single cell. In multi cellular organisms many cells have been used for this process. Inside the body of plants and animals for the conduction of different kinds of activities, tissues of different features are arranged in a different group. In this way, the group of tissue arranged in a group is called organ. Organ is a part with complex structure and performing special function. Some organs perform only one function whereas some organ performs more than one function. Different kinds of organs are arranged to form a system. In one system, organs combine to perform a function. The body of any organism is conducted from mutual relationship of cell, tissue, organ and system. For example, for the transport in plant, complex tissues xylem and phloem have been working in combination. Whereas in developed organism heart, blood, blood vessels as well as organs have been working in group.

Mouth, tongue, throat, oesophagus, stomach, gall-bladder, large intestine, small intestine, pancreas and liver, etc organs belong to digestive system of human. The function of digestive system is to digest food and absorb

the nutrition present in the food.

The system found in the human body, its main organ, tissue and function are given in the table:

System	Organ	Type of tissue	Function
Digestive system	Stomach, liver, pancreas	Columnar epithelium, involuntary muscle	To digest and absorb food
Respiratory system	Pharynx, lungs	Cubical epithelium, pavement epithelium	To inhale oxygen and exhale carbon dioxide
Blood circulatory system	Heart, blood vessel	Voluntary muscle, connective tissue, pavement epithelium	To maintain oxygen in the body
Excretory system	Kidney, liver, ureter	Cubical epithelium, pavement epithelium	To excrete out unnecessary materials
Nervous system	Brain, spinal cord	Nervous tissue	To communicate
Skeletal system	Bones	Connective tissue	To hold body
Reproductive system	Ovary, testis	Cubical, columnar epithelium	To produce babies

Plant tissue

Cells combine to form tissues to conduct different kinds of activity inside the body of plants. The tissues found in plants can be divided into mainly two parts.

1) Meristematic tissue

Meristematic cells combine to form meristamatic tissue. These cells are arranged together, due to which there is no space between cells. The wall of cells is thin, where nucleus and thick cytoplasm is present. Meristematic cells are actually found at the tip of plants. Here, cell division occurs fast. According to the position of meristematic tissues they are classified as follows:

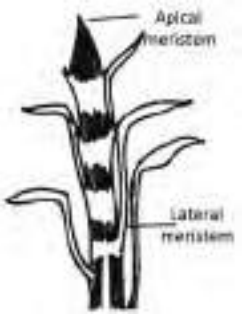


Fig 18.1: Meristematic tissue

a) Apical meristem

This kind of tissue is present at the tip of root and stem. This increase the length of plant's root or stem.

b) Lateral meristem

These tissues are found in lateral sides of root or stem. It increases the growth of the root or the stem.

2) Permanent tissue

Generally, cell division does not occur in the cells found in permanent tissue. The cells found in this tissue are dead or living and cell wall is thick or thin. Permanent tissues found in the plant are of three types:

a) Simple permanent tissue b) Complex permanent tissue

c) Special permanent tissue

A) Simple Permanent Tissue

Simple permanent tissues are made up of similar cells and perform similar function. On the basis of structure of cells, these tissues are of three types:

i) Parenchyma

Parenchymatous tissue is made up of thin walled living cells. Intercellular space is present in between the cells present in this tissue. The outer part (cortex), mesophyll of root or stem and middle part of stem (pitta) are made up of parenchyma.

The parenchyma is present in the leaf has chloroplast, which is called chlorenchyma. It prepares food by the process of photosynthesis. It stores and transports food and keeps plant healthy.

The parenchyma filled with air in between the cells is called aerenchyma. Hydrophytes are made up of aerenchyma, which helps to float in water.

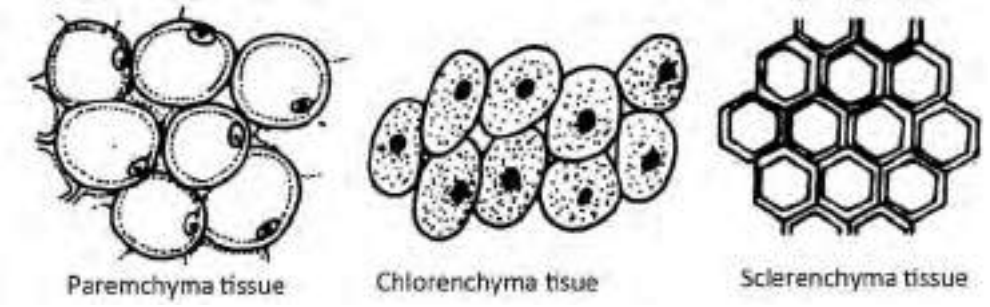


Fig 18.2: Simple permanent tissue

ii) Collenchyma

Collenchymatous tissue is made up of the combination of elongated cells. The corners of these cells are thick due to the substances like cellulose and pectin. The cells present in this tissue are living cells. This tissue functions to strengthen the growing part of the plant and to prepare food. The collenchyma having thin cell wall helps in the growth of the cells, spreading of liquid substances and flexibility.

iii) Sclerenchyma

Sclerenchyma is made up of elongated, narrow cells having thick cell wall. The cells found in this tissue are living or dead. These cells are fiber structured, pointed at the both sides. These tissues are found in plants and veins of leaves. The major function of it is to hold the plant.

Activity 1

To observer the tissues found in plants:

a) Take a piece of maize or gram.

b) Cut the stem with right hand by keeping one drop of water on blade.

c) Put the slice of them stem in watch glass. Add some water.

d) Select the thin sliced part, keep it in another watch glass and put one drop of safranin.

e) After some time, put the thinnest slice on the slide.

f) Put one drop of glycerine and cover it with a coverslip.

g) Observe the slide under microscope.

h) Draw the observed things in diagram.

B) Complex tissue

Complex tissue is made up of the group of different types of cells. Although the structure and function of these tissues are very different, they work in a group. They are made up of living or dead cells.As the major function of it is conduction, this tissue is also called vascular tissue. Complex tissues are of two types and they are;

a) Xylem

Xylem is made up of dead cells. It is formed by four types of cells. They are; trachea, trachids, wood fibre and wood parenchyma. These types of tissues are found in inner layer of root, stem, leaf and other hard parts of a plant. Xylem transports minerals and water from root to different parts of the plants. It provides mechanical support to the plant and stores food.

b) Phloem

Phloem is made up of the group of living cells. This tissue is made up of different types of cells. They are; sieve tube, companion cell, phloem parenchyma and phloem fibre. It is found in all parts of plant like root, stem and leaf. The major functions of it are as follows:

i. It transports the prepared food in leaf to different parts of the body.

ii. It stores food.

iii. It provides mechanical support to the plant.

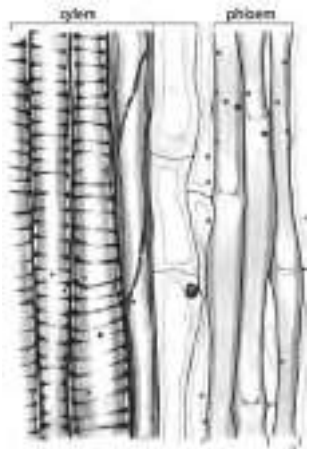


Fig 18.3: Complex tissue

Xylem	Phloem
1. It is the complex tissue made up of dead cells.	1. It is the complex tissue made up of living cells.
2. Trachea, trachids, xylem parenchyma and xylem fibre cells are found in it.	2. The cells like sieve tube, companion cell, phloem parenchyma, phloem fibre are found in it.
3. It transports minerals and water from root to different parts of the plant.	3. It transports the prepared food in leaf to different parts of the plant.

C) Special tissue

The cells present in special tissue perform in excretion and secretion. This is modified for the special function. Special tissue is of two types. They are; glandular tissue and lactiferous tissue. Glandular tissue is made up of the layer one cell or cells. These cells secret various types

of chemicals like digestive juice, resin, gum, etc. This type of tissues are found in plant like dhaturo, tulasi, salla. Lactiferous tissue prepares milk. Lactiferous tissue is found in the plant like lalupate, pineapple etc.

Skeletal System of Human Body

When you touch head, hand, knee of your body, you find hard part, what can be the name of that hard part? What can be this hard part made up of? If soft part of body, muscles is removed only skeleton is left, these skeleton is made up of combination of different kinds of bones. Bone is made up of combination of mineral calcium. Due to which it is hard. Though bone is seen like non-living thing it is made up of osteocytes cells. It has blood vessels and nerves. The bone present in ear and nose is soft and flexible. It is called cartilage. It acts as a shock absorber. In human body there are total 206 bones including short and long bones. The skeleton made up of these different types is called skeletal system. In this unit, we will study about the different type of bones and the function of skeletal system.

The bones present in the human body are of different shape. Among them some are long, some irregular shape, cube shape and some flat. The bone of hand and leg are long. The bones of head and ribs are flat whereas the bones of wrist and knee are of cube shaped. The shape of bone of vertebral column is irregular.

The bone of human body can be studied into two groups.

a) Axial skeleton

b) Appendicular skeleton

A) Axial skeleton

The bone of head, chest, vertebral column and rib is called axial skeleton.

i) skull

The bone of head is called skull. It has been divided into two parts.

- Cranium
- Facial bone

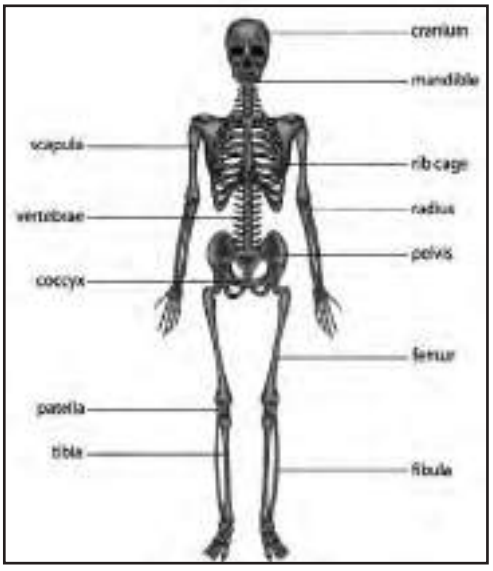


Fig 18.4: Human skeleton

Cranium

Cranium is like round box. It protects the brain. It is made up of 8 flat bones closely attached together.

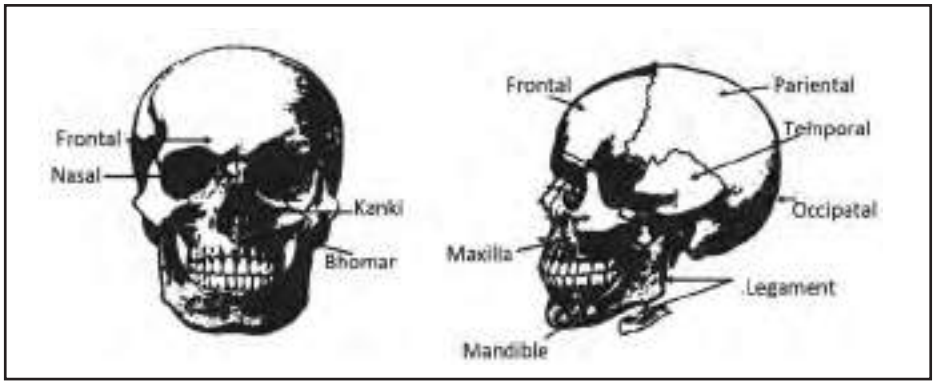


Fig 18.5: Bones of head

1. **Frontal:** The bone of forehead is called frontal. It is only one. It makes roof of eye and nose.
2. **Parietal:** It is present at the both left and right side of the brain.
3. **Ethmoid:** It is single bone and located in between two eyes. In its upper part base of roof of nose and brain is made.
4. **Sphenoid:** It is single bone, which is in front of temporal bone.
5. **Occipital:** It is single bone which is present in front of temporal and base of the skull.
6. **Temporal:** These two bones are present in both left and right side, below the skull.

Facial bone

There are 14 facial bones. These bones are made closely packed with each other. The bones of nose, cheek, ear, palantine and gum belong to this. The facial bones are as follows.

1. **Maxilla:** Two bones join together and make bone of upper jaw (maxilla) and it makes roof of mouth. Air is present in these bones and it is related with nose.
2. **Mandible:** Among the bones of skull, the one bone that can be moved is mandible.

3. **Zygomatic:** The two bones which make the upper part of cheeks at both side is called zygomatic.
4. **Nasal:** Two flat bones which is present at the left and right of nose making bridge, it is called nasal.
5. **Vomer:** The blade of a spade shaped bone found in the lower part of nose is called vomer.
6. **Lacrimal:** The two bones of finger shape is present inside of both eyes, it is called lacrimal.
7. **Palantine:** Two L shape palantine bones which make the roof of upper part of plate and mouth, it is called palantine bone.
8. **Inferior nasal conchae:** The side of hole of nose, two bones at the sides are called inferior nasal conchae.

Ear Ossicles

There are three pieces of bones in middle ear, which is called malleus, incus and stapes. The smallest bone of our body is stapes.

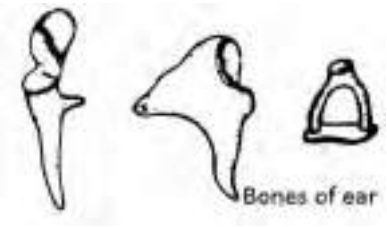


Fig 18.6: Ear ossicles

Trunk

The vertebral column present in our body and thorax combines to make trunk. Trunk is made up of irregular shape bones. There are 33 bones in the vertebral column of a child where as in adult vertebral column there are 26 bones.

1. **Cervical Vertebrae**

   The Cervical vertebra is made up of seven vertebrae. Its first vertebra is called atlas where as its second vertebra is called axis. Axis holds the head where as atlas help the head to move.

2. **Thoracic Vertebrae**

   The thoracic vertebra is made up of 12 vertebrae and it makes the upper back part of body. Parts of 12 pairs of ribs of chest are joined to it.

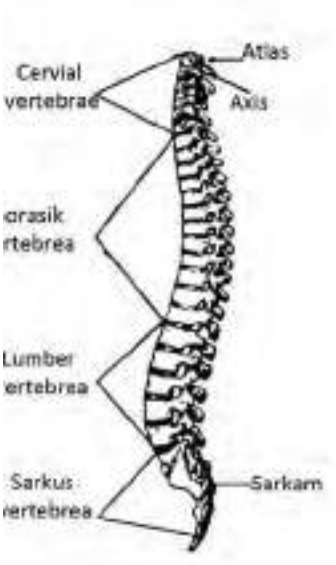


Fig 18.7: Bones of vertebra

3. **Lumbar Vertebrae**

   Lumbar vertebra is made up of five vertebrae and it makes lower back part. This vertebra is big and heavy than others. They can tolerate heavy weight.

4. **Sacral Vertebrae**

   In childhood stage, sacral vertebra is made up of 5 vertebrae. But in adult stage 5 bones fuse to form one vertebra, which is called sacrum.

5. **Coccyx**

   This is tail bone made up of four small bones. In other animals tail is formed from this bone. Vertebra is attached together by a group of white fibre, which is called ligament. It keeps the bone grouped together. Ligament is of elastic nature.

(A)Thoracic bone

There are 12 pairs of semicircular shaped bones in chest, which are called ribs. Along with it, there is broad and ling bone, those is called sternum. Ribs of chest work as the rod of cage. It gives protection to the organs like heart, lungs. Ribs are of three types. The seven pairs of ribs attached directly to the sternum are called true ribs. Similarly, three pairs of ribs are attached indirectly to the sternum those are called false ribs and two pairs of ribs are not attached anywhere, those ribs are called floating ribs.

Activity 2:

BONE IS HARD DUE TO CALCIUM

1. Take approximately 6cm long bone of hen or goat.
2. Dip that bone in a beaker with dilute hydrochloric acid.
3. Approximately after half an hour, take out the piece of bone from hydrochloric acid with the help of tong and wash properly with water.
4. Touch that bone. Will the hardness of bone be changed or not? Discuss within yourself and make a conclusion.

B] Appendicular Skeleton

The bone of left and right side of the body is called appendicular skeleton.

The bones of hand, leg and shoulder belong to this. It has been divided into two parts. They are: bones of upper extremities and bones of lower extremities. Hand, shoulder, etc belong to upper extremities. Similarly, thigh, knee, etc belong to bones of lower extremities. The bones of upper extremities are divided into two groups.

a) Pectoral girdle

Scapula clavicle arranges to make pectoral girdle. Scapula is triangular and flat in shape. Clavicle is bow shaped. It is below neck and its one side is attached with sternum whereas other side is attached with scapula.

b) Upper limbs

In one hand there is in total 30 bones. The number of bones of both the hands is 60. The bone of hand is made from the combination of following bones.

1) **Humerus:** The bone from shoulder to elbow is called humerus.

2) **Radius and Ulna:** From elbow to wrist, there are two bones, as ulna and radius. Ulna is located towards little finger side whereas towards thumb side radius bones located.

3) **Carpals:** There are 8 small carpals in wrist. They are arranged in two lines of four.

4) **Metacarpals:** Hand is made from the combination of five metacarpals. These bones are attached to carpal in one side whereas at the other side is attached to phalanges.

5) **Phalanges:** In five fingers there are 14 bones. In thumb there are two whereas in rest four fingers there are three bones in each.

Bones of lower extremities

The lower part of human body is divided into two groups as pelvic girdle and bone of legs.

Pelvic girdle

The bowl shaped sacrum and coccyx spread on both side is called pelvic girdle.

The pelvic in female is wider than in male. It makes suitable to conceive and to give birth to baby. It helps to keep the organs like intestine, reproductive organ, stomach, urinary bladder safe as well as holds the weight of upper body.

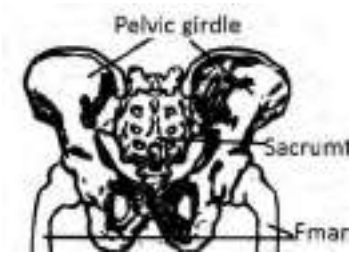


Fig 18.8: Pelvic girdle

Bones of lower limb

The longest and strongest bone of the body is femur. Its lower limb is joined with bone of the calf. The bone of knee i.e. patella is flat and square. The inner part of femur is made up of spongy bone as it has to carry the weight of body. In calf there are two bones, which are called tibia and fibula. On the outer side of calf, there is fibula whereas at inner side there is tibia. It holds the weight of body. The bone of foot is divided into three parts. They are: tarsal, metatarsal and phalanges. As these bones have to hold the weight of body, they are stronger than the bones of hand.

Tarsals are made up of 7 bones. Metatarsals are round and are in three rows. Metatarsals make the lower part of leg by the arrangement of 5 long bones. These are joint with tarsals and phalanges. Similar to the phalanges of finger, there are 14 bones in the phalanges of leg. In each thumb there are two bones and in other fingers there are 3 bones in each.

Functions of\skeletal system

The major functions of skeletal system are as follows:

1. It determines the height and shape of the body.
2. It protects the main soft part of the body like: heart, kidneys, brain, etc.
3. Muscles are attached to the bones, which helps in the movement of different parts of body.
4. It acts as the storage of calcium. When calcium is not enough in the body, the calcium present in the bone is used.
5. Cartilage present in the larynx helps to produce voice.
6. In the red bone marrow of bones red blood cell is formed.

Human nutrition

How does digestion of the food we eat take place? In our body the complex molecules present in the food breaks down and change into simple particles that can be absorbed by cell. This process is called digestion. The digestion of food takes place in long tract which is called as digestive tract. In this way, the system made for the digestion of food by the combination of different organs mouth, oesophagus, stomach, small intestine, large intestine is called digestive system. The different parts under the digestive system as well as the digestion of food in them are described as follows.

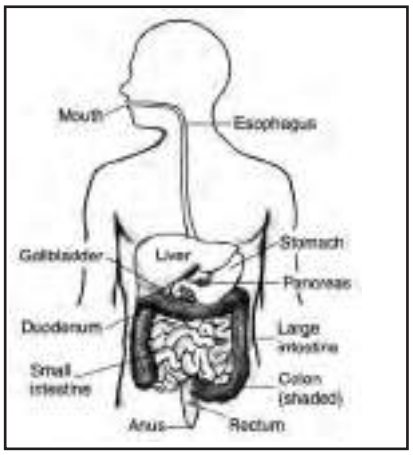


Fig 18.9: Digestive system

Mouth

Mouth is the top most part of the digestive system. It has salivary gland and it produces saliva. When we chew food in mouth, it becomes small and gets mixed with saliva and it becomes soft. Amylase enzyme is present in the saliva, which partially converts the carbohydrate present in the food into glucose. The process of breaking down of food taken by human is done by teeth. Therefore, these teeth has important role in the digestive process. Teeth are temporary and permanent in nature. The milky teeth changes and new permanent teeth appears in the human's mouth.

Oesophagus

The food goes to the oesophagus through pharynx from mouth. This is narrow and muscular. Digestion of food does not take place in it.

Do you know?
When we chew bread and beaten rice for long time, the carbohydrate present in it breaks down in glucose and sweet taste comes.

Stomach

The food that we eat reaches to stomach through oesophagus. Stomach lies in the left side of abdomen. It is muscular J shaped. Its lower part is attached with intestine. Gastric gland is present in stomach. It produces gastric juice. In gastric juice many enzymes like pepsin, lipase are present. Pepsin converts protein into peptide and lipase converts fat into fatty acid and glycerol. Also, hydrochloric acid gets produced in stomach. It makes pepsin active and kills the harmful germs present in the food. The food in the stomach becomes mixture of enzyme, which is called chyme.

Small intestine

The longest part of digestive tract is called intestine. This is narrow shaped, which reaches to the large intestine from the lower part of stomach. In this part the food that we eat is completely digested into simple molecules glucose, amino acid, fatty acid and the elements present in it is absorbed by cells.

Do you know?
The soury liquid materials comes out from the stomach and goes towards the oesophagus. In this situation there is burn in chest and throat. This is called heart burn. The muscle of the oesophagus shrinks systematically and the food goes to stomach, it is called peristalsis.

There are three parts of small intestine; duodenum, jejunum, and ileum. Duodenum is C-shaped and approximately 30cm long. Digestive process takes place in this mostly. The enzymes secreted by pancreas and gall bladder mixes in the duodenum. The bile juice produced from gall bladder emulsifies the food. There are different kinds of enzymes trypsin, lipase in the pancreatic juice produces by pancreas. Trypsin enzyme converts protein into polypeptide whereas lipase converts lipid into fatty acid and glycogen. In the inner surface of this tract finger like parts is projected which is called villi. It absorbs the small particles of the broken food.

The other part of small intestine is jejunum. It is 2.5m long. It also absorbs the small particles digested by villi. Ileum is approximately 3m long. The villi and microvilli present in it absorb nutrients and mixes in blood. Intestinal juice is produced in small intestine, the amino-peptidase enzyme present in it converts polypeptide into peptide and amino acid. Similarly lactase converts lactose into glucose.

Large intestine

The unnecessary materials go to large intestine from small intestine. Large intestine is 1.5m long. It has ascending, transverse and descending colon. It absorbs approximately 90% water. Unnecessary materials are collected in rectum and defeated through anus.

In this way, the nutrients present in the food is absorbed and mixed with blood. It reaches into the cell and tissue through the blood medium and combines with oxygen. Energy is produced during the oxidation of food. This energy is utilized to conduct different activities of body.

Importance of Digestive system

1. It converts complex food into simple food materials, which is used by

the body to produce energy, growth and repair of cell.

2. It helps in the absorption of simple food materials in blood.
3. It helps in the excretion of unnecessary materials that cannot be digested.

Respiratory System

Different kinds of activities are being conducted inside the human body. To conduct these activities how has the energy been gained from? Energy is necessary to keep body temperature constant, to excrete the unnecessary materials, to move organs, etc. Energy is generated by the reaction between food and oxygen in the cell to perform these different kinds of activities. This process is called internal respiration. The process made from the combination of different organs to conduct respiration process is called respiratory system. Nose, Pharynx, larynx, trachea and lungs belong under respiratory system. These organs are described below.

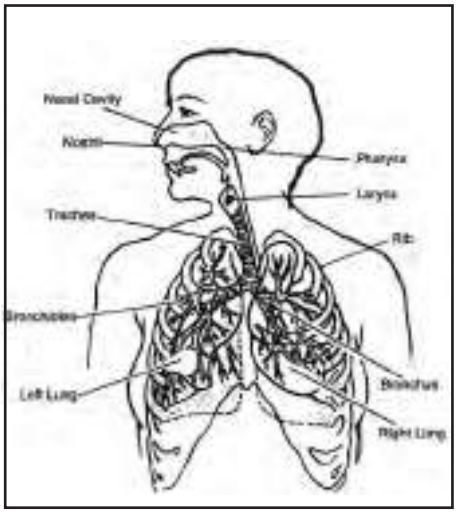


Fig. 18.10: Respiratory system

a) Nose

Nose is the outer part of respiratory system. It has two nostrils. The hair present in the inner layer functions to block and filter the dust particles that passes inside the nose. The air comes in and goes out from nose.

b) Pharynx

Pharynx joins nose and throat. It functions both as respiratory tract and digestive tract. From the end part of pharynx respiratory pipe and food pipe start. Epiglottis is present in the mouth of respiratory pipe. Epiglottis closes mouth of the respiratory pipe. When the epiglottis is not closed properly we feel a choke during swallowing food and we cough.

c) Larynx

Larynx is also called voice box. It is spread from the end part of tongue to the upper part of respiratory pipe.

It is hollow and made up of cartilage. During swallowing of food when we touch the front part of throat with finger we feel it moving up and down. That is the larynx. Larynx has two folds, it is called vocal cord. Sound is generated from here. It makes the air passing from nose, larynx warm and moist and sends towards wind pipe and sends out the air coming from wind pipe.

d) Trachea or Wind pipe

Trachea is a cylindrical shaped muscular pipe made from the combination of rings of cartilage bone. It starts from the lower part of larynx and in below separated into two parts as left and right, which are called bronchi. Bronchi are also made up of cartilage. Bronchi attach to lungs and again divide into small wind pipes, which are called bronchioles. These bronchioles are distributed in the lungs and makes small pipe without cartilage. It takes the structure of small air sac, which is called alveoli. Alveoli are very thin, where diffusion occurs. Air sacs are covered with the net of blood capillaries. Here, the carbon dioxide coming from the blood vessels is sent to wind pipe and the oxygen entering the wind pipe from outside is mixed in the blood vessels.

e) Lungs

Lung is the most important part of respiratory system. It is located safe in the inner side of the ribs of chest. Lung is like sponge and flexible organ, which has air sacs. Lung is divided into two parts; left and right. Right lung has three lobes whereas left has two lobes. Windpipes, air sacs, artery, vein and blood capillaries are present inside the lungs. Lungs are covered by two layer skin, which is called pleura. There is a type of liquid material on the surface of pleura, which protects lungs from friction.

f) Respiratory process

During breathing, lungs expand and the volume of chest becomes big. The muscles of chest as well as diaphragm when returning to its previous stage, chest becomes small. In this situation, air comes out of lungs. Generally, an adult person respires 18-20 times in one minute. The rate of respiration increases during running, doing exercise and excitement.

The oxygen taken from the atmosphere reaches to the air sac of lungs through nose, wind pipe, bronchus. Air sacs are covered with the net of blood capillaries. The oxygen present in the air sac goes to the blood

capillaries by diffusion whereas the carbon dioxide gas present in the blood capillaries goes to air sac.

The oxygenated blood reaches the heart. Heart takes that oxygenated blood through different types of pipes to different parts of the cell.

Inside the cell, due to the reaction between food and oxygen energy, water and carbon dioxide is utilize to conduct different kinds of activities in the body whereas blood with carbon dioxide returns to the heart through vein. The blood reaches the lungs from heart through pulmonary vein.

Air sac present in the lungs is covered with the net of blood capillaries, where exchange of air takes place. That carbon dioxide gas comes out through small pipes, bronchioles, wind pipe and mouth. In this way, the human body performs the task of taking oxygen and throwing out carbon dioxide continuously.

Importance of Respiratory system

a) It fulfills the demand of oxygen necessary to the body.

b) It helps the body to remove the harmful gas (like carbon dioxide).

c) It affects every function of the brain.

d) Without oxygen the cells of body cannot perform any function.

e) The cells of brain die in the scarcity of oxygen.

f) In the scarcity of oxygen neuron cannot transmit the electrochemical message.

Do you know?
In the both lungs of an adult person, there are approximately 700 million alveoli.

Excretory system

All living organisms need food to conduct their daily activities. We gain energy from food. Not any organisms can be alive without food, from food not only energy but also unnecessary materials are produced. The unnecessary material produced this way should be removed from human body. To throw the unnecessary materials from the body special organs like skin, nose, mouth, lungs, large intestine, liver, kidney, etc are being used.

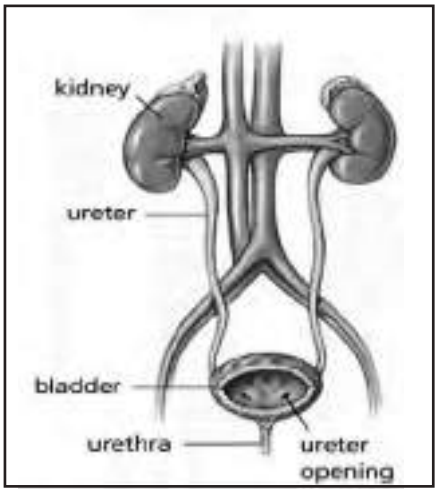


Fig. 18.11: Excretory system

Skin is present in the form of excretory organ in human body. It helps the sweat, salt and water to come out of the body in the form of urea. Similarly, nose and mouth helps, nasal secretion, saliva and sputum to come out of the body. The large intestine throws out the undigested food material and unnecessary materials from the body through anus. Similarly, lungs help to throw out the carbon dioxide and water in the form of gas. Liver helps to throw out different unnecessary materials from the body.

In human body urinary system is the main excretory system, which throws out the nitrogenous material from the human body. It occupies a pair of kidney, a pair of urinary tract, urinary bladder and urethra. Kidneys are solid and dark coloured bean shaped. They are found in the both side of vertebral column and in front of last rib. Nephron is present in each. This nephorn functions to separate nitrogenous material from blood and throws out of the body in the form of urine. Urinary bladder is a bag made up of one muscle to collect blood and when that urinary bladder filled with urine comes out through urethra.

Importance of Excretory system

1. Due to the presence of mixture of urea and nitrogenous compounds which harms the body, that is why it is excreted specially in the form of urine.
2. The unnecessary material generated from the metabolic activities inside the body which comes out through cell, these materials reach to the excretory organs through blood medium and excreted through body.
3. The unnecessary materials like carbon dioxide and urea generated from the metabolic activities inside the body is thrown out from the respective excretory organ.
4. The main organ of excretory system liver plays important role in the excretion. It excretes unnecessary materials from the body in the form of urine whereas selecting unnecessary materials from the body it resends into the blood.

Things to remember

1. The group of cells of same size performing similar type of certain work is called tissue and organ is made from the combination of group of tissue wheras system is made from the group of organs.

2. Skeleton is made up of bones. Bones are of different shape; flat, long and cube shaped.
3. Bones are divided into two groups as axial and appendicular skeleton.
4. There are 28 bones including 8 bones in the brain of human head, 14 in face, 6 in ears.
5. The function of bone is to give shape to the body, to protect, to move, to store calcium, prepare blood cells, etc.
6. In human body, voccal cavity, oesophagus, stomach, small intestine, large intestine, anus and digestive glands are present.
7. Nose, pharynx, larynx, trachea and lungs belong to human respiratory system.
8. Lungs convert deoxygenated blood into oxygenated blood and send to heart.
9. Energy is generated from the chemical reaction between food and oxygen in the cell, that energy is used to perform different body function.
10. The process of throwing out excess amount of water in the body of plant through its stem and leaf in the form of vapour is called transpiration.
11. Transpiration helps to make body cool, to conduct the water in the plant body, for raining to keep the atmosphere moist.

Exercise

A) Put correct (√) sign in the correct answer of the following multiple choice questions.

1. Which one of the following does not take part in digestive system?

   a) stomach b) liver c) pancreas d) lungs

2. What is the group of cells called which is made to do certain work and is of similar shape and type in the body of plants and animals?

   a) tissue b) organ c) system d) none of these

3. Which tissue does help the aquatic plants to float on water?

   a) Aerenchyma b) Collenchyma c) Sclerenchyma d) Parenchyma

4. For what work does the plant use vascular tissue?

   a) to strengthen plant b) to prepare food

   c) to conduct water and food d) to increase the thickness of plant.

5. What is the work of glandular tissue?

   a) to secrete digestive juice, gum, resin

   b) to secrete white liquid substance like milk

   c) to take water to leaves d) all of the above

6. Which is the bone that suits to conceive and give birth to a child?

   a) femur b) tibio fibula c) pelvic girdle d) pectoral girdle

7. What is the reason for the sweetness of bread after chewing for long time?

   a) The carbohydrate present in the food is converted into glucose.

   b) The protein breaks into peptide.

   c) The fat present in the food converts into fatty acid

   d) All of the above

8. For which purpose Hydrochloric acid produced from stomach is used

   a) to kill the harmful bacteria b) to decrease sourness

   c) to break food d) all of the above

9. Which gas is exchanged in the air sac of lungs?

   a) oxygen and nitrogen b) oxygen and carbon dioxide

   c) nitrogen and carbon dioxide d) all of the above

B) Answer the following questions:

1. What is meant by tissue? Describe in brief about the inter-relationship between cell, tissue, organ and system.
2. Write two difference between xylem and phloem found in plants on the basis of structure and function.
3. What is the main function of skeletal system. Prepare the list of bones of chest
4. Write the name of four main parts of bone of skull with a diagram.
5. "If skeleton is absent in human body, it would be a ball of meat without shape". Prove this statement with necessary reason.

6. Bone becomes moist when kept in dilute hydrochloric acid, why?
7. Describe in brief the digestion of food in stomach in human digestive system.
8. Digestion of beaten rice, meat is slower than digestion of glucose, fruits, why?
9. How is blood in lungs oxygenated? Describe.
10. What is the importance of excretory system in human body? Write any three importance.
11. What is the main function of kidney? Write how it works.
12. What is called meristematic tissue? Write its type along with example.

Project Work

1. Using rubber or plastic bladder prepare materials to show the respiratory system and exhibit it in class.
2. Observing the model of skeleton made up of plastic. Write the name of different type of bones. Draw the diagram of bones in a chart paper, and paste it on the wall of classrooms.

Glossary

Meristematic tissue:	living cells found in the tip of growing plants where cell division takes place.
Oesteocyte:	One type of cell found in bones
Bone of neck:	group of bones made from the combination of seven vertebrate.
Atlas:	the very first vertebrate of vertebral column, where head is held.
Pepsin:	One type of enzyme, which breaks protein into peptide
Chyme:	mixture made from the combination of food and enzyme in stomach
Lipase:	one type of enzyme which digest lipid
Epiglottis:	part present in the mouth of wind pipe
Pleura:	two layered membrane that covers chest
Stomata:	tiny pores present in leaf

Unit 19

Sense Organs

Have you seen flowers blooming in a garden? How do you receive information of colour, taste, smell, hardness or softness of the flower and the sound of insects on it? All these pieces of information are perceived through the sense organs. What would have happened if sense organs were not present in our body? All these organs are acting as the doors of knowledge to the human beings and other animals.

There are many organs in the human body to perceive the sense. The function of the various organs has been specified in the human body. Some organs among these are very important and sensitive for us. These organs show reaction to a specific stimulus. The different receptors distributed to different parts of human body send the information received from external environment to brain. Brain interprets all the stimulations in a correct way and orders for the reaction. The various organs which connect the human body with the external world are called the sense organs. In this unit we study about eye, nose, ear, tongue and skin.

Eye

Eye is one of the important organs of the human body. It is located in deep socket of the skull called orbit. It lies inside the lacrimal bones. It is made up of three layers. They are sclera, choroid and retina. These layers are explained in the following ways:

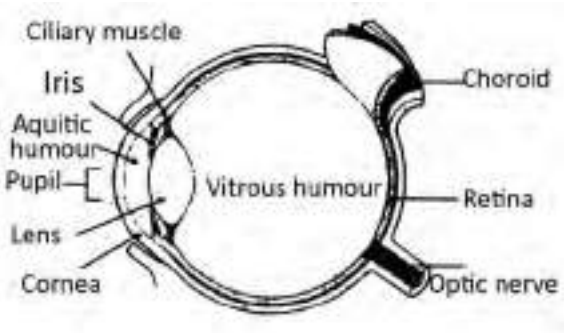


Fig 19.1 Eye

Sclera : It is the outermost layer of the human eye which is white, strong and made up of connective tissues. Its front part is transparent and is called cornea. Cornea is covered by an extra layer called conjunctiva. It gives a shape to the human eye and also protects the inner parts.

Choroid: It is the second layer of the eye consisting of connective tissue richly supplied with blood vessels. As it is a black layer, absorbs radiations and prevents reflection. It provides food and oxygen to the eye.

Retina: It is the third and innermost layer of the human eye. The image of an object is formed on this layer. There are light sensitive cells like rods and cones present in this layer. Rodopsin present in the rod cells help to see in dim light and iodopsin found in the cones help to see the things in bright light and help to distinctinguish the colour. Colour blindness and the defect of vision are hereditary. Likewise, night blindness is another disease of the human eye. A person suffering from this disease cannot see clearly at night.

These are other important parts of eyes which can be explained as below:

Cornea: It is the front and transparent layer of sclera. It refracts the light rays.

Iris: It is present in between eye lens and cornea. It is the colourful part of human eye. It allows only essential rays to enter inside it controlling the light rays that fall upon the eyes.

Pupil: A small aperture at the centre of iris is called pupil. The size of pupil, small or large, is determined by iris muscle. Pupil becomes smaller on viewing bright light or near objects but it becomes larger on viewing distant objects. It passes the light rays inside.

Lens: An object which is transparent, biconvex, crystalline present behind the iris is lens. It helps to form real, inverted and diminished image by refracting the light rays on retina.

Ciliary Muscles: Eye lens becomes thin and thick by the contraction and expansion of ciliary muscles or its focal length changes, ciliary muscle contracts while looking at the distant objects and lens becomes thinner but it expands while looking at the nearby objects and lens becomes thicker.

Optic nerves: This nerve is connected to the brain. It links the image formation of an object at retina to the brain and makes the image upright or erect.

Aqueous Humour: The watery fluid present in the chamber between cornea and lens is called aqueous humour.

Vitreous Humour: The chamber in between lens and retina is filled with thick jelly substance called vitreous humour. It maintains the round shape of the eye and helps in the refraction of light.

Do you know?

Conjunctivitis: Usually this disease is caused due to the infection of germs on the outer layer of the conjunctiva and inner part of eye lid. If any thick pus like substance is seen in the eye, it shows the infection of the germs there. Likewise, if eye infection occurs due to allergy or due to any chemical substance, eye becomes itchy. The patient of this disease should be isolated and should take medicine prescribed by doctors.

Functioning of Eye

Eye lens focuses the light rays coming from any object at the retina to form the image. The image is real and inverted. The image formed in this way passes to the brain through optic nerve. In the brain, the upright or erect image is formed and we see the object.

Care and hygiene of human eye

It is essential to care our eyes as they are very important organs. To care the eyes, we should take vitamin A containing yellow fruits and green vegetables. We should avoid reading in very bright and dim light. We should always wash eyes with clean water and the medicine should not be used unnecessarily in the eyes. Similarly, the care and protection of eyes can be done with-out rubbing eyes with hands, consulting eye specialist time to time, using glass and other eye protecting materials while working in the factories and not playing dangerous games like 'Dandibiyo', etc.

Activity 1:

Observation of pupil of eye

- Tell one of your friends to close his eyes and open after a while.
- What happens to the pupil? Observe.
- Again, observe the pupil after focusing a torch light to the eye. Tell how it is seen.
- Tell him to see distant and nearby objects turn by turn. What change does occur to the pupil? Write.

Hence, on observing the eyes, the pupil becomes wider at dim light and it becomes smaller at bright light.

Ear

Ear is an importantht sense organ which gives the sense of hearing and maintains physical balance. A person is able to hear sounds with the help of ear and 8th pair of cranial nerve.

Activity 2:

To find the location of an object through hearing.

Blindfold a student with a clean handkerchief in your class. Put a clock at any place of the classroom which gives tik-tik sound. Let that student find the location of the clock. For this, the student with eyes covered moves towards the direction of the clock and finds its location.

Structure of ear

The human ear is divided into three parts: external ear, middle ear and internal ear. Let's make a short discussion on them.

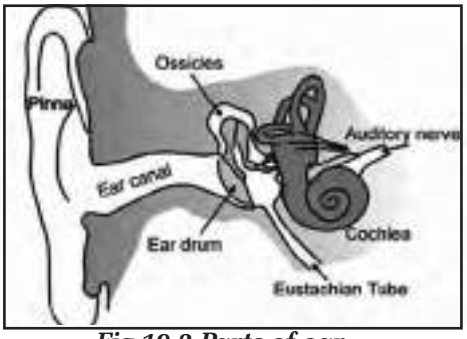


Fig 19.2 Parts of ear

External Ear: It is also divided into three parts, namely, pinna, auditory canal and eardrum. The outermost part of the ear is pinna. It is made up of cartilage. The thin muscles are covered by fatty tissue which collects the sound waves and send them to the auditory canal.

Auditory Canal: It is extended from pinna to ear drum. It is covered by hairy skin which consists of ceruminous and sebaceous glands. Ceruminous glands produce earwax and sebaceous glands produce oily material. They prevent the entrance of dust particles inside and drying of ear.

Tympanic membrane: Eardrum is also called tympanic membrane. It is situated between auditory canal and the middle ear, which is highly elastic. The vibrations produced while striking the sound waves on thin fibers of eardrum move towards the middle ear.

Middle ear: The air filled chamber behind the eardrum is called the middle ear. It consists of three irregular bones named malleus, incus and stapes. These three bones collect the sound wave and send them to the internal ear. An eustanchian tube connected to the pharynx is present in the middle ear which maintains a balance of air pressure of middle ear

and external ear. It opens while swallowing and yawning and air passes inside the middle ear. So, a chocolate is given to chew in the planes.

Internal ear: It is situated in between the bones of cheeks and is also called labyrinth. It consist of bony labyrinth and membranous labyrinth. In between these two parts, a liquid called perilymph is filled. It consists of vestibule, semicircular canal and cochlea. The membranous labyrinth is filled with the transparent liquid called endolymph.

Physiology of hearing

The sound waves produced from a source are collected by pinna and pass inside through auditory canal to vibrate ear drum. Thus, vibration occurs in the middle ear which later on reaches the endolymph. The sound waves after reaching the cochlea through perilymph, the sensory cells are stimulated. The impulse is now carried to the centre of hearing of the brain by auditory nerves and we hear the sound.

Care and hygiene of ear

We can care and protect the ear through various ways, like washing ear with clean water, not allowing any hard object inside the ear, not taking any medicine unnecessarily, avoiding the chance of mother's milk entering the ear of the baby and consulting doctors immediately if any problem related to ears arises.

Nose

Nose is a sense organ for smelling the things and helping in breathing. It is present in all animals. It is comparatively less sensitive in human beings. Structurally, it is divided into external and internal parts. Externally it consists of two bones which are downwardly connected with maxilla and upwardly with frontal bone.

Internal part

It is called nasal cavity. It is very sensitive for smelling the things. It is richly supplied with the blood vessels and olfactory neurons. So it is called olfactory region. The upper region consists of receptor cells to smell the things. The lower parts of these cells are connected with olfactory region. When we smell the things, the receptor cells stimulate and the stimulation is

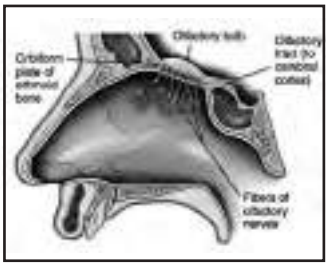


Fig 19.2 Structure of ear

carried to the brain by olfactory nerve. Then, we can detect the smell of that substance. This process of getting smell is called olfaction.

When we suffer from common cold, the mucus membrane of our nose swells. Due to this, smell does not reach inside the olfactory nerves and we cannot detect it. So, we cannot smell the things and do not get taste. The hairs of the nose make the enhaled air hot and do not allow the dust particles to enter inside the lungs.

Care and hygiene of nose

To remove the mucus, we should not blow the nose so strongly. We should take hot water vapour while getting common cold. We should not pick the nose, we should wash the nose in the morning with clean water. We should not use any hard material while cleaning nose.

Tongue

Tongue is a muscular and very important organ of digestive system, which is covered by the mucus membrane. Its one end is connected to the hyoid bone and its lower surface is connected to floor of the mouth. It has two surfaces, upper and lower. The upper part of tongue is called extrinsic muscle, which is connected to the root of the tongue, bones of chin and throat. It helps the tongue to raise and allows it to move in and out. The lower region is made of intrinsic muscle. It helps to change the shape of tongue. The upper surface of the tongue is rough due to elevations called papillae. Papillae contain receptor cells of taste. The taste buds present in the papillae are supplied with nerves. Papillae are of three types. They are vallate papillae, fungiform, and filiform. These all papillae give the sensation of taste.

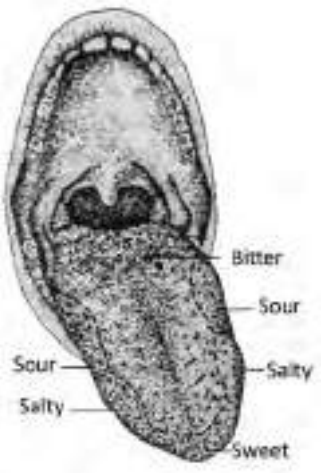


Fig 19.4 Tongue

Physiology of taste

Mainly, there are four tastes: sweet, salty, sour, and bitter. All other tastes are the combination of these four tastes. There are four different taste buds on the tongue. The chemical of a substance dissolves in the saliva. The dissolved chemical stimulates taste receptors and later on the nerve fibers carry the taste sensation to the brain. Hence, we get the real taste of the

substances.

Tongue carries out sensory function and motor function. It detects the tastes like sweet, salt, bitter, sour under sensory function and under the motor function, it helps to chew the food, swallow it and produce sound. The taste of salt is detected faster than bitter. It is because the taste buds of salt are at the tip of the tongue and the taste buds of bitter taste are at the back of the tongue.

Care and hygiene of tongue

Tongue can be cared by keeping the tongue clean, reducing the use of hot liquors, avoiding the habit of keeping sharp things in the mouth, taking juicy food items, consulting doctor if any problem arises related to the tongue.

Skin

Skin covers different parts of the body with different thickness. Its outer part consists of a thin layer of cells which is not supplied with the blood vessels and inner part is elastic and fibrous. The inner part is supplied with nerve, blood capillaries, sweat glands, sebaceous gland etc. Skin is responsible to the sense of touch. It gives the sensation of heat, cold roughness, soft, pain etc. It has many functions. It protects the body from the external environment. Structurally, skin consists of outer epidermis and inner dermis. Outer skin (epidermis) is a thin layer and stratified epithelium tissue. From the small holes of this layer, different substances like sweat come outside the body. The layer inside the epidermis is dermis. It is made of elastic connective tissue and is richly supplied with blood vessels, nerve fibers, sebaceous gland, sweat gland. The lower part of inner skin contains a layer of fat which is loose. It makes the body hot. It is called subcutaneous fat. Its amount is more in females than in males. Covering from outside, skin protects the body from dangerous events and gives sense to the body as soon as possible. It helps to maintain the right temperature of the body by the evaporation of sweat. Absorption of fatty materials, separation of fat and sweat, removal of unwanted things from body, formation of vitamin D with the help of solar radiation and

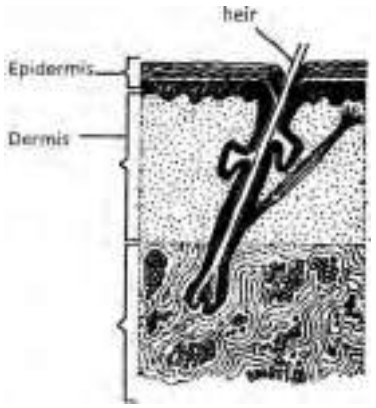


Fig 19.5 Skin

ergosterol are some of its functions. Similarly, storing water and fat to use them when necessary, healing the cut part and wound of skin are also the functions of skin.

Do you know?

People believe that they can get vitamin D from sun light, but they cannot get. The ultraviolet radiation of sun light changes the ergosterol chemical of our body into vitamin D.

Activity 3:

Identification of the sense centres on the skin.

Take lukewarm water in a container. Put your hand there slowly. How do you feel? Write it. The sense centres give the sensation of warmth on putting hand in that water.

Care and hygiene of skin

Timely bathing, being away from itchy and burning materials, using soap and clean water for taking bath, less use of cosmetics etc. are some ways to care the skin. Similarly, for the care and hygiene of the skin, we should not use very hot and very cold water. We should use mosquito net and we should take nutritive and vitamin A containing foods.

Things to remember

1. The important organs of the body which connect us from external world are called the sense organ.
2. Eye, nose, ear, tongue, and skin are the sense organs of our body.
3. The three layers of eyes are sclera, choroid and retina. Image is formed at retina.
4. The watery liquid present in between cornea and lens is called aqueous humour.
5. The space between lens and retina is filled with a thick jelly substance called vitreous humour.
6. The middle ear consists of malleus, incus and stapes.
7. Ear gives the sense of hearing and helps to balance body.
8. The taste buds help to detect tastes like sour, salty, bitter, etc.

9. When we smell things, the receptor cells stimulate and the stimulation is sent to the brain by olfactory nerves so that we identify the smell.
10. The touch receptors of the skin give the sensation of heat, cold, rough, smooth, pain etc. and protect the body from external environment.

Exercise

A. **Tick (√) the right answer in the following multiple choice questions.**

1. What are the important organs of the body which connect us to the external world?

   i) Organs of head ii) Sense organs

   iii) Legs iv) Hands

2. Which one of the following consists of retina?

   i) Nose ii) Ear iii) Eye iv) Tongue

3. To which of the following does auditory nerve belong?

   i) Tongue ii) Nose iii) Eye iv) Skin.

4. Which organ does gain the sense of touch?

   i) Nose ii) Ear iii) Eye iv) Skin.

5. Which one of the following organs balances the body?

   i) Nose ii) Ear iii) Eye iv) Skin.

B. **Answer the following questions:**

1. Write the names of different sense organs of the human body and their functions.
2. How does the tongue get different tastes? Explain.
3. How do you see the things around? Explain.
4. What are the ways of cleaning ear? Mention any four points.
5. Draw a neat diagram of an eye and label any five parts.
6. Seats are not seen as soon as we enter a dark room from a bright area, why?

7. We feel dizziness after spinning for sometimes. Give reason.
8. Chocolates are given to the passengers in the airplanes, why?
9. We do not get the real taste of food when we suffer from common cold. Give reason.
10. Describe the functional relation between nose and ear.
11. How should we care and protect our eyes? Write some points.
12. How does the skin gain the sensation of touch? Clarify.

Project Work

1. Dissect an eye of an animal using dissection box with the help of your teacher. Observe its various parts. Now prepare a report including the functions of their various parts with a neat and labeled diagram.
2. Observe nose, ear, eye and skin of your friend. Find the sanitation condition of each sense organ and suggest him/her for better sanitation of the organs. Write the facts drawn from observation and suggestions in the following table.

Sense Organ	Sanitation Condition	Better sanitation to be made
Nose		
Ear		
Tongue		
Eye		
Skin		

3. Observe your own sense organs directly or by using mirror. Identify the weaknesses observed in the aspect of sanitation and adoptsome ways to improve the existing status. Note the improvement observed every day. Prepare a report after one month including the findings observed and analyzed during that period.

Glossary

Lacrimal bone	:	One of the facial bones in the eye socket.
Cone cell	:	A cell found in retina which becomes active during bright light.
Rod cell	:	A cell found in retina which becomes active during dim light.
Middle ear	:	The part of ear between outer and inner ears.
Ergosterol	:	A chemical which changes into vitamin D in the presence of solar radiation.
Auditory canal	:	A duct that extends from pinnae to ear drum.
Optic nerve	:	A nerve that connects eye to the brain.

Unit
20

Evolution

Earth consists of many plants and animals. The animals and plants on earth range from unicellular simple form like amoeba, euglena to complex form like mammals and flowering plants. Besides these, shape, size and character are different. What might be the reason of such diversity among living beings? Let's think about it.

Do the plants and animals of today's world exist on earth from beginning?

On the basis of similar and different characters, living organisms are categorized into different groups. Same group of living organisms also possess different characters, like human, cow, birds, frog are vertebrates but possess different characteristics. We can assume the origin of simple organism occurred at the first phase based on the similar and dissimilar characters. Gradual change on such simple organisms give rise to different types of living organisms. Offspring's of same living organisms remain unchanged in the same environment while change in structure of organism occur in different environment. This unit deals with history of evolution and its principle.

Evolution

Unicellular organism originated first on the earth. Then various types of simple organisms originated. Changes in environment cause the change in body of living organisms. Evidences of evolution show the origin of complex organism from simple organism. Thus, the origin of complex organism from simple organism is known as evolution. According to principle of evolution, changes on living organisms which occurred years and years ago still exist and it will continue in near future. Some of the developed living organisms extinct while some of them are still surviving. In development process, origin of new plants and animals will take million of year. In nature, simple organism give rise to complex organism. In similar way, principle of evolution focuses on origin of flowering and non-flowering plants, origin of vertebrates like fish, ape, reptiles, birds and mammals after the origin of invertebrates.

Main evidences of theory of evolution are listed below.

(A) Evidence from fossils

Fossils are found in sedimentary rocks like remaining parts, mark or print of dead plants and animals from the remote past. Such fossils provide information about living organisms which exist in remote past. The strong evidence of evolution is evidence from fossils. How are fossils formed? Fossils are found on sedimentary rocks. After the death of living organisms, dead bodies are taken away by rivers along with soil, sand around rivers. Finally, such remainings sediment on big lakes or oceans. Continuation of such process forms one after another layer. After million of years, sedimentary rock is formed. The soft tissues or muscles get decomposed while bone, cellulose remains as it is in each layer. The hard portion of living organisms forms mark on the rocks. Such marks are known as fossils. Thus, sedimentary rocks contain the fossils of simple organism like algae on its lowermost part. The upper part contains fossils of mammals. This clearly explains the development of complex organism from simple organism. From the development point of view, evidences from are highly important.

(B) Evidences from comparative Morphology and Anatomy :

The structure of plants and animals are of their own type and possess some common characters. This evidence shows the origin of living organisms from same ancestors. Evidences from comparative morphology and anatomy are as follows:

I. Homologous Organs :

The study of structure of hands and legs of vertebrates shows that pieces of bones are arranged in same pattern and position. This helps in deriving the inter-relationship between animals. Organs, which have common embryonic origin but perform different functions are regarded as homologous organs. For example: The structure of bones present in hand of human, fore limb of horse and wings of birds are similar, but organs having similar function and different embryonic origin are known as analogous organs. In such way, organs of body have some similarity. Thus, evidence obtained from study of homologous organs helps to justify evolution.

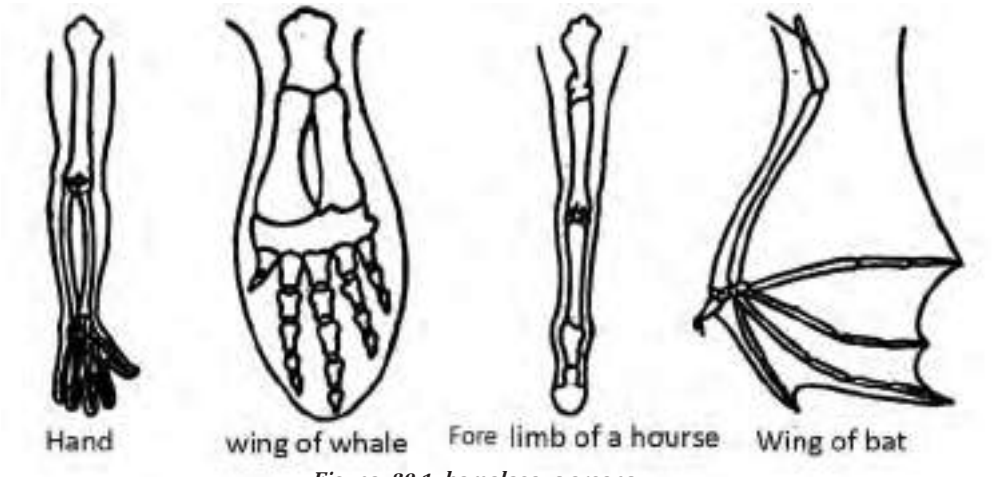


Fig. no. 20.1: homologous organs

II. Evidences from vestigial organs :

Some organs present in our body are homologous to the organ found in other animals. For example: Human are unable to use muscles of ear compared to that of cow, rabbit etc. Organs, which are functionless and are in reduced form in one organism while it is developed and functions well in other organisms are referred as vestigial organs. We can find such examples on human as well as on other animals. Almost every animals posses canine teeth but it is developed only in dogs, cat, lion. They use to tear flesh, canine teeth remains vestigal in herbivores. Similarly, vermiform appendix is present near large intestine in human which remains vestigial. But, the same organ is developed and functions well in cow, rabbit etc. It proves the origin of all animals from same ancestors. This evidence helps in evolution.

Do you know?
Age of fossils are measured by Carbon dating and Uranium dating.

III. Embryonic Evidence :

The study and observation of embryo from different group of animals are very similar in the early stage and it is often difficult to separate them apart. The structure of embryo differ with the development of embryo and eventually develops into living organism. For example: The initial phase embryo of fish, hen, human, birds etc. are similar to greater extent. The structure of embryo changes with the development of its phase. Thus, embryonic evidences justify the development of simple organism is followed by complex organism.

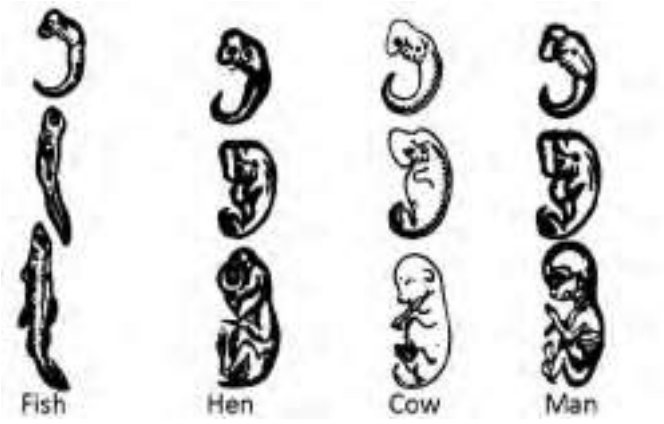


Fig. 20.2: Development of embryonic

IV. Evidences from distribution of organisms :

Different types of animals and plants are present on different places of earth. Some living organism have specific habitat while some are present everywhere. Although the type of environment is same, animals and plants of same nature cannot be found. For example: Elephant found on India and Africa cannot be observed in Brazil. Differences in living organism are assisted by geographical reasons like oceans sea, rivers, mountains etc. Long duration of gap between two areas give rise to different types of animals. When the living organisms are distributed from original habitat, changes occur in body as environmental changes become favorable. This gives rise in difference of plants and animals.

V. Evidences from bridge animals:

The structure and behavior of organisms resembles partly with lower grade organisms and partly with higher grade organisms. It is assumed that lower grade animals are developed into higher grade animals. For example: duck billed platypus. It has duck like peak while body is covered with fur, like that of mammals. It lays egg like birds and breastfeed its newborn ones. Similarly, study of archaeopteryx fossils shows both the characteristics of birds and reptiles. It provides evidence on development of birds from reptiles.

Theories of Evolution

Different scientist gave different view on evolution and development of animals and plants of nature. Among them, Charles Darwin, Jean Baptistc Lamark, Alfred Russel Wallance, Hugo vries etc are leading scientists.

However Lamark and Darwin's theory are highly accepted till today.

A) Lamark's Theory :

Jean Baptistc Lamark was a French scientist. He purposed theory of evolution for the first time in 1809 A.D. His theories are listed below.

a) Environment has effect on organisms:

Changes occur in the characteristics of organism. It brings transformation of body's structure. Thus, transformation on structure of body will cause the origin of new species.

Example : Yak of himalayan region has thick and long hair which protect it from cold.

b) Use or disuse of organs brings changes in body structure :

Development of organs of organisms is directly affected by its continuous use. Frequently used organs are developed and strong while disused organs will slowly disappear. According to lamark, reptiles like calottes and snake both possessed leg. Snake, discontinued the use of leg and slowly it got disappeared but calottes continued the use of leg. As a result calottes still have legs.

c) Acquired or changed characteristics is transferred into the next generations :

Effect of environment on organism or use or disuse of organs causes change in structure. Characters acquired from such transformation is known as acquired characters. Such acquired characters are transferred from one generation to next generation. As a result, new species are originated. According to Lamark, ancestors of giraffe were short necked due to lack of grass on land, they started feeding on leaves of tall trees. For this purpose, they have extend their neck and it finally development of long necked giraffe occurred. Continuation of this process for several year give rise to giraffe of today's world.

Criticism of Lamarkism:

During the process of evolution criticism on Lamark's theories are as follows:

a) Change in structure of body by use or disuse of organs is not practically accepted.

b) Development of new organs according to wish to organisms is not proved clearly.

c) During development process, symptoms of small and big organisms are not observed.

d) On dozens of generations, mouse with cut tailed give birth to normal mouse i.e. with tail

Darwin's Theory

Charles Darwin was an English Scientist. In 1859, he published the book named "Origin of Species". This book includes the following concept about evolution.

A) Enormous Fertility

All species have potential fertility capacity. The population size would be double if all the individuals survive. Population size of species will increase in geometric pattern while the no. of species will remain constant in nature.

B) Struggle for Existence

The population size will increase to the higher extent if all the population that are born will survive. It will create scarcity of food and shelter. Despite of this, organisms have to struggle for food, shelter, fertility, disease and environment in order to survive. Those species which succeed in adapting themselves will exist and those unable to adapt will extinct from environment. Darwin defined it as struggle for existence.

C) Variation and heredity

Offsprings of species are similar, however some of the characteristics differ. In this way, difference in shape and characteristics is known as variation. All organism does not possess variation according to environment.

Thus, species whose variation occur according to environment will survive. But those species whose variation occur against environment will not survive.

D) Natural Selection

Organisms which can adapt to their environment tends to survive longer than those which are unable to adapt. Nature itself selects the survival period of organisms. Organs or characteristics which serve the organisms during struggle for existence will get transferred to their offsprings. More effective development of such characters will occur in every off springs. After several years, succeeding generations will bear

totally new characters. Thus, selection of progressive organism will occur. This is called as natural selection. Organisms able to overcome the struggle will survive.

E) Origin of Species

Organisms which struggle for their survival eventually become able to survive. Such Favorable characteristics which helps in survival also transferred into their off springs. In such way, characteristics of organisms which are able to survive an changed environment will be transferred into their off springs. After many years, off springs develop into new organism. Two or more than two species originate from same ancestors.

Criticism of Darwinism

1. Origin of species from variation is not described clearly.
2. Natural selection only helps in development of new species. It is not the complete cause because mutation also causes difference in organisms.
3. In natural selection, if the selection of useful character only occur, then rejection of useless character/things should go hand by hand. But practically, it is not applicable.

Things to Remember

1. Evolution is a gradual process where new species originate from simple old species.
2. Main principles of theory of evolution are evidences from fossils, comparative morphology and structure, embryo, geographical distribution and bridge animals etc.
3. Highly accepted theories of evolution are Lamark's and Darwin's theory.
4. According to Lamark, organisms use or disuse some organs based on environment they survive. Organs which are used will be developed while organs discontinued to use will vanish after certain duration. Thus, after various generation new organism will originate.
5. According to Darwin, organisms able to struggle for their survival or able to adopt on changing environment will survive. Changes occurring on such organism will give rise to organism with new characteristics after various generation.

Exercise

A. Choose the correct one and put the tick mark(√)

1. Which of the following is process of origin of complex organism from simple ones ?

   i. Lamarkism ii. Darwinism iii. Evolution iv. All of above

2. Which of the following is strong evidence of Evolution ?

   i. Evidence from vestigial organ ii. Embryonic evidence

   iii. Evidence from distribution organisms iv. None of these

3. What is the function of vermiform Appendix in herbivores ?

   i. Digestion of food ii. Excretion of useless materials

   iii. Functionless iv. All of above

4. When did Charles Darwin publish "Origin of Species" ?

   i. 1857 A.D ii. 1859 A.D iii. 1860 A.D iv. 1959 A.D

B) Answer the following questions :

a. Evidences from vestigial organs prove the principle of theory of evolution. Explain briefly.

b. Write down the Lamrk's theory of evolution. Write down the reason for its rejection.

c. Explain in brief, Darwin's theory of "Struggle for existence" and " Variation and heredity."

d. How does new organism originate according to Darwin ? Explain briefly.

e. Write down the three points for criticism of Darwinism.

f. How does embryonic study help in providing theory of evolution? Explain

g. Study of fossils shows the origin of complex organisms occurs from simple organisms. Explain briefly.

Project work

Remaining of organisms may be present near your school or rivers, caves etc. observe the print and draw it.

Glossary

Vermiform appendix : Undeveloped part of large intestine.

Duck billed platypus : Mammal with peak like duck.

Unit

21 Nature and Environment

How is earth's surface formed? Have you ever thought about it ? Actually, earth's surface is formed from soil and rocks, rivers, lakes, ponds, ocean etc. All such factors comprises earth's surface. What kind of relationship exist between the earth's surface and living organisms ? Various factors of physical world have direct or indirect effect on life of living things. There exist deep relationship between various factors of physical environment and living beings. Substances like food, water, oxygen, carbon dioxide, minerals etc. are constantly obtained by living organisms from physical environment. If the factors of physical environment like air, light, temperature, soil etc. deteriorate, then it will have adverse effect.

What do you mean by community ? what kind of relationship exist between different communities? Living organisms present in environment depend on each other and they live in the same environment. This is known as community. There is continuous regulation of such interrelationship between complete ecosystem and physical environment. Eventually it forms Ecosystem. Ecosystem consists of biotic factors like producer, consumer, decomposers as well as a biotic factors like sun air water, soil, rocks etc.

This unit emphasizes on key factors which affect animals and plants of environment, effect of change on climate, ecosystem, autotrophic and heterotrophy and dependence of human on other organisms.\

Factors influencing plants and animals

Environment comprises of living beings and surrounding factors like light, heat, water, soil, air etc. These environmental factors have direct or indirect effect on living beings. The interrelationship between living organisms of environment and physical environment is a continuous cycle. This continuous cycle forms permanent condition, is known as ecosystem. Factors of environment can be categorized into two types : abiotic factors and biotic factors.

Abiotic factors

A) Air :

The layer of air surrounding earth is atmosphere. Various gases like Nitrogen, Oxygen, Carbon dioxide, Helium, Neon etc. are present in atmosphere. Water droplet and water vapor are also available in atmosphere. Plants prepare their own food by photosynthesis process. During photosynthesis process, plants take carbon dioxide gas and liberate oxygen gas. Human as well as other animals inhale oxygen and exhale carbon dioxide gas during respiration. Pollination in plants and transfer of seeds of plants are also assisted by air.

B) Solar energy :

Sun is the main source of energy. It provide us light and heat, which is essential for living beings. In the presence of sunlight, plants prepare their food by photosynthesis process. Some places have adequate solar energy while its availability is inadequate in some places. The major reason for unequal distribution is the geographical structure of earth. Due to this the climate of different places, rainfall, production of food etc. also differ. Thus, it results in diversity between plants and animals of different places.

C) Soil :

Soil is also an important abiotic factor. Soil is formed from small particles of rocks, minerals etc. Structure of soil varies from place to place. The color of soil varies from one place to another due to the presence of mineral particles. The quality of soil increases when degraded materials, rotten food and dead bodies get mixed into soil.

Soil consist, of minerals, organic matters, organisms and chemical factors like Nitrogen, Potassium, phosphorous, Calcium etc. These factors are highly important for plants. Plants absorb water and minerals from land. Disorder in the composition of soil has direct and adverse effect on plants and animals.

D) Water :

Water is essential factor for the life cycle of both plants and animals. Water is necessary for building up of living being's life. Plants absorb water from land for photosynthesis process. Man including other birds and animals use water from river, lakes, ponds, springs, sea etc for their livelihood.

Biotic factors :

All living organisms are biotic factors. Living components of environment are interrelated and interconnected with each other. Biotic factors refer to ecosystem which include producers, consumers and decomposers. On the basis of flow of energy, biotic factors are classified as follows :

A) Producer :

Producers are living beings who can prepare their own food. Plants with green pigments are producers. They are also known as autotrophs. Other organisms of ecosystem obtain their food from producers.

B) Consumer :

Consumer are the living organisms which depend on producers for food. On the basis of food they obtain, they are classified into following groups.

Primary consumers, Secondary consumers and tertiary consumers.

Primary consumers are herbivores and they depend directly on plants for food. Example of primary consumers are cow, buffalo, goat, rabbit, squirrel etc.

Likewise, living beings which depend directly upon primary consumer for food are known as secondary consumer. They are carnivores Example: cat, fox, frog etc. Living beings which depend upon primary and secondary consumers for food are known as tertiary consumers. These living beings are physically developed and strong. Examples are cheetah, whale, crocodile etc. Animals like primary and secondary consumers are carnivores while some of them are omnivores.

C) Decomposers :

Microorganisms like bacteria and fungi present in soil help to decompose dead bodies and convert finally into small particles. Such small particles are absorbed by root of plants. Plants obtain essential particles from soil. Decomposers help in maintaining balanced ecosystem.

Introduction to ecosystem

What kind of plants and animals are there near your house or school or open environment? Observe carefully. From where do the plants of open environment obtain their food ?

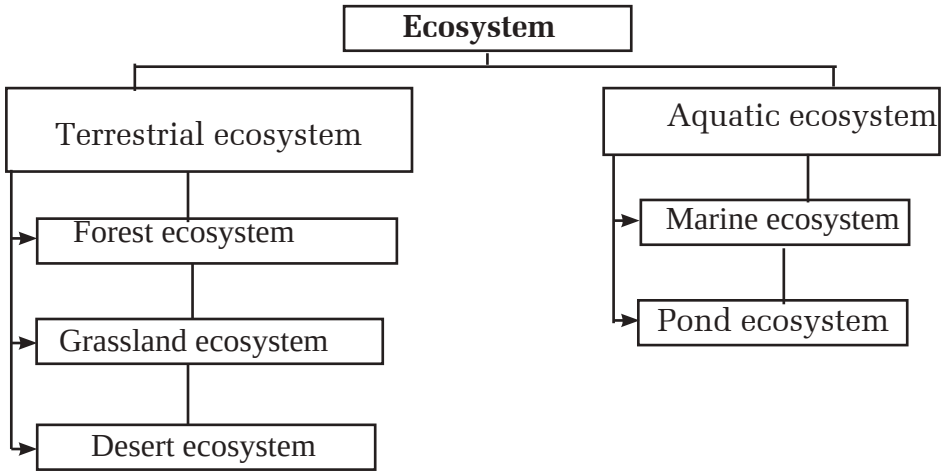
If we observe an open environment carefully, we can find plants, grass, insects, small birds, frog, snake etc.

Fig 21.1: Ecosystem

Green plants prepare their food by photosynthesis process. Insects feed on such green plants. Similarly, snakes feed on frog. At the end, when living organisms die, microorganisms like bacteria and fungi present in soil decompose them. It is converted into simpler form. Such particles are absorbed by the roots of plant and prepare their food. In such way, living beings are either directly or indirectly depend on each other. There exists continuous relationship between living beings present in an environment and physical environment. This permanent process is called ecosystem. Ecosystem consists of both biotic and abiotic factors. Equilibrium between these factors helps in regulation of ecosystem.

In the given example, green plants are producers and prepare their food by photosynthesis process from surrounding environment. Insects survive on producers. They are also known as primary consumers. A frog survives on primary consumer and known as secondary consumer. Organisms like snake survive on both primary and secondary consumer. They are called as tertiary consumer. Living organisms like eagle survive on tertiary consumers. They are quaternary consumers. Dead body of all living organisms are decomposed into smaller particles by microorganisms like bacteria and fungi. They are also known as decomposer. These simple decomposed particles are absorbed by the roots of plants in order to prepare their food.

Ecosystem are of different types. Among them major types of ecosystem are listed below.



1. Forest ecosystem

Producer = Grass, shrubs, tree

Primary consumer = Deer, zebra, wild buffalo

Secondary consumer = Fox, hyena, wolf

Tertiary consumer = Tiger, lion.

2. Pond ecosystem

Producer = Hydrilla, algae, a single cell green plant (Phytoplankton)

Primary consumer = Small fishes, tadpoles, Dragonfly, larva of mosquito (zooplankton)

Secondary consumer = Frog, big fish

Tertiary consumer = snake

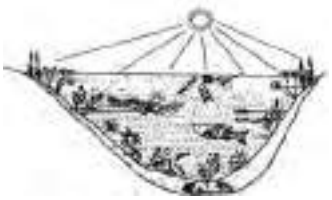


Fig. 21.2: Water ecosystem

Regulation of food in ecosystem

Energy is essential factor for regulation of life cycle. Food is main source of energy. Plants prepare their own food. Mushroom, fungi are parasites. They acquire their food from other living beings. Living beings acquire their required food from different sources. Producers and consumers are related in ecosystem. Thus, the transfer of food forms food chain.

Food chain

In an ecosystem, relationship between producer and consumer forms food chain. The main source of food is producer. Energy flows from producer to consumers and decomposers. There are different types of consumers. Birds feed on insects. Again, carnivorous birds like eagle, hawk feed on birds. After the death of all such consumers, decomposer present in the soil convert them into smaller particles. These particles are absorbed by the root of plants and prepare their food. In this way, process of transfer of food energy from producer to primary consumer, secondary consumer is called as food chain.

Example : Grass ⟶ Deer, Musk ⟶ Tiger.

Food Web :

Interrelation between food is known as food chain. Living organisms obtain their nutritious factors from food chain. The inter linkage of many food chain forms an integrated network. This is called as food web.

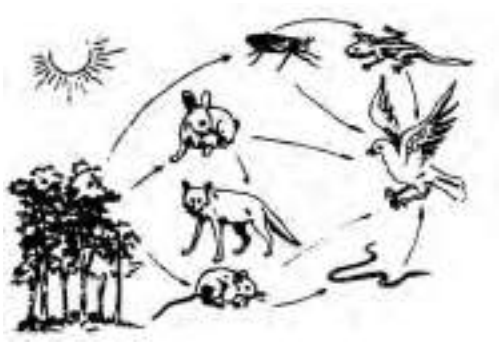


Fig. no. 21.3 food web

Activities

Make a group of friends and visit nearby field. Prepare a short note based on observation and study of producer, primary consumer, secondary consumer and decomposer of that ecosystem.

Interrelationship between animals and plants

Plants and animals are interrelated with each other in an ecosystem. Plants use simple organic matter to prepare complex organic matter. On the basis of their feeding habit, they are classified as autotrophs and heterotrophs.

Autotropic organism:

Living organisms who can prepare their own food are known as autotrophs. Producers like green plants are autotrophic organisms. Green plants absorb UV-radiation with the help of chlorophyll. They prepare their food with the help of water and carbon dioxide by the process of photosynthesis.

In this tropic level, living organisms prepare organic matter by transforming in organic matter with the help of solar energy.

Heterotrophic organism

Organisms who are unable to prepare their own food and depend on other living organisms for food are known as heterotrophic organism. They are also known as consumers as they only consume food. Animals & plants without chlorophyll fall under this group. Thus, the tropic level where living organisms depend on other living organisms for food is known as heterotrophism. On the basis of feeding habit, they are classified into three types.

Parasite :

Parasite are the living organisms which have complete dependence on other living beings for food. They acquire their food by sucking other living organisms. Living organisms on which they feed on are known as hosts. Living organism which feed on host is parasite. Worm on stomach, tapeworm, bug etc are parasites.

Saprophyte:

Saprophyte are those organisms which feed on dead and decayed organisms. Example : Mushroom, bacteria etc.

Holozoic :

Organisms acquire food from both small and big animals and plants. This type of nutrition is worldwide. All organisms including human pertain to this type of nutrition. In holozioc nutrition, the food obtained ingested it is converted into absorptive material. This material is absorbed by body and remaining undigested food materials exit out.

Ecosystem services:

Humans are benefited from ecosystem, known as ecosystem services. Ecosystem services are listed below.

1) Provisioning services :

Products obtained from ecosystem is known as provisioning service. It includes following factors :

A) Food and fiber :

Things required in large amount by human beings are available in ecosystem. Food, silk, wood, firewood etc. can be obtained from animals and plants.

B) Fuel :

Wood, timber, excreta of animals and other organic matters are used as fuel. All of these factors are obtained from ecosystem.

C) Ornamental resource :

Various skin, shell, bones etc. are obtained from animals. These materials are used as ornaments by people of different caste according to their religion and culture.

2) Regulating services :

Regulating services refers to the advantages gained by human beings as a result of regulation of balanced ecosystem.

a) Climate regulation :

Ecosystem affects both local and world's climate. It helps in maintaining temperature of forest and rainfall in local level. Likewise production of carbon dioxide gas also effect on climate.

b) Water purification :

Ecosystem directly or indirectly helps in water purification. It helps in filtering impure substances and degradation of organic matter present in water. Similarly change in ecosystem affects in pollination, regulation of human diseases, erosion control etc.

3) Cultural services :

Change in ecosystem affects natural beauty, peaceful environment, culture of people, religious faiths, values and norms. Similarly it increases the norms and values of social relation and cultural heritage. In the balanced ecosystem, clean environment, natural scenario, and natural beauty increases. It assists in tourism. These places help people to utilize their leisure period in peaceful environment.

4) Supportery services :

It includes services like nutrient recycling of food materials essential for animals, primary production and soil formation. It provides services like food regulation, water purification etc.

Things to be remember

1. Important aspect of environment is ecosystem which is made up of biotic and abiotic factors.
2. Abiotic factors include air, water, soil, sun, energy etc while biotic factors include producers, consumers and decomposers.
3. Abiotic factors help in regulation of ecosystem. These factors are continuously available in appropriate way and help in regulation of ecosystem.
4. Green plants are producers. Those who survive on green plants are consumers.

5. In ecosystem, decomposers help in decaying and decomposing of dead bodies and mix them in soil. These are used by plants to prepare their food.
6. Some of the living beings are both herbivores and carnivores. They are also known as omnivorous.
7. Green plants prepare their own food, known as aurotroph. Living beings which depend on others for food are known as heterotrophs.
8. Thus, process of transfer of food between living beings is food chain and food web.

Exercise

A] Select the correct answer from following multiple choice questions and put tick (√) mark.

1. What kind of living organism depend on each other and survive on common environment?

   i. Abiotic factors ii. Biotic factors

   iii. Society iv. Parasite

2. Which of the following is decomposer?

   i. Green plants ii. Insects, predators

   iii. Mushroom iv. Calottes

3. Which of the following is producer in pond ecosystem ?

   i. Algae ii. Tadpole

   iii. Bacteria iv. Fish

4. What is formed between the process of transfer of food between producer and consumer?

   i. Food web ii. Food chain

   iii. Society iv. All of above

5. What are the essential factors obtained from plants and animals?

   i. Food ii. Shelter

   iii. Clothes iv. All of above

6. Which of the following is not parasite?

   i. Tapeworm ii. Mosquito iii. Earthworm iv. Bug

B] Answer the following questions :

1. Give short description of ecosystem. What are abiotic factors of ecosystem? How do they affect ecosystem? Explain it.
2. What is food chain? Describe about water and land ecosystem around your surrounding with figure.
3. Explain the relationship between plants and animals
4. Describe briefly the role of decomposer in ecosystem with example.
5. Differentiate between food chain and food web in two points.
6. Draw a neat diagram of pond ecosystem and mention producer, primary consumer, secondary consumer and decomposer.
7. There is balanced cycle between producer, consumer, decomposer and environment in an ecosystem. If imbalance occurs on any factor, ecosystem will also be damaged. Justify it with reason.
8. What will happen in ecosystem if all the snakes of land ecosystem are killed? Explain it.
9. What is ecosystem service? Explain briefly.

Project work

Visit nearby pond, lake or river. Identify the producers, primary consumers, secondary consumers present in the environment.

Glossary

Heterotropism : Living organisms who depend on another living organisms for food.

Saprophyte : Living organisms which consume their food from dead and decomposed things.

Holozoic : Living organisms which consume their food either from living organisms or from plants.

Food web : Network of food chain.

Food chain : Transfer of food energy between producer and consumer.

Unit

22

Natural Hazard

Different events occur continuously in nature. Such events either cause balance or dis balance in environment. Natural energy creates these condition on nature. This might cause negative impact on all living beings including human beings. It is called as natural hazard.

Do you know?

On 2071.04.16, Sunkoshi river was blocked due to landslide on jure of Mankha V.D.C, Sindhupalchok at midnight around 3:30 am. 8 people died, 39 injured, 100 are unreachable, more than 2 dozens of houses were submerged and 11 districts were reported to be at risk of flood. (Based on news of gorkhapatra published on 17th Shrawan.

Events occurring in nature are either continuous or they occur after certain interval of time. Example of natural hazards are flood, landslide, hurricane, cyclone, earthquake, lightening, eruption of volcano etc.

Nature of natural hazard and its effect vary from place to place. It is due to geographical structure of different countries. Landslides and flooding in Nepal, Earthquake in Japan, cyclone in marine area are some examples of natural hazard.

This unit deals with the study of introduction on natural and manmade crisis, crisis management, glacier flood, glacier lake outburst and causes of cyclone, its effect and preventive measures.

Hazard :

Natural energy is the possible reason for various events on nature. When such events reach to extreme level, they will have huge impact on the human and other living organisms. Some natural events are very dangerous while some are of intermediate type. For example : Probability of occurrence of earthquake and volcanic eruption. These threats are destructive and cause great loss of life and property. Human activities are

also responsible for various such natural venture. For example : Human activities like deforestation leads to natural hazard like flood, landslide, soil erosion etc. These hazards are beyond the control of human. Naturally occurring internal energy is powerful. It causes drastic changes. Hazard is mainly categorized as natural and manmade.

Natural hazards

Naturally occurring threats are natural hazards. It includes flood, landslide, hurricane, cyclone, earthquake, volcanic eruption etc.

Manmade hazards

Human activities may cause the occurrence of destructive venture, known as manmade hazard. These threats are epidemic diseases, vehicles accident, desertification, accidents created from chemical industries etc.

Management of natural hazards

Natural hazard cannot be avoided in a simple manner. But it can be managed in order to minimize its predictive destruction. Measures for management of natural hazards are as follows:

a) Conduct awareness program and pre-preparation carefully.

b) Immediate actions should be taken to rescue victims of hazard.

c) Physical and economic support for hazard victims.

d) Organizations which are established to help victims of hazards should be regulated.

Management of manmade hazards

a) Criteria of age and ability should be maintained for vehicle license.

b) Minimize the use of atomic and chemical industries or precautions should be taken.

c) Emphasize on cleanliness and conduction of awareness program.

d) Maintaining the balance of soil fertility capacity.

e) Preservation of forest and afforestation program should be conducted.

f) Minimizing the unhealthy competition between peoples.

g) Awareness program should be conducted at local level via radio and television

h) Planning on use of land and its implementation

i) Earthing should be done while constructing home.

If the hazard occurs due to natural and human activities, it will create crisis. Effective management measures should be taken in case of occurrence of hazard. Disaster management cycle should be implemented which are as follows :

1. Works to be done before crisis

a. Pre-plan before crisis can be done as follows

Analysis of crisis, plan for pre-preparation, management & storage of relief materials and management of information system.

b. Following measures should be taken before crisis in order to minimize risk.

Implementation of effective measures to minimize the loss of sectors besides construction site, obtaining organic process, construction of canals, prevention of soil erosion by constructing of walls, dams, etc. and protection of human settlement.

2. Works to be done during crisis

Precaution should be taken and disabled should be helped and protected.

3. Works to be done after crisis

a. For rescue

Works should be performed immediately for rescue, treatment of victims, regulation of trained health workers and primary treatment should be done.

b. For relief

Distribution of dry and packed food and other foods, availability of clean drinking water, management of medicines, clothes and utensils and place to live

c. For the identification of needs and damage

Activities like analysis of damage and identification of needs should be conducted, prioritization should be made, management of temporary shelter, food and source of clean drinking water should be identified and used. Similarly, education on treatment of health, management of clothes etc. should be done. Works like conduction of income generating program, re-settlement, preparation of necessary tools required for managed settlement should be done. Likewise, situation analysis of damage should be done and based on probability of occurrence of future hazards, settlement should be planned either on same old place or other appropriate place. Services like house, drinking water, drainage, school, health centers, roads, bridges and other services help in crisis management. Social security and other developmental activities also assist in management of crisis.

Glacier Flood

Fig No. 22.1 glacier flood

Himalayan region consists of large amount of snow. Breadth of snow varies due to latitude and altitude. Himalayan region of Nepal also consists of excess amount of snow. Climate change results in rise of temperature. The rise in temperature causes the melting of snow of Himalayan region and they eventually forms glaciers. Nepal also consists large number of glaciers. Among them, some glaciers have already exploded while some glaciers are in the risk of explosion. It causes flood in the rivers of Nepal and causes great loss of life and property. Some rivers of Nepal like Arun, Trishuli, Dudhkoshi etc. are originated from Tibet and flow towards Nepal. Study shows that flooding on these rivers causes great loss of life and property at different time period. Thus, glaciers of Nepal and Tibet create the risk of flood in rivers of Nepal. Many years ago, explosion of various glaciers of Nepal and Tibet caused flood in rivers.

Causes of glacier flood :

a. Change in climate
b. Internal energy of earth
c. Raise in temperature of world
d. Explosion of glacier lakes

Do you know ?

In 2012 A.D, glacier flood from Annapurna mountain caused flood in Seti river of Pokhara. 20 people died, Hundreds were out of contact. It caused great loss of life and property.

e. Earthquake

f. Exploitation from human

Effects of glacier flood :

a. Flood on rivers

b. Loss of life and property

c. Destruction of developmental infrastructures

d. Destruction of agricultural sectors and crops.

e. Destruction of organisms and animals.

Some protective measures of glacier flood

a) Study investigation and analysis about the condition of glaciers present in Himalayan region.

b) Activities which create pollution in atmosphere should be discouraged.

c) Measures should be taken to prevent glacier lake outburst.

d) Measures should be taken to prevent effect of glacier flood.

e) Pre-preventive measures should be taken in the places where there is risk of glacier flood.

f) Identification of risk area and settlement should not be made below the risk area.

g) Management of siren(bell) on such sensitive area after the pre-analysis of future risk.

h) Equipped pre-preparation and effective plan should be done for relief and rescue.

Glacier lake outburst:

Lakes of Himalayan region are glacier lakes. Formation of glacier lake occur naturally. Accumulation of snow on small and big valley of Himalayan region forms glacier lakes. These glaciers are either in solid state or in melted state. Increment in the area and surface of water is due to climate change. It is proved that increase in area of glacier lake is due to the melting of snow.

Fig No. 22.2 glacier lake outburst

Environmental problems or hazards like glacier lake outburst and flood due to its outburst is mainly caused by increase in temperature of world. It causes the melting of snow day by day.

Do you know?
In 1968 A.D, flooding occured in Budhigandaki river due to glacier lake outburst. Similarly, In 1985 A.D, due to glacier lake outburst, hydropower station situated near Jhane village of Namche bazzar was destroyed.

Specially countries having snow covered Himalayan region are facing such problems. Because snow of such countries are melting and area of glacier lake increases. Similarly layer of water increases on such lakes. Increment in the layer of water and extension of its area, creates the risk of glacier lake outburst. There is possibility of glacier lake outburst as the increment in the area of lake causes melting of nearby snow. During the outburst of glacier lakes, excess amount of water increases in rivers and flows at high speed. It causes destruction of nearby places. In other word, flooding occurs in river and causes great loss of life and property. Thus, negative effect of glacier lake outburst is known as hazard due to glacier lake outburst.

Glacier lakes are natural lakes or ponds surrounded by snow. Outburst of such lakes causes glacier flood, destruction of snow blocks, vibration of land due to earthquake and increment in the amount of water in glacier lake due to heavy rainfall.

Glacier lake outburst and its impact :

a. Flooding in rivers
b. Damage of life and property
c. Destruction of infrastructure of development
d. Destruction of agricultural area and crops.

Cyclone

Cyclone is also a kind of natural hazard like glacier flood and glacier lake outburst. Cyclone occurs in countries having oceans, not in landlocked countries. Thus, it causes great loss of life and property in such area. Small and big cyclones occur in ocean. A small cyclone in ocean is known as tropical storm. But if it is big, it is cyclone, typhoon, hurricane. Meteorologists name differently in different regions of world. For example: In 1970A.D, Bhola cyclone hit Bangladesh, in 1998A.D, Hurricane Mitch smasher into the countries like Honduras, Nicaraguan of Caribbean sea and Mitch cyclone in other countries.

In 2005, Katrina hurricane occurred in USA, In 2008A.D Nargis cyclone occurred in Myanmar & Haiyan hurricane occurred in 2013A.D etc.

Cyclone is an area of closed circular fluid motion rotating at high speed on sea or oceans. The centre of cyclone is called eye. The spiraling wind rotates anticlockwise in the northern hemisphere and clockwise direction in southern hemisphere. Heavy rainfall occur when cold air and hot air collide with cyclone. It is circular and cyclone's center has lowest atmospheric pressure than its peripheral surface.

Fig no. 22.3 Cyclone

Causes of cyclone :

When the temperature of ocean's water below 50m raises to 26.5° c or more, process of formation of cyclone begins. Formation of cyclone occurs in both 5°-25° North and South latitude. In the region of low atmospheric pressure, air from all around gets centralized. Water vapor and hot air move upward and circular fluid motion forms cyclone, also known as tropical disturbance. This process continues to increase quantity and speed of air moving towards the centre of cyclone. When the speed of surrounding air decreases, cyclone becomes more powerful and takes large circular shape. Hurricane is converted into cyclone when the speed of air inside circular motion increases about 119km/hr. Water vapor raises up and cools down during cyclone. Eventually latent heat appears outside which is major source of energy for cyclone. During cyclone, temperature of internal area is more than that of surrounding area. Hot air from central region moves downward and water vapor rises up and cools down. It creates a circular motion of cyclone.

Storm surge is the process of increasing the level of water during cyclone. It submerges the area near oceans. Continuous rise in temperature causes various cyclone and also creates the chances of occurrence of powerful cyclone.

Effects of cyclone

Cyclone causes strong wind which causes destruction and damage of villages and death of people. Storm surge causes the raise in sea level and human settlement may get submerged. Cyclone near sea causes the destruction of land and pile up different types of soil, sand on it.

It causes destruction of crops and decreases fertility of soil. Edges of ocean also change to worst form. This can be summarized as follows :

a) Effect on settlement near the edges of sea and on stip.

b) Chances of occurrence of flood near the edge of ocean

c) Effect on fertility of soil.

d) Damage of lives and other properties.

e) Uproot the trees.

Some protective measures of cyclone

a) Cyclone resistance building should be made near the area of chances of occurrence of cyclone.

b) Emergency settlement should be made in different places in order to be safe from cyclone. Development of technology on ships is essential which provides information as soon as possible.

Do you know ?
Nepal consists of about 3252 small and big glacier and about 2323 glacier lakes.

c) Conduction of awareness program. Management of first aid treatment, relief materials, trained health workers and volunteers.

d) Management of rescue team, when hazard occurs.

Things to remember

1. Natural hazards are naturally affecting events that effect the natural structure and large no. of lives and property.
2. Natural hazards are name according to places like ; Natural emergency, ecological damage, extreme event etc.
3. Glacier lakes are natural ponds or lakes which are surrounded by snow on all sides.
4. The process of destruction of property and lives due to outburst of glacier lakes is known as glacier lake outburst hazard.
5. Glaciers, glacier lakes and cyclone cause negative impact on environment.
6. Melting of snow from northern Himalayan region forms glaciers and glacier lakes.
7. Cyclone is known as speedy wind on large mass of water like sea or oceans.

Exercise :

A) Choose the correct option

1. What is the cause of Natural events ?

   i. Internal energy ii. Geographical energy

   iii. Chemical energy iv. Physical energy

2. What is the nature of hazard occuring due to natural energy compred to that of human activities ?

   i. Less destructive ii. Highly destructive

   iii. Useful iv. Helpful

3. Which one of the following factor is affected by natural hazards besides human ?

   i. Soil ii. Rocks

   iii. Any organism iv. All organisms.

B) Answer the following questions

1. What is natural hazard? Explain
2. Give the examples of natural hazard.
3. Are humans the cause of natural hazard ?
4. What is glacier flood ?
5. Make the list of places where glacier flood occur.
6. What is glacier lake outburst?
7. Show the relationship between glacier flood and glacier lake outburst.
8. Write down in points, the cause of glacier lake outburst.
9. Explain the reasons of cyclone.
10. Find out the preventive measures for glacier flood.
11. Write down the measures to minimize the effect of cyclone.
12. Write down the preventive measures for glacier lake outburst.

Project work :

Prepare a report based on crisis event occurring near your area, its causes, effect and works done for crisis management.

Glossary

Natural hazard : Naturally occurring event which causes damage of lives and property and natural condition.

Glaciers : Rivers flowing from Himalayas

Glacier flood : Increase in volume of glacier causes flood.

Volcanic eruption : Magma present inside the earth, comes outside in the form of lava.

Cyclone : High speed wind occurring in water of sea and oceans.

Unit
23

Green House

Do you feel hotter on a cloudy day? Have you heard news about the artificial green houses? What is the importance of green house in our daily life? What happens in its absence? What are its benefits? Think for a while.

In this unit, we will study about the green house and its effects, importance of artificial green house, its utilities and climate change.

Green house effect:

Increasing industrialization with the increase in population has become the cause of air pollution. Similarly, due to the climate change, the earth's temperature has been found increased. So, earth can be compared with the green house. Some of the solar radiations return back after reflection from the surface of the earth and from the atmosphere. The different green house gases (like carbon dioxide, chlorofluorocarbon, methane, nitrous oxide etc.) send the reflected solar radiations back to earth surface. The increased green house gases absorb the heat and they prevent reflected heat waves from escaping out of the earth's atmosphere. As a result, the heat gets collected as that of the artificial green house and the earth's atmospheric temperature increases. Hence, the phenomenon of increase in the temperature of the earth due to increased green house gases in the atmosphere is called green house effect.

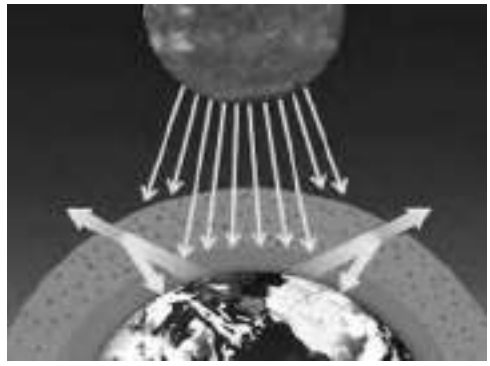


Fig. 23.1: Model of natural green house

Do you know?
Green house are smaller to industrial sized. Small green house is called cold frame.

Natural green house effect is essential. In its absence, the living beings get problems in the earth and human beings may extinct. But highly increased green house effect causes various negative impacts on the environment. Finally, it also changes the climate.

Adverse effects of green house effect

a) It increases atmospheric temperature.

b) It brings change in water cycle.

c) It causes adverse effect on human health.

d) It decreases agricultural production and fertility.

e) It causes melting of ice of the himalayas.

f) Melting of ice results to rise in sea level which causes problem to the people near sea-shore.

g) It declines the biodiversity.

h) It may cause desertification.

i) It adversely affects ecosystem and imbalance it.

Artificial green house

Artificial green house is made up of transparent glass or plastic. It is called warm house. Actually, they are of two types: plastic house and glass house. So the houses made of transparent plastic or glass to keep plants are called artificial green houses.

Fig 23.3 Artificial green house

The solar radiations of short wavelength enter the green houses through glass or plastic and certain energy is absorbed by the green house after entering it. Now, these radiations of short wavelength change into the radiation of long wave length. They cannot escape out of the green house and these radiations change into heat energy. As a result, heat energy is stored in the green house. Thus the temperature of the green house increases which is called green house effect.

Importance and utility of artificial green house

As temperature increases in the artificial green houses, unseasonable vegetables can be grown in them. We can make better income from such unseasonable vegetables. It is useful to protect the plants which are at

the stage of extinction. Besides, plants of hot climate can be grown in the cold places with the help of green houses. Following points show its importance and utility.

a) Certain types of plants can be grown throughout the year.

b) It is helpful to produce food materials in the countries of cold climate.

c) It is useful to produce flowers, vegetables, fruits and other different plants.

d) The plants grown in the green houses help to control environment pollution.

Climate change

Nepal has geographical diversity. It has been extended from 60m. to 8848m. from sea level. It has three regions namely terai, hilly and mountaineous regions. The climate is different in places which is very cold somewhere and very hot in other places. The average condition of weather over a long period of time is called climate. Nepal is very sensitive in regard to the climate change. It is the current major issue of climate change for Nepal which has climatic diversity.

Causes of climate change

Climate change is a natural process in the country like Nepal which has diversity in its geography.

1. **Increase in temperature**: Due to geographical diversity on earth, the difference in heating effect causes different in temperature from place to place. On comparing the temperature of the earth from 2001 to 2010 AD with the temperature of the year 1980 AD, it has been found that the temperature has increased in the recent years.
2. **Release of green house gases**: The fossil fuels (coal, petroleum products) and carbon dioxide released from industrial activities cause environmental pollution which enhances climate change. Likewise, nitrous oxide, black carbon, methane etc. released from any sources also help in climate change.
3. **Deforestation**: Forest is being destroyed day by day for wood, firewood, coal etc. Similarly, it is being destroyed for getting the raw materials of paper, industrial products, , grazing and agriculture. It results in increase in the amount of carbon dioxide. It helps the earth to absorb more carbon and helps to store more carbon dioxide in the atmosphere. Finally, climate change occurs due to global warming.

4. **Increase in the use of chemical fertilizer**: Use of excessive amount of chemical fertilizer in the field causes adverse effects on the environment and increases temperature. The chemical fertilizer left unused in soil makes the land dry and increases the green house gases. Also the chemical fertilizer which flow with water causes the death of aquatic organisms. Hence, due to green house gases results the increase in earth temperature and climate change.
5. **Industrialization**: the dust and smoke from industries get collected in the atmosphere. The gases like carbon dioxide, sulphur dioxide produced in this way cause acid rain and fogs. It results the increase in green house effect and global warming and climate change takes place.
6. **Volcanic eruption**: During the volcanic eruption, dust and sulphur compounds are released and get collected in the atmosphere which block the solar radiations. It results the decrease in earth's temperature and affects climate.

Effects of climate change

All the living beings including humans have been affected due to climate change. Some major effects of climate change are as follows

Change in air temperature: Comparative study of temperature of the world in the year 2001to 2010 and in the year1980 has shown that the temperature has been increased in the recent years. The data collected from the year 1976 AD to 2005 has revealed that the temperature of Nepal has been increasing at the rate of 0.04°C per year. It proves that the earth's temperature is increasing day by day.

1. **Impact in biodiversity and ecosystem**: Plants and animals of different species are being endangered and getting extinct due to difficulty to adopt themselves with the changing climate of the environment.

Do you know?
The temperature of earth has been increased by 1.40°F. since the last 100 years. If it continues, the earth's temperature will be increased in the days to come.

2. **Impact on human health**: Occurrence of various diseases in the human beings, blow of hot air, heating of the land are caused due to global warming. It reduces the efficiency of a person to do work and organisms suffer from different diseases.
3. **Impact on agriculture**: Climate change causes green house effect, heavy rainfall, drought and change in earth surface. It adversely affects

agricultural system. Farmers are compelled to depend on rain water for farming their fields, landslide in the hilly areas, floods in terai are some of its effects which ultimately reduces the fertility of soil.

4. **Disaster caused due to climate change**: Climate change causes heavy rainfall, flooding, landslide and drought. It generates various environmental problems.
5. **Negative effect on water resources**: The most affected area due to climate change is water resource. Irregularity occurs in the flow of river water due to less snow fall in the himalayas, but faster when ice melts. Glaciers increase in their size due to more water collection after melting of ice and chance of their burst increases. It also affects the ecosystem.
6. **Energy crisis**: Water resource is essential for hydro electricity. Increase or decrease of water resources change energy production. The activities do not accomplish on time due to energy crisis and affects the whole economic sector badly. In Nepal, load shedding is more in winter than in the summer due to energy crisis.
7. **Impact on human settlement**: The life of people living in mountains, hills, riverside, sea shore are facing various problems. For example, due to blockage of Sunkoshi of Sinduplanchowk, many homes getting submersed, many people getting displaced due to Koshi flood, etc. show the impacts on human settlement.
8. **Impact on physical facilities**: Various physical structures like road, bridges, buildings and temples, watersheds may get destroyed due to natural disasters.

Measures of climate change management

1. Adopting afforestation as a special campaign
2. Conducting awareness developing programmes.
3. Reduction in production of greenhouse gases
4. Minimum use of fossil fuels
5. Promotion of alternative sources of energy
6. Controlling pollution of industries and factories
7. Proper management of means of transport
8. Proper management of waste materials
9. Controlling unmanaged and unplanned developmental activities
10. Construction of environmental friendly bridges and roads
11. Conservation of natural environment.

12. Improving agricultural system.
13. Development of better and disease resistant species.
14. Proper management and conservation of water resources.

Points to remember

1. The house made of glass or transparent plastic to keep the plants is called the green house.
2. Heat gets collected in the green houses due to the presence of different gases and temperature increases there, which is called green house effect.
3. Green house effect is the increase in temperature of the earth's atmosphere due to the green house gases there.
4. Artificial green house is useful to produce some of the plants throughout the year to produce flower, vegetables etc. in the off seasons as well.
5. Climate is the average condition of weather over a long period of time.
6. Various causes of climate change are increase in temperature, deforestation, maximum use of chemical fertilizer, industrialization, volcanic eruption etc.
7. The effects of climate change are change in atmospheric temperature, effects on biodiversity and ecosystem, adverse effects on human health, adverse effects on agricultural system and its production etc. Similarly, natural disaster, impacts on water resources, energy crisis, impacts on human settlement and physical structures are also the effects of climate change.

Exercise

A. **Tick (√) the right answer.**

1. Which is the main greenhouse gas in the atmosphere?
   i) Carbon dioxide ii) Chlorofluorocarbon
   iii) Methane iv) Ozone.
2. Which one of the following increases the atmospheric temperature?
   i) Greenhouse ii) Plants
   iii) Animals iv) Substances.

3. What is the green house made of ?
   i) Plastic ii) Glass
   iii) Plastic or glass iv) Green glass
4. What is the small green house called?
   i) Cold frame ii) Hot frame
   iii) Green frame iv)White frame.
5. Which energy is stored in the green house?
   i) Light ii) Heat
   iii) Solar iv) Kinetic.
6. What type of climate does hilly area of Nepal have?
   i) Very hot ii) Very cold
   iii) Moderate iv) Cold
7. What is the reason behind the climate change in Nepal?
   i) Increase in temperature ii) Deforestation
   ii) Industrialization iv) All of the above
8. What are the effects of climate change in Nepal?
   i) Change of temperature of air ii) Energycrisis
   iii) Effects in physical structure iv) All of above.

B. **Answer the following questions:**

1. What is an artificial green house?
2. What do you mean by greenhouse effect?
3. Write some names of greenhouse gases.
4. Write the reasons for greenhouse effects in earth.
5. Write the effects caused due to greenhouse effect.
6. The roof of artificial green house is made slanted, why?
7. Explain the reasons of climate change.
8. “One of the reasons of climate change in Nepal is the generation of green house gases”, justify.
9. What are the effects of climate change? Write some points.
10. How does the climate change affect human settlement? Clarify.

11. What are the various measures to minimize the impacts of climate change? Mention them.

Project Work

1. Prepare a report on 'The earth behaves as a natural green house.' Present your report in the class..
2. What are the effects of climate change seen in your settlement area? There may be various factors of climate. Study and find them. Ask your teacher. Ask the people of your place. Prepare a report including the measures to minimize the effects of climate change and present it in your class.
3. Construct an artificial green house near your house and study its effects.

Vocabulary

Green house : A house made of plastic or glass constructed to grow unseasonal plants and to control heat and humidity of the air.

Green house gas : Carbon dioxide, nitrous oxide, methane, water vapour like gases which retain heat.

Cold frame : Small green house.

Climate : Average condition of weather.

Unit

24 The Earth in the Universe

Have you ever observed open sky at night? If you have observed, what have you seen in the sky? Can you say? You might have seen highly bright and less bright objects while viewing the sky. What are these objects seen in the sky? How they might have been formed? Have you seen their different motions in different time? Let's think for a while about them.

All the heavenly bodies that you see in the sky are moon, stars, planets, satellites, galaxy, and constellations. In this unit, we will study about the rotation of the earth, revolution of the earth, phases of the moon, the relation of the sun, earth and moon, umbra and penumbra, lunar and solar eclipse, etc.

The Universe

The universe is the total matter of the sun, the moon, stars, planets, satellites, galaxy, constellations, asteroids and the space between them. There are many galaxies in the universe. The universe is formed from these galaxies. Our solar system is situated in the Milky Way galaxy. It consists of 10^{11} stars. We can also see other galaxies, if we view them by using powerful telescope.

The sun is the medium- sized star nearest to the earth. There are eight planets in our solar system namely Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. In addition, there are 173 satellites in it. Among the eight planets, the earth is only a planet having suitable environment for living beings. It means, the things necessary for survival of living being such as air, water, soil and so on are also available on the earth. The earth revolves round the sun in an elliptical orbit. This type of motion of the earth is also called an **orbital motion or revolution.** In addition to it, the earth rotates itself on its own axis. It is called **rotation of the earth.** Days and nights occur because of rotation, whereas the seasons change because of revolution.

Units related to astronomical distance

As the heavenly bodies in the sky are very far from each other, it is very difficult to mention their distance in metre and kilometre. The distance

between heavenly bodies in the sky is called **astronomical distance.** Generally, the following units are used to measure the distance between heavenly bodies.

a. Light year b. Astronomical unit c. Parsec

Light year

The total distance covered by light in one year passing through vacuum is called **light year**. This is a unit used to measure the distance between the heavenly bodies in the universe.

The speed of light in the vacuum = 3×10^{8} m/s

One light year = velocity x time = $(3 \times 10^{8} \times 365 \times 24 \times 60 \times 60)$ m

$= 94608000 \times 10^{8}$ m

$= 9.4608000 \times 10^{15}$ m

Therefore, one light year equals to 9.4608000×10^{15} m.

Astronomical Unit

The average distance between the sun and the earth is called **astronomical unit.** Its value is 1.5×10^{11} m.

Parsec

The unit, which is bigger than light year and can be used to measure the distance between the heavenly bodies is called **parsec**.

1 Parsec = 3.26 light year.

The solar system

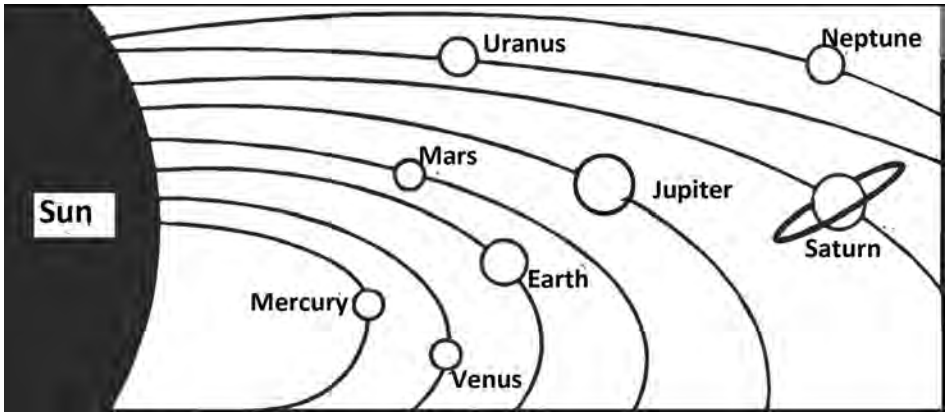


Figure no. 24.1: The solar

The solar system consists of the sun, eight planets and their satellites, meteorites, comets, etc. The sun is the main body in the solar system, whereas other heavenly bodies move around it. Among these bodies, only the sun has its own light, whereas other bodies do not have their own light and glow by reflecting the light of the sun.

Do you know?
There are only eight planets in the solar system. Pluto has been removed from the list of planet and is regarded as a dwarf planet by International Astronomical Union/Association in 2006.

The distance between the sun and the earth is 1.5×10^8 km. Therefore, it takes around 8 minute and 20 second for the sun light to reach the earth.

Rotation and revolution of the earth

Rotation and revolution are two different motions of the earth. When the earth rotates around the sun in an elliptical orbit, it is called **revolution**, whereas when it rotates on its own axis, it is called **rotation**.

Rotation of the earth

The earth takes 23 hours, 56 minutes and 4 seconds to complete one round on its own axis. This period is also called **one solar day**. While rotating the sun, the earth rotates in anti-clock wise direction from west to the east. When the earth rotates on its own axis and revolves around the sun, the part of the earth facing towards the sun receives the sun light. This part of the earth is called a day. At the same time, night falls on the other side of the earth, which does not receive the sun light. While moving on its axis, the bright side of the earth slowly moves towards dark side and the dark side moves towards bright side. In this way, day and night occur continuously.

The effects of rotation of the earth are occurrence of days and night, virtual motion of the sun and stars (e.g. the sun rising from the east and setting in the west), rising and setting of the sun.

Revolution of the earth

The rotation of the earth around the sun in an elliptical orbit is called **revolution of the earth.** It takes 365 days and 6 hours to complete one round around the sun. 365 days make one year, and the sum of the remaining 6 hours for four years results 366 days once in every four year which is called **a leap year.**

The revolution of the earth causes change in seasons and variation in the duration of day and night of a particular place. While rotating the sun in

an elliptical orbit, the earth sometimes receives the direct rays from the sun, which results the hot weather. On the other hand, when the earth is far from the sun, it receives diffused rays from the sun, which results cold weather. This is a main reason why, there occurs seasonal change.

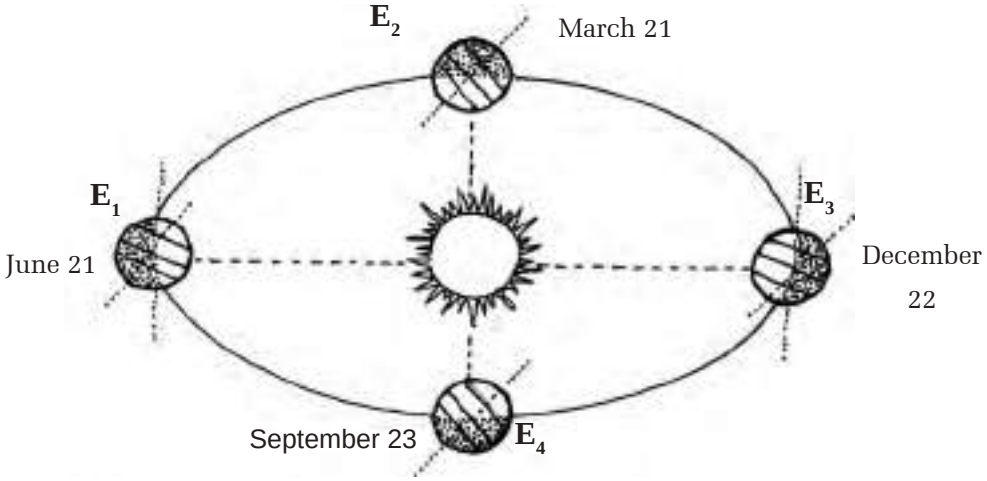


Figure no. 24.2 Revolution of the earth

As shown in the figure, in the position 'E_1', when the earth is in the northern pole, the rays of the sun directly fall, where days are longer and nights are shorter. This stage of the earth is called summer solastice. In the same way, when the earth reaches to the position E_3, the rays of the sun fall straight in the southern part. There is the longest day and the shortest night in the southern pole of the earth. During March to September (position E_4 – E_2), there is summer in the northern pole, whereas there is winter in the southern pole (E_2 – E_4). This is caused as the northern part of the earth is facing straight to the sun. There is the shortest day in northern pole on 22 December, whereas there is the longest day in southern pole. The duration of days and nights are equal, when the sun is right above the equatorial line. It falls on 21 March and 23 September. These two days, when days and nights are equal are called equinoxes.

Effects of annual motion

The effects of annual motion are listed below:

a) Changes in seasons e.g. winter, spring, summer and autumn
b) The variation in days and nights
c) Occurrence of leap year

Sidereal and synodic month

The moon also rotates around the earth as the earth does to the sun. The moon takes 27 days 7 hours 43 minutes and 11 seconds to complete

one round to the earth. This period is called synodic month of the moon. The time that the moon takes to complete one round on its own axis and to complete one round to the earth is equal. Therefore, the moon always revolves the earth facing only one side to the earth. It takes 29 days 12 hours 44 minutes and 3 seconds to the moon to make a complete revolution to the earth and remains in the same position as before the revolution.

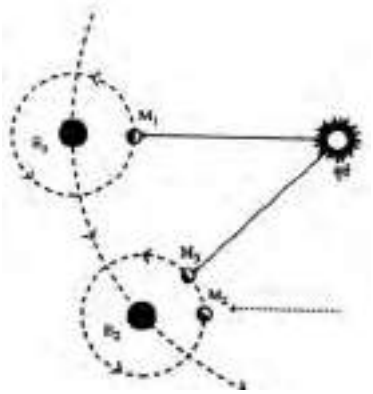


Figure no. 24.3: Synodic month and sidereal month

The earth also moves around 30° forward on its axis to revolve around the sun, while the moon revolves the earth on its previous position. While the moon is between the sun and the earth, the dark half part of the moon is facing to the earth, which causes new moon on the earth. In about 29 days, 12 hours, the earth reaches to E_2 from E_1. When the earth reaches to E_2, the moon makes one complete revolution around the earth in about 27 days, 7 hours. This period is known as **sidereal month**. For the next new moon, the moon has to reach M_3 from M_2. It takes around 2 days and 5 hours for the moon to reach M_3 from M_2. In this way, there is around 29 days between two new moons, which is called **synodic month.**

Phases of the moon

Have you observed the moon in the sky at night? In what shape have you seen the moon? The moon is the natural satellite of the earth. The moon itself does not have its own light. However, it looks bright as the rays of the sun fall on its surface and are reflected. The brightness of the moon depends on the sun light that falls on the surface of the moon and is reflected to the earth. In new moon, no reflected sun light reaches to the earth, whereas in full moon, the highest amount of the reflected sun light reaches to the earth.

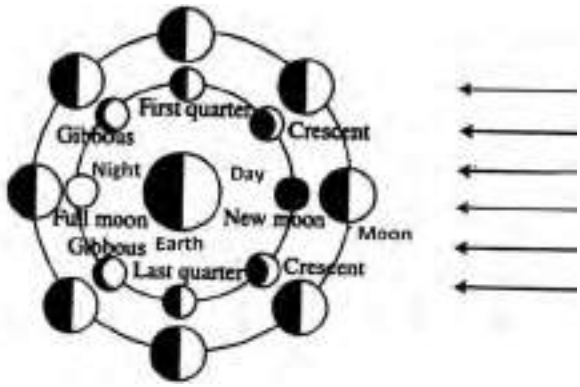


Figure no. 24.4: Phases of the moon

When the moon is revolving the earth, the different shapes of the brighter

parts of the moon are seen from the earth, which are called **phases of the moon.** There are some causes behind different phases of the moon. They are the revolution of the moon to the earth on its own orbit, reflecting the sun light that falls on its surface, the moon being an opaque body and the movement of the light in the straight line.

Do you know?
It is said that the whole part of the moon is seen on the full moon day, however, only the 50% of the moon is seen in that day. The reason is, the remaining 50 % part is covered by its own shadow.

When the moon comes in between the earth and the sun in the process of revolving the earth, the half of the brighter part of the moon does not face towards the earth. This time is known as new moon or no moon. After each day of the new moon, the moon forms an angle of 12^o. An observer from the earth can see a small portion of the moon, which is known as **waxing crescent.** The moon and the sun remain in 90^o in the first quarter. Therefore, the observer can see the half part of the moon in the southern part of the sky after the sun sets. Gradually, the brighter part of the moon keeps on increasing and it crosses the angular distance of around 168^o. During this time, only a very small part of the moon remains dark, which is known as **waxing gibbous.** During the full moon stage, the moon crosses an angular distance of 180^o. Therefore, an observer can see the half bright part of the moon in the east as soon as the sun sets. After the full moon, when the moon crosses a distance of around 192^o, only a small part of the moon remains dark, which is known as **waning gibbous.** After that, the black part of the moon keeps increasing and the observer can see a quarter of the moon in the eastern sky at the mid night in the last quarter. During this time, the moon crosses an angular distance of 270^o. When the moon crosses an angular distance of 348^o, only a small portion of the moon looks brighter, this is known as **waning crescent.** Gradually, the brighter part of the moon keeps on decreasing and the moon remains invisible from the earth. During this time, the moon completes an angular distance of 360^0, this stage is known as **new moon or no moon.**

Bright half

The period in between new moon to full moon is known as **bright half.** During this time, the brightness of the moon keeps on increasing. It lasts for 15 days.

Dark half

The period in between full moon to new moon is known as **dark half.** During this time, the brightness of the moon gradually keeps on decreasing. It also lasts for 15 days.

Position of the sun, earth and moon

The sun is a medium sized star in the universe. It is also the nearest star to the earth. It is a burning ball of gases. It contains more than 70% hydrogen. It emits a lot of energy in the form of heat and light. It revolves around a galactic center as well as also rotates on its own axis.

All eight planets including the earth rotate the sun. The earth has a suitable environment for living beings to survive. The earth also revolves around the sun in an elliptical orbit. While revolving, sometimes the earth goes far away and some other time, it remains closer to the sun.

The bodies that revolve the planets are called **satellites**. The satellites are both natural and artificial. The moon is the only one natural satellite which revolves the earth. In course of revolving the earth, it also revolves the sun.

Let's study the following table that presents the facts about the sun, the earth and the moon.

Base/ components	**Sun**	**Earth**	**Moon**
Mass	2.0×10^{30} kg	6.0×10^{24} kg	7.35×10^{22} kg
Average radius	695508 km	6371 km	1737 km
Average Temperature of the surface	5700°C	15°C	-125°C to 130°C
Escape velocity	617 km/s	11.2 km/s	2.38 km/s
Duration of rotation	300000000 days	24 hrs	27 days
Atmospheric gases	H_2, He	N_2, O_2, CO_2, Ar	Ar, He, Na, K, H_2, Rn

Umbra and Penumbra

In a sunny day in your break time, stand in the ground and try to observe your shadow. Now, think for a while, how is the shadow formed.

When an opaque object is kept on the way of light, the light cannot pass through it. As a result, the rays of the sun do not reach to the screen. In this situation, a black mark is formed on the screen, which is called **shadow**. Umbra and penumbra are two types of shadows. We mainly need three situations for a shadow to be formed. They are source of light, an opaque object and curtain.

The totally dark shadow is called **umbra**, where the rays of sun do not reach completely, whereas the partially dark shadow is called **penumbra**. The rays of the sun are partially reached in it.

Activity

a. Keep a piece of cardboard in one end of a table and keep a ball at the centre.

b. Now, light a torch light on the cardboard from the other end of the table.

c. You will then see totally dark shadow and partially dark shadow formed on the cardboard.

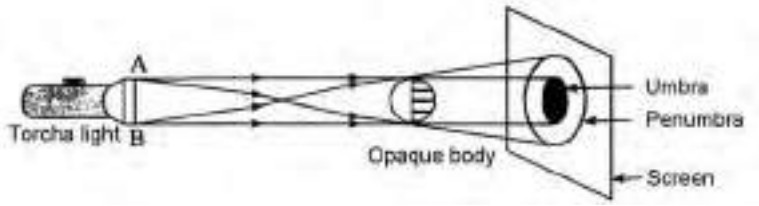


Figure no. 24. 5: Umbra and Penumbra

Eclipse

When the rays of light coming from their source fall on an opaque body, it results a dark shadow. In the same way an eclipse occurs. The eclipse occurs as a result of the motion of the sun, the earth and the moon. As the sun, the moon and the earth lie on a straight line, either the shadow of the moon falls on the earth or vice- versa. This situation is called **eclipse**. We can observe both solar eclipse and lunar eclipse from the earth.

Causes of the eclipse

a. Light travels only on a straight line.

b. The moon revolves round the earth and the earth also revolves round the sun.

c. When the sun, the earth and the moon lie on a straight line.

Types of eclipse

a. Lunar eclipse b. Solar eclipse

Lunar eclipse

During the revolution of the earth round the sun and the revolution of the moon round the earth, sometimes, the earth comes in between the sun and the moon. As a result, these three heavenly bodies lie on a straight line. The earth blocks some part of the sun light to fall on the moon. In this situation, the shadow of the earth falls on the moon, which results **lunar eclipse**. Total lunar eclipse is formed when the totally dark shadow of the earth falls on the moon. On the other hand, partial lunar eclipse is formed when the partially dark shadow of the earth falls on the moon.

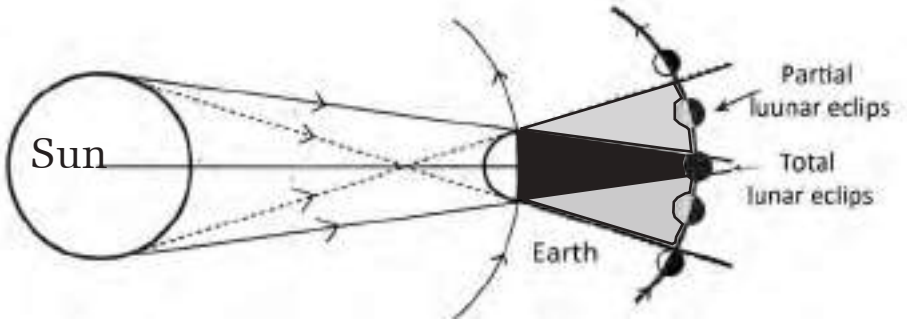


Figure no. 24.6: Lunar eclipse

Causes of lunar eclipse

a. Light travels only on a straight line
b. When the shadow of the earth falls on the surface of the moon
c. When the sun, the earth and the moon lie on a straight line
d. When the earth revolves around the sun on its own orbit and the moon revolves around the earth on its own orbit.

Types of lunar eclipse

Total lunar eclipse

Total lunar eclipse is the situation, in which the surface of the moon is completely covered by the dark shadow. In this period, the sun light cannot reach the moon.

Partial lunar eclipse

The moon remains partially dark in partial lunar eclipse. It lasts for long time. The moon and the earth revolve in the same direction on their own orbits. It takes long time for the moon to pass through the big shadow that falls on the moon as the earth is bigger than the moon. The longest lunar eclipse recorded so far is 1 hour 40 minutes. The moon turns slightly red during the lunar eclipse. This is because of refraction of some sun light from the earth's atmosphere. The lunar eclipse starts from the eastern part of the moon and ends in the west. This happens as the moon revolves from the west to the east.

Solar eclipse

When the moon lies in between the sun and the earth on a straight line, the moon blocks the sun light, resulting **solar eclipse**. When the moon revolves from west to the east, it blocks the western part of the sun and keeps moving towards the east from the west. If an observer observes from

the umbra, he/she can see the total solar eclipse, whereas if the observer observes from penumbra, he/she can see the partial solar eclipse.

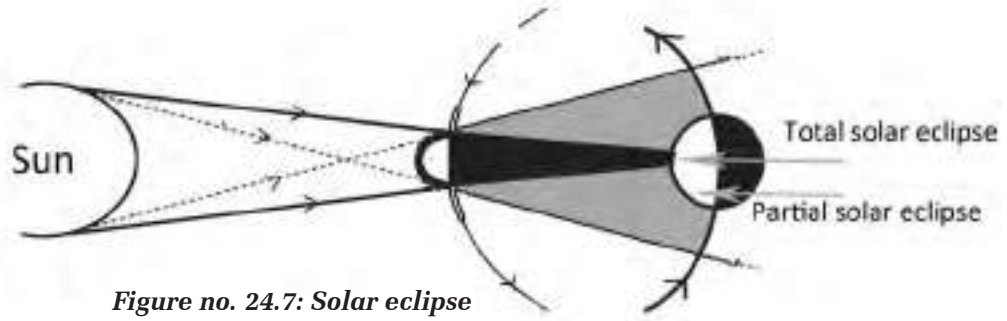


Figure no. 24.7: Solar eclipse

Causes of the solar eclipse

a. Light travels only on a straight line
b. When the shadow of the moon falls on the surface of the earth
c. When the sun, the earth and the moon lie on a straight line
d. When the earth revolves around the sun and the moon revolves around the earth on their own orbits respectively.

Types of solar eclipse

There are three types solar eclipse. They are:

Total solar eclipse

The sun is observed to be fully dark in the total solar eclipse. It takes place once in 360 years in any part of the earth. It is recorded to have 8 minutes long solar eclipse so far.

Partial solar eclipse

The sun is observed to be partially dark in the partial solar eclipse. It can be observed from the part of the earth, where there is partial dark shadow of the moon.

Annular eclipse

The upper end of the umbra of the moon cannot reach the earth because of the increasing distance of the earth and the moon. Thus, the shadow formed on the earth surface covers the middle part of the sun only. Now, the sun is appeared as a ring like structure called annular eclipse. This is because the moon cannot cover whole part of the sun as the moon is small. It results annular ring around the moon. It is called annular eclipse. This takes place once in 1000 year in any part of the earth.

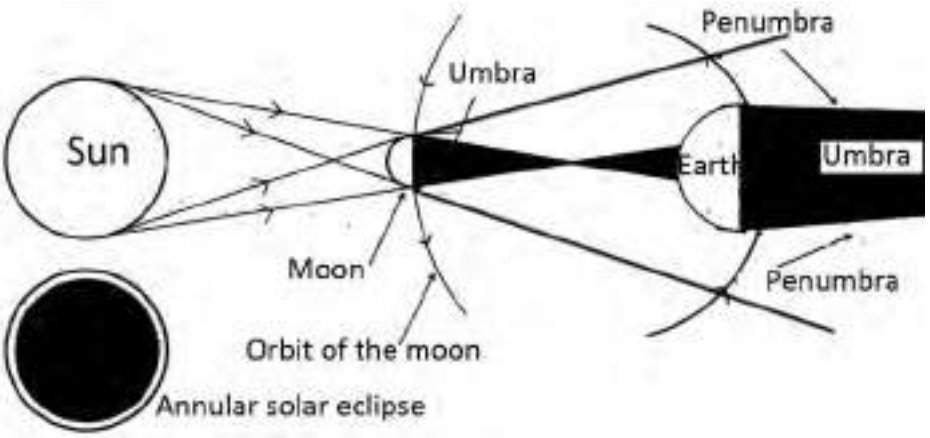


Figure no. 24.8 Annular eclipse

Eclipse does not occur in every new moon and full moon, why?

Eclipse takes place when the sun, the moon and the earth lie on a same straight line. However, the orbits of the earth and the moon do not occur in the same straight line in every new moon and full moon. An angle of 5.15° is formed between the orbital plane of the moon and the orbital plane of the earth. Therefore, the eclipse is not possible. The orbital planes of the moon and the earth intersect in two places, which are called **nodes**. These nodes are called **rahu** and **ketu**. The sun, the moon and the earth should be in the nodes for eclipse to occur, which is not possible in every full moon and new moon. Therefore, eclipse does not occur in every new moon and full moon.

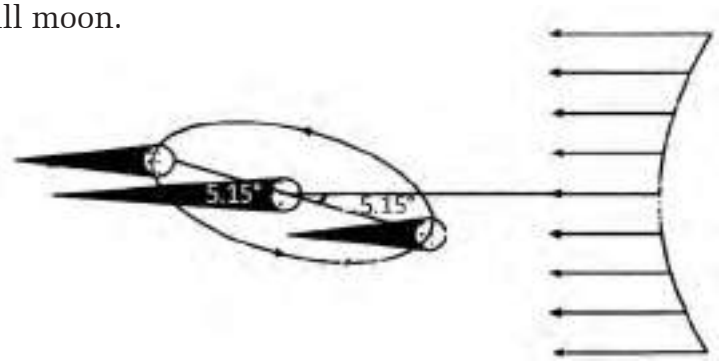


Figure no. 24.9:Eclipse does not occur in every new moon and full moon, why?

Points to remember

1. The family that consists of sun, eight planets and their satellites, meteorites, comets, etc. is known as solar system.
2. Our solar system is situated in the Milky Way galaxy.
3. The earth revolves round the sun in an elliptical orbit, which is known as an orbital motion or revolution

4. The earth rotates itself on its own axis, which is called the rotation of the earth.
5. Change in seasons, the variation in the duration of days and nights and occurrence of leap year are the effects of annual motion of the earth.
6. The causes of eclipse are light travelling on a straight line, occurrence of shadow of one heavenly body into another, revolution of the heavenly bodies on their own orbits, laying the heavenly bodies on the same straight line.
7. While observing at the surface of the moon from the earth, different shapes of the brighter parts of the moon are seen, which are called phases of the moon.
8. When the sun, the earth and the moon lie on the same straight line, the earth blocks the sun light. As a result, the shadow of the earth falls on the moon, which is called lunar eclipse.
9. When the sun, the moon and the earth lie on the same straight line, the moon blocks the sun light. As a result, the shadow of the moon falls on the earth, which is called solar eclipse.

Exercise

(A) Tick (✓) the correct alternatives.

1. What is the distance between the earth and the sun?
   (i) 1.5×10^8 km (ii) 1.5×10^7 km
   (iii) 1.5×10^6 km (iv) 1.5×10^9 km
2. What is the distance that light covers in a second?
   (i) 3.0×10^8 m (ii) 2.2×10^8 m
   (iii) 3.0×10^6 m (iv) 2.2×10^6 m
3. What is the temperature at the surface of the sun?
   i) 5400^oC ii) 5700^oC iii) 5000^oC iv) 7000^oC
4. The time that the earth takes to rotate on its own axis is called…
   (i) Solar day (ii) Sidereal month
   (iii) Phases of the moon (iv) Synodic month
5. How long does the sidereal month last?
   (i) 29 days (ii) 28 days (iii) 27 days (iv) 26 days
6. What type of eclipse does occur in a place where there is totally dark shadow?
   (i) Total eclipse (ii) Partial eclipse
   (iii) The first two (iv) None of the above

(B) Answer the following questions.

1. What is solar system? Explain.
2. Where is the location of the sun in the Milky Way galaxy?
3. What are the masses of the sun, the earth and the moon?
4. Write the dates, on which the days and nights are equal on all parts of the earth.
5. What are the phases of the moon? Also, explain its causes.
6. Why is there a difference of around 2 days and 5 hours between synodic month and sidereal month?
7. What is lunar eclipse? Why is lunar eclipse longer than solar eclipse?
8. Why does an eclipse not occur in every new moon and full moon? Explain the reasons.
9. How does lunar eclipse occur? Explain its causes and draw the figure.
10. How does solar eclipse occur? Explain its causes and draw the figure.
11. What would be the effects on solar and lunar eclipse, if the moon and the earth have the same orbital plane?

Project work

1. Demonstrate the process of the formation of umbra and penumbra using candle, matches and cardboard. And, also draw the figure.
2. Ask with your parents, guardians or seniors about the solar and lunar eclipse that took place after 2060 B.S. and in what time interval will these occur in upcoming two years? Find out and discuss in class.

Glossary

Asteroids = the small planet-like objects that are found between Mars and Jupiter

Heavenly bodies = the bodies present in the space

Parsec = the unit used to measure the distance between heavenly bodies

Leap year = a year of 366 days, which occurs once in every four years

Equinoxes = the day when day and night are equal

Summer solastice = the shortest night and the longest day