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Untouchability is Inhuman and a Crime

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PREFACE

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

HOW TO USE THE BOOK

- This Science text book for the third term has 9 units.
- Each unit has simple activities that can be demonstrated by the teacher and also few group activities for the students to do under the guidance of the teacher.
- Infographics and info-bits are added to enrich the learner's scientific perception.
- The "Do you know?" and "More to know" placed in the units will be an eye opener.
- Glossary has been introduced to learn scientific terms.
- ICT corner and QR code are introduced in each unit for the digital native generation.

How to get connected to QR Code?

- Download DIKSHA app from the Google Play Store.
- Tap the QR code icon to scan QR codes in the textbook.
- Point the device and focus on the QR code.
- On successful scan, content linked to the QR code gets listed.
- Note: For ICT corner, Digi Links QR codes use any other QR scanner.

QR GUIDE

UNIT 1

SOUND

H9J9R5

Learning Objectives

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

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

Introduction

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

1.1 Production of Sound

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

Activity 1

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

Figure 1.1 Vibration in a stretched rubber band

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

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

Activity 2

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

Figure 1.2 Vibration produced in metals

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

Activity 3

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

Figure 1.3 Vibrating plate produces waves in water

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

1.2 Propagation of Sound

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

Activity 4

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

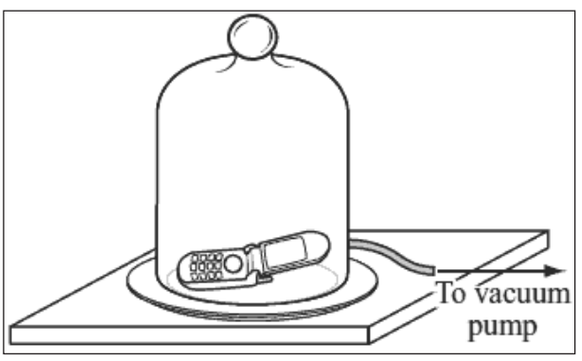

Figure 1.4 Bell jar

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

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

Activity 5

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

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

More to know

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

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

Problem 1

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

Solution

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

$v = n\lambda$

$v = 50 \times 10$

$v = 500$ ms^{-1}

Problem 2

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

Solution

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

$v = n\lambda$

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

The speed of sound depends on the properties of the medium through which it travels, like temperature, pressure and humidity. In any medium, as the temperature increases the speed of sound also increases. For example, the speed of sound in air is 331 ms^{-1} at 0°C and 344 ms^{-1} at 22°C. The speed of sound at a particular temperature in various media are listed in Table 1.1.

Table 1.1 Speed of sound in different media at 25°C

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

More to know

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

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

In order to understand this let us consider a vibrating tuning fork. When a vibrating tuning fork moves forward, it pushes and compresses the air in front of it, creating a region of high pressure. This region is called a compression (C), as shown in Figure 1.5. When it moves backward, it creates a region of low pressure called rarefaction (R). These compressions and rarefactions produce the sound wave, which propagates through the medium.

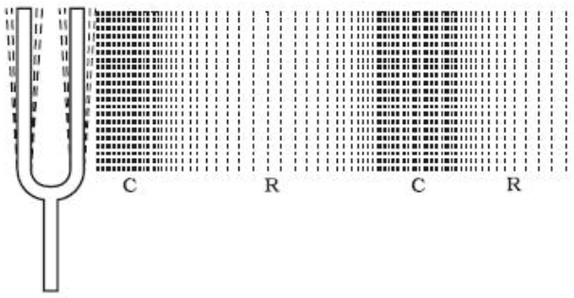

Figure 1.5 Vibrating tuning fork

1.3 Sound Waves

Activity 6

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

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

1.3.1 Characteristic of wave motion

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

DO YOU KNOW?

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

1.3.2 Types of mechanical wave

There are two types of mechanical wave. They are

1. Transverse wave
2. Longitudinal wave

Transverse wave

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

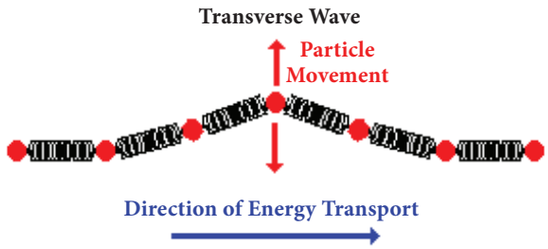

Figure 1.6 Transverse wave

Longitudinal wave

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

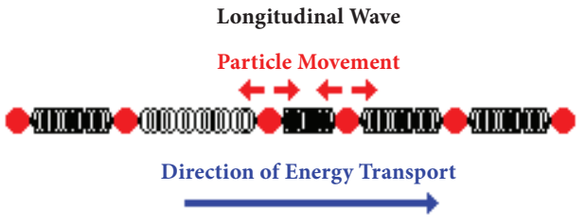

Figure 1.6 Longitudinal wave

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

1.4 Properties of Sound

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

1.4.1 Loudness

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

More to know

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

1.4.2 Pitch

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

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

1.4.3 Quality or Timbre

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

1.4.4 Audibility and Range

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

- Audible sound
- Infrasonic sound
- Ultrasonic sound

Audible sound

Sound with frequency ranging from 20 Hz to 20000 Hz is called sonic sound or audible sound. These sounds can be heard by the human beings only. Human ears cannot hear sounds with frequencies below 20 Hz or above 20000 Hz. So, the above range is called as audible range of sound.

Infrasonic sound

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

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

Ultrasonic sound

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

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

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

1.5 Musical Instruments

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

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

Wind instruments

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

Reed instruments

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

Stringed instruments

Stringed instruments make use of a string or wire to produce vibrations and hence the

Figure 1.8 Musical instruments

specific sound. These instruments also have hollow boxes that amplify the sound that is produced. The frequency of sound is varied by varying the length of the vibrating wire. Violin, Guitar, Sitar are some of the examples of stringed instruments.

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

1.5.4 Percussion instruments

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

1.6 Sound produced by Humans

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

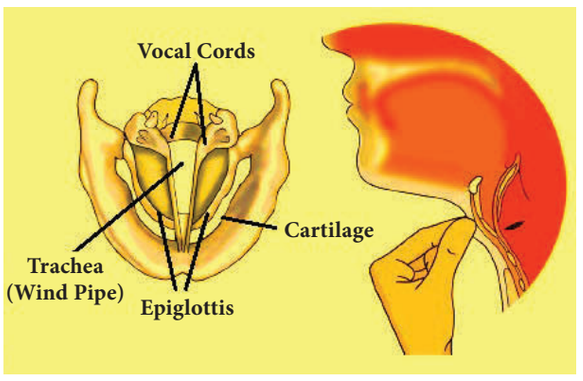

Figure 1.9 Structure of Larynx

generally have thicker and longer vocal cords that produce a deeper, low pitch sound in comparison with females.

1.7 MECHANISM OF HUMAN EAR

The ear is the important organ for all animals to hear a sound. We are able to hear sound through our ears. The human ear picks up and interprets high frequency vibrations of air. Ears of aquatic animals are designed to pick up high frequency vibrations in water. The outer and visible part of the human ear is called pinna (curved in shape). It is specially designed to gather sound from the environment, which then reaches the ear drum (tympanic membrane) through the ear canal. When the sound wave strikes the drum, the ossicles move inward and outward to create the vibrations. These vibrations are then picked up by special types of cells in the inner ear. From the inner ear the vibrations are sent to the brain in the form of signals. The brain perceives these signals as sounds.

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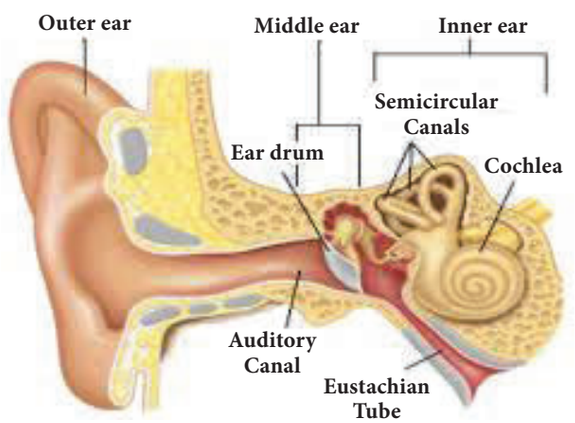


Figure 1.10 Human Ear

1.8 Noise Pollution

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

1.8.1 Health hazards due to noise pollution

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

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

1.8.2 Controlling noise pollution

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

- Strict guidelines should be set for the use of loudspeakers on social, religious and political occasions.

- All automobiles should have effective silencers.
- People should be encouraged to refrain from excessive honking while driving.
- Industrial machines and home appliances should be properly maintained.
- All communication systems must be operated in low volumes.
- Residential areas should be free from heavy vehicles.
- Green corridor belt should be set up around the industries as per the regulations of the pollution control board.
- People working in noisy factories should wear ear plugs.
- People should be encouraged to plant trees and use absorbing materials like curtains and cushions in their home.

1.8.3 Hearing Loss

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

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

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

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

Points to Remember

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

A-Z GLOSSARY

Amplitude	The measure of a sound wave.
Echo	Reflection of sound.
Pitch	How high or low a sound is. It is determined by the frequency of the vibration.

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

B5C5Y8

TEXT BOOK EXERCISES

I. Choose the best answer.

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

II. Fill in the blanks.

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

III. Match the following.

1.	Ultrasonics	-	Frequency below 20Hz
2.	Speed of sound in air	-	Needs material medium
3.	Infrasonics	-	330m
4.	Sound propagation	-	Frequency more than 20000 Hz

IV. Choose the correct option.

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

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

C. Assertion is true but reason is false.

D. Assertion is false but reason is true.

E. Both Assertion and reason are false.

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

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

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

   Reason: There is no atmosphere on moon.

V. Answer briefly.

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

VI. Answer in detail.

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

VII. Problems.

1. Ruthvik and Ruha hear a gunshot 2 second after it is fired. How far away from the gun they are standing? (Speed of sound in air is equal to $330 ms^{-1}$)
2. A sound wave travels 2000 m in 8 s. What is the velocity of the sound?
3. What is the frequency of a mechanical wave that has a velocity of 25 ms^{-1} and a wavelength of 12.5 m ?
4. A wave with a frequency of 500 Hz is traveling at a speed of 200 ms^{-1}. What is the wavelength?

REFERENCE BOOKS

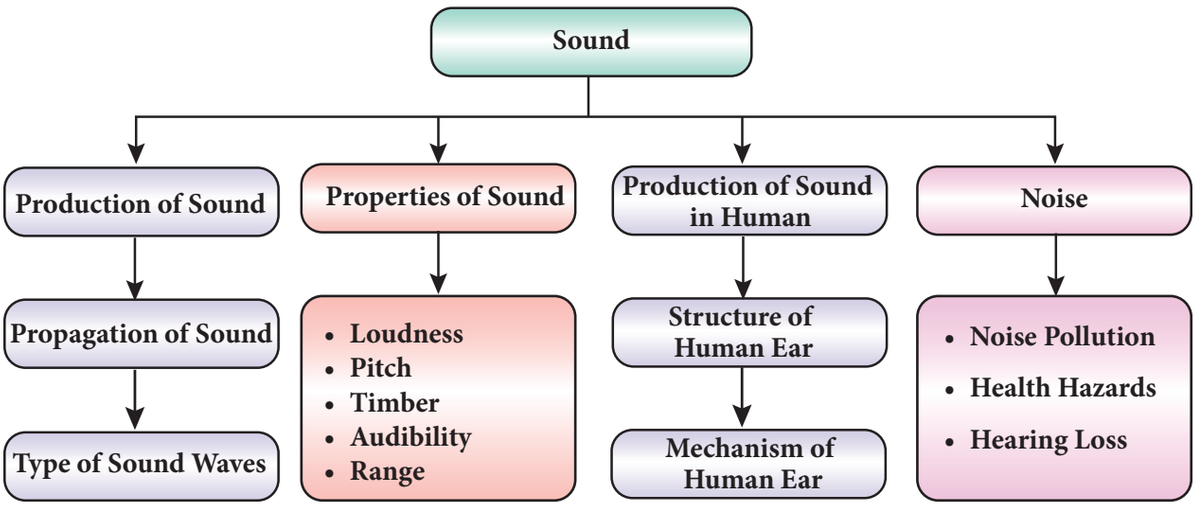
1. The everyday physics of hearing and vision by Bejamin de Mayo
2. Vibration and Waves by Anthony French

INTERNET RESOURCES

www.pbslearningmedia.org

www.scholastic.com

Concept Map



ICT CORNER

Sound

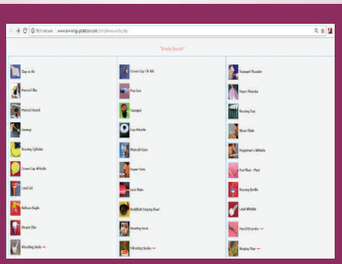
Make simple science toys from trash and enjoy the sounds so produced.

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

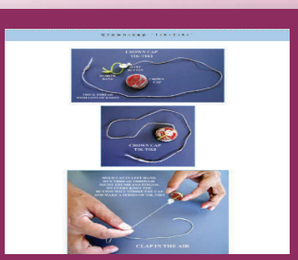
Step 2 Toys from Trash page will open. Simple science toys will appear under the heading 'Simple Sounds'.

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

Step 1



Step 2



Step 3

Web URL:

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

*Pictures are indicatives only.

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

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UNIT 2

MAGNETISM

H8V9A4

Learning Objectives

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

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

Introduction

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

2.1 Classification of Magnets

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

Natural Magnets

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

Figure 2.1 Natural magnet

DO YOU KNOW?

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

Artificial Magnets

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

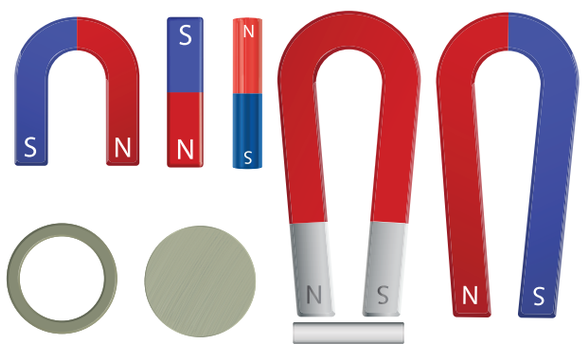


Figure 2.2 Artificial magnets

Table 2.1 Difference between natural and artificial magnets

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

Know Your Scientist

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

2.2 Magnetic Properties

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

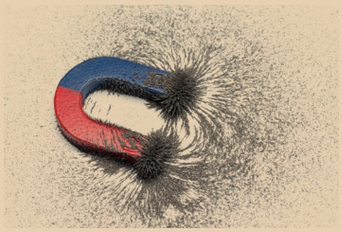
- Attractive property
- Reflective property
- Directive property

2.2.1 Attractive Property

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

Activity 1

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



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

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

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

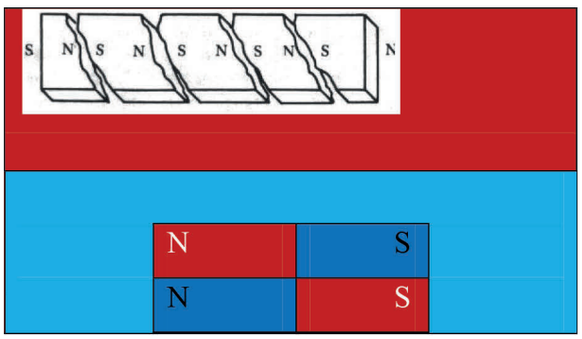
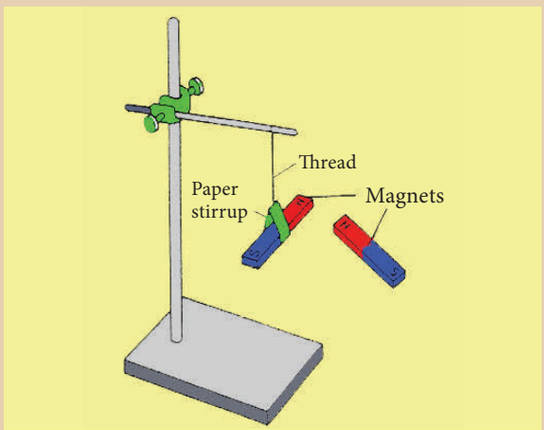


Figure 2.3 Magnetic poles exist in pair

2.2.2 Repulsive Property

Activity 2

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

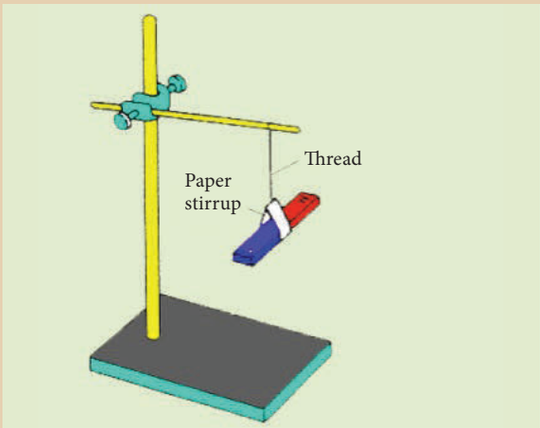


This activity explains another property of a magnet that like poles repel each other i.e., a north pole repels another north pole and a south pole repels another south pole. If you bring the south pole of the magnet close to the north pole of the suspended magnet you can see that the south pole of the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

2.2.3 Directive Property

Activity 3

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



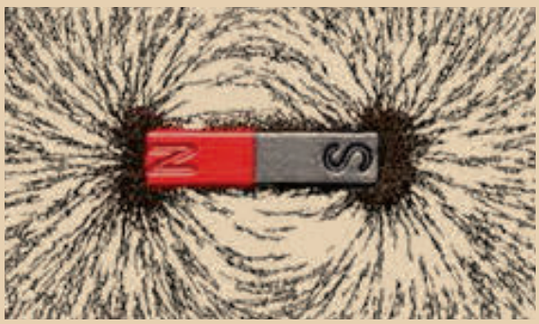
This experiment shows that a freely suspended bar magnet always aligns itself in the geographic north-south direction. The property of a magnet, by which it aligns itself along the geographic north-south direction, when it is freely suspended, is known as the directive property of a magnet. The north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

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

2.3 Magnetic Field

Activity 4

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



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

2.3.1 Tracing the magnetic field

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

The bar magnet is placed on the line at the centre of the paper with its north pole facing the geographic north. The outline of the bar magnet is drawn. The plotting compass is placed near the North Pole of the bar magnet and the end of the needle (north pole) is marked as A. Now the compass is moved to a new position, such that its south pole occupies the position previously occupied by its north pole. In this way it is proceded step by step till the compass is placed near the south pole of the magnet. Deflecting points are marked as B, C, D, E, F, G, H and I. A curved line is then drawn by joining the plotted points marked around the magnet. This represents the magnetic line of force. In the same way several magnetic lines of force are drawn around the magnet as shown in the Figure 2.4. These curved lines around the bar magnet represent the magnetic field of the magnet. The direction of the lines is shown by the arrows heads.

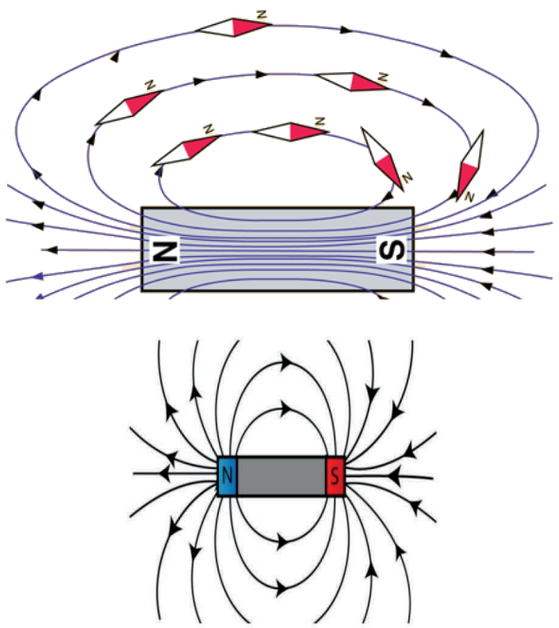


Figure 2.4 Magnetic Field

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

DO YOU KNOW?

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

2.4 Magnetic Materials

Activity 5

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

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

- Diamagnetic
- Paramagnetic
- Ferromagnetic

2.4.1 Diamagnetic materials

Diamagnetic materials have the following characteristics.

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

2.4.2 Paramagnetic materials

The following are the characteristics of paramagnetic materials.

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

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

2.4.3 Ferromagnetic materials

The characteristics of ferromagnetic materials are given below.

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

More to know

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

2.5 Artificial Magnets

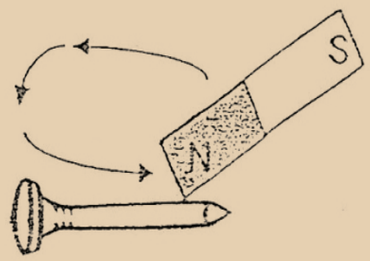
Artificial magnets are produced from magnetic materials. These are generally made by magnitising iron or steel alloys electrically. These magnets are also produced by stroking a magnetic material with magnetite or with other artificial magnets. Depending on their ability to retain their magnetic property,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

2.5.1 Temporary Magnets

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

Activity 6

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



DO YOU KNOW?

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

2.5.2 Permanent Magnets

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

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

DO YOU KNOW?

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

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

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

2.6 Earth's Magnetism

Z8W2M1

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

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

DO YOU KNOW?

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

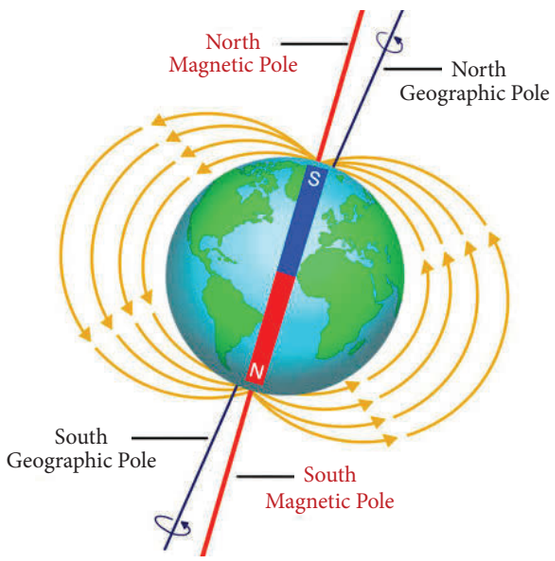


Figure 2.5 Earth as a magnet

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

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

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

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

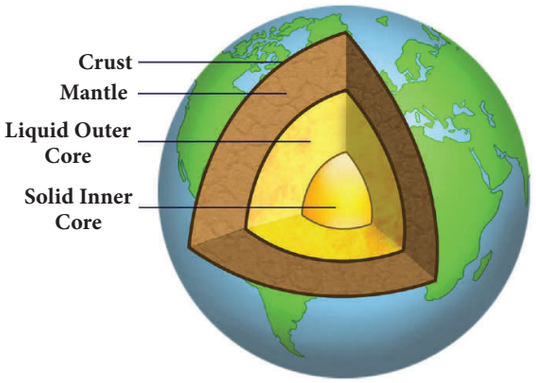


Figure 2.6 Core of the Earth

DO YOU KNOW?

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

2.6.1 Earth's Magnetic Field

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

DO YOU KNOW?

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

2.7 Uses of Magnets

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

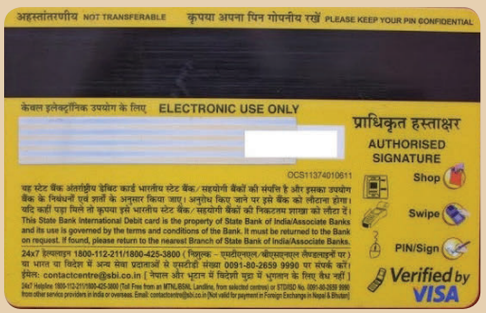
- In ancient times the magnet in the form of 'direction stone' helped seamen to find the directions during a voyage.
- Nowadays, magnets are used to generate electricity in dynamos.
- Magnets, especially electromagnets are used in our day to day life.
- They are used in electric bells and electric motors.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

DO YOU KNOW?

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

DO YOU KNOW?

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



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

Figure 2.7 MRI Scanning machine

Points to Remember

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

A-Z GLOSSARY

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

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

F6R6W2

TEXT BOOK EXERCISES

I. Choose the best answer.

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

II. Fill in the blanks.

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

III. Match the following.

1.	Magnetite	-	Magnetic lines
2.	A tiny pivoted magnet	-	Natural magnet
3.	Cobalt	-	Compass box
4.	Closed curves	-	Ferromagnetic material
5.	Bismuth	-	Diamagnetic material

IV. Choose the correct option.

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

B. If both assertion and reason are true, but the reason is not the correct explanation of the assertion.

C. If the assertion is true, but the reason is false.

D. If the assertion is false, but the reason is true.

1. **Assertion:** Iron filings are concentrated more at the magnetic poles.

   Reason: The magnets are so sharp.

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

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

V. Answer briefly.

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

VI. Answer in detail.

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

VII. Higher Order Thinking Questions.

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

REFERENCE BOOKS

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

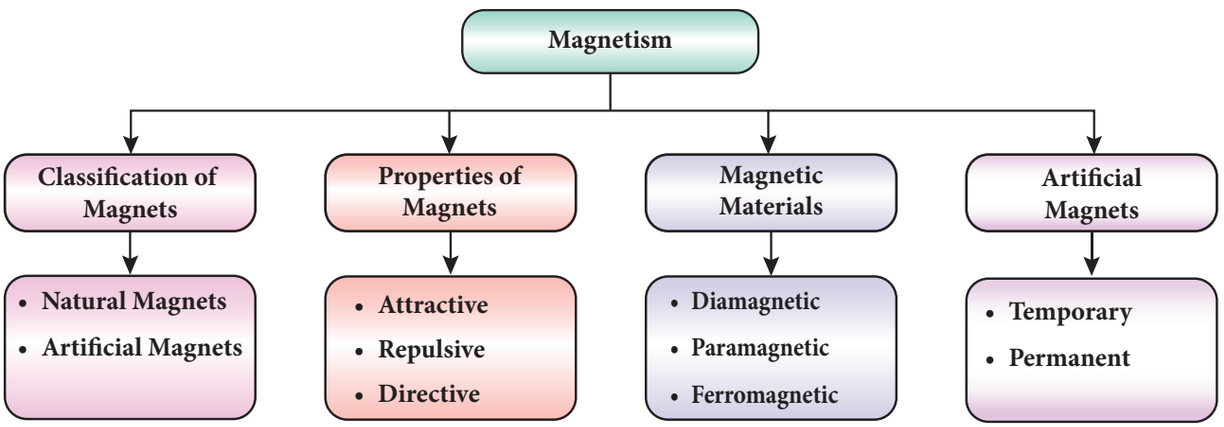
INTERNET RESOURCES

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

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

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

Concept Map



UNIT 3

UNIVERSE AND SPACE SCIENCE

Learning Objectives

F8U9A8

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

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

Introduction

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

3.1 Rockets

The universe is a great mystery to all of us. Our minds always try to know about the space around us. Understanding the space will be helpful to us in many ways. Space research provides information to understand the environment of the Earth and the changing climate and weather on Earth. Exploring the space will help us to answer many of the challenges we are facing these days

Discovery of rockets has opened a small portion of the universe to us. Rockets help us to launch space probes to explore the planets in the solar system. They also help us to launch space-based telescopes to explore the universe.

DO YOU KNOW?

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

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

3.1.1 Parts of Rockets

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

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

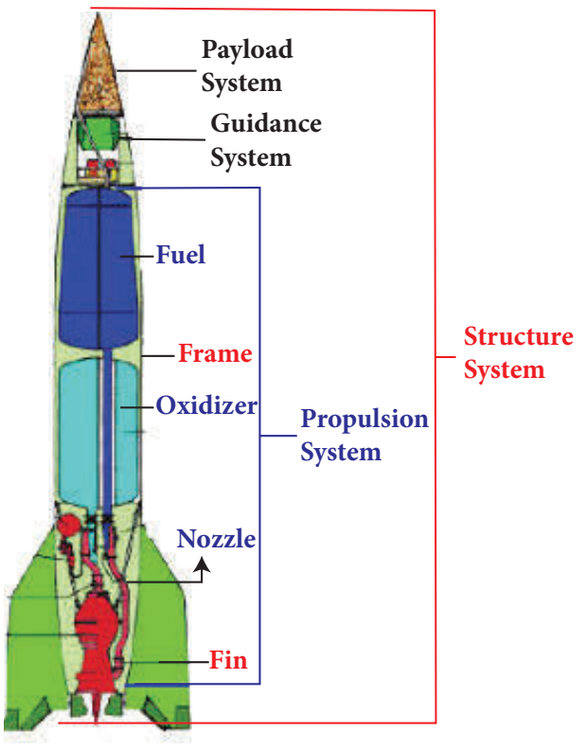


Figure 3.1 Parts of a Rocket

Structural system (Frame)

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

Payload system

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

Guidance system

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

Propulsion system

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

DO YOU KNOW?

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

Activity 1

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

3.1.2 Types of Propellants

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

a. Liquid propellants

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

Liquid Hydrogen

Fuming Nitric Acid

Figure 3.2 Liquid Propellants

b. Solid propellants

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

Polyurethanes

Poly butadienes

Figure 3.3 Solid propellants

c. Cryogenic propellants

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

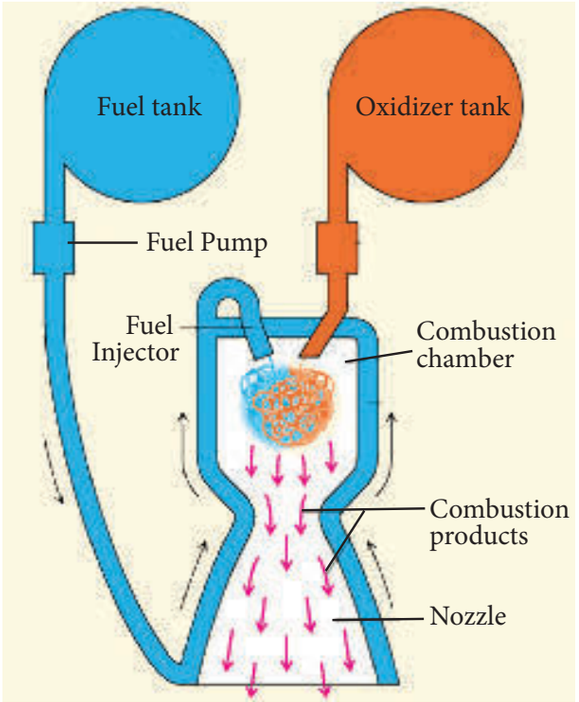


Figure 3.4 Cryogenic Fuels

3.1.3 Launching of Satellite

Activity 2

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

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

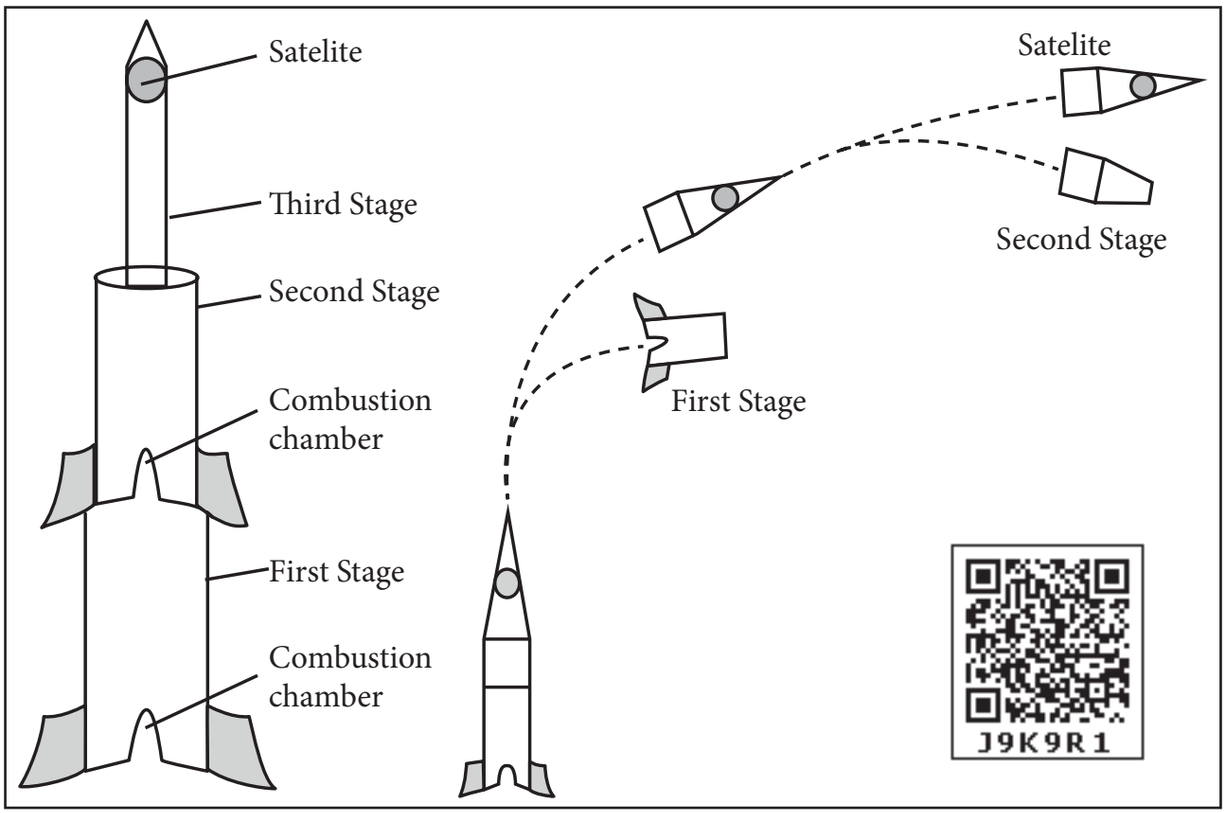


Figure 3.5 Launching of Rocket

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

3.2 India's Space Programmes

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

Activity 3

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

DO YOU KNOW?

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

3.2.1 Chandrayaan - 1

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

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

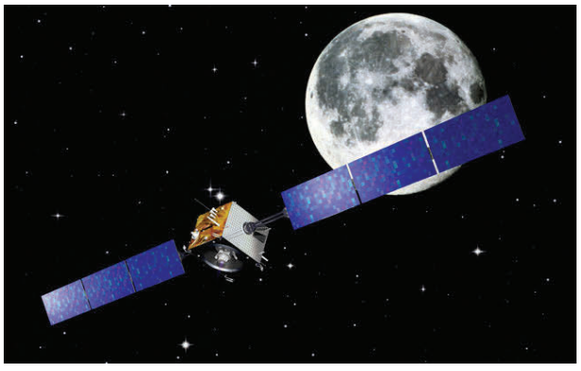


Figure 3.6 Chandrayaan - 1

a. Objectives of Chandrayaan-1

The following were the objectives of Chandrayaan – 1 mission.

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

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

b. Achievements of Chandrayaan-1

The following are the achievements of Chandrayaan-1 mission.

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

Know your Scientist

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

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

3.2.2 Mangalyaan (Mars vehicle)

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

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

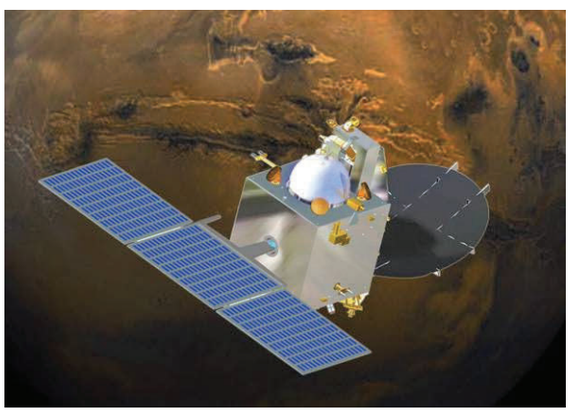
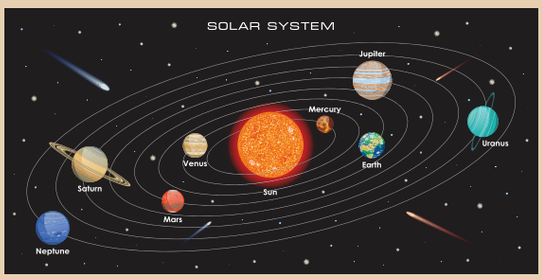


Figure 3.7 Mangalyaan

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

More to know

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



Activity 4

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

a. Objectives of Mangalyaan

The following are the objectives of Chandrayaan – 2 mission.

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

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

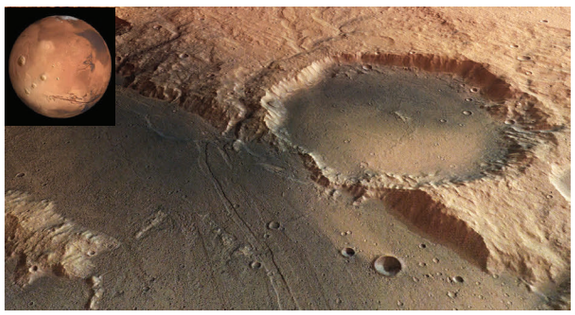


Figure 3.8 Images from Mars Orbiter Mission

DO YOU KNOW?

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

3.2.3 Chandrayaan - 2

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

Orbiter

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

Lander

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

Rover

It is a 6 wheeled robotic vehicle named as 'Pragyan' (Sanskrit word) that means wisdom. Chandrayaan-2 was successfully inserted into the lunar orbit on 20th August 2019. In the final stage of the mission, just 2.1 km above the lunar surface, Lander 'Vikram' lost its communication with the ground station on 7th September 2019. But the Orbiter continues its work successfully.

Figure 3.9 Vikram Lander

Know your Scientist

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

More to know

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

3.3 NASA (National Aeronautics and Space Administration)

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

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

3.3.1 Apollo Mission

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

Figure 3.10 Apollo Mission by NASA

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

3.3.2 NASA's work with ISRO

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

3.3.3 Work of Indians at NASA

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

Kalpana Chawla

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

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

Activity 5

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

Sunitha Williams

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

Points to Remember

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

GLOSSARY

Universe	All existing matter and space.
Galaxy	System of millions of stars.
Mineralogy	Scientific study of minerals.
Geological	Study of earth's physical structure and substance.

Space probe	Vehicle sent into space to study the planets.
Propellant	Fuel or explosive substance.
Cryogenic	Study of very low temperature.
Payload	Satellites kept in the launching rockets.

I8S4L5

TEXT BOOK EXERCISES

I. Choose the best answer.

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

II. Fill in the blanks.

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

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

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

IV. Match the following.

1.	Chandrayaan	-	Fuel
2.	Mangalyaan	-	Moon
3.	Cryogenic	-	First manned mission to the moon
4.	Apple - 8	-	First man landing mission to the moon
5.	Apollo - 11	-	Mars

V. Answer briefly.

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

VI. Answer in detail.

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

VII. Higher Order Thinking Questions.

1. Why we are always seeing one side of the Moon?

REFERENCE BOOKS

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

INTERNET RESOURCES

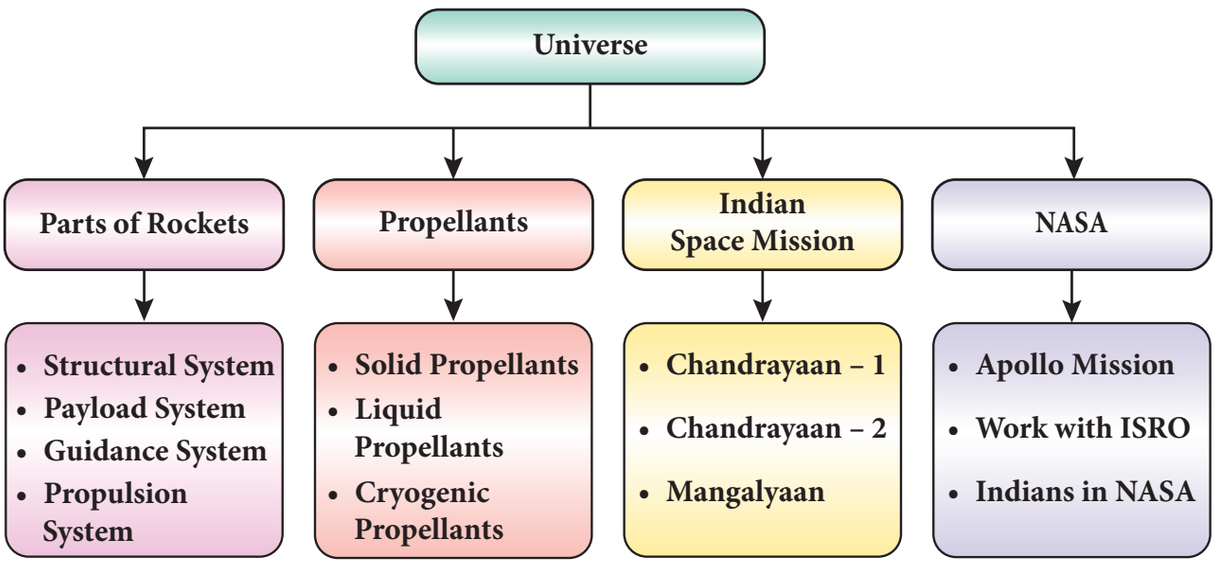
https://www.isro.gov.in/Spacecraft/chandrayaan-1

https://www.isro.gov.in/chandrayaan2-home-0

https://www.isro.gov.in/pslv-c25-mars-orbiter-mission

https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-was-apollo-program-58.html

Concept Map



UNIT 4

WATER

Learning Objectives

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

- understand the importance, properties and uses of water.
- write the chemical equations for the reaction of water.
- explain water treatment methods.
- discuss about the different methods of softening water.
- know about the causes and consequences of water pollution.
- list out the ways by which water pollution may be controlled.

Introduction

நீர்இன்று அமையாது உலகெனின் யார்யார்க்கும்
வான்இன்று அமையாது ஒழுக்கு – குறள்

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

4.1 Composition

Three fourths of our planet earth is filled with water. Water exists in three states namely solid, liquid and gas. Water on the surface of the earth is found mainly in oceans (97.25%), polar ice caps and glaciers (2.05%) and the remaining is in lakes, rivers and aquifers - ground water. Even our body is made up of 65% of water but it is not apparent. Water is a chemically stable compound. Its chemical name is dihydrogen monoxide (H_2O). It can be broken up into hydrogen (H_2) and oxygen (O_2) when an electrical current is passed through it. The process of breaking down of water molecules by the passage of electric current is known as electrolysis of water.

4.1.1 Electrolysis of Water

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

The electrodes are connected to a battery and current is passed until the test tubes are

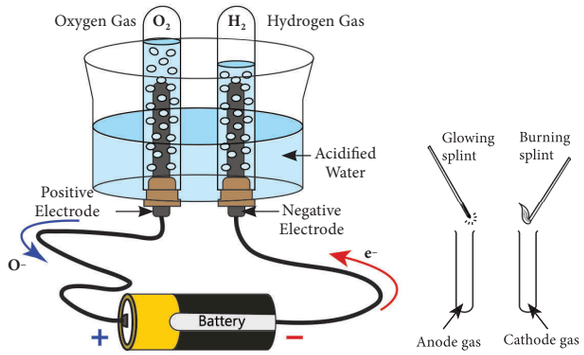


Figure 4.1 Electrolysis of Water

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

$$2H_2O \xrightarrow{\text{Electrolysis}} 2H_2 + O_2$$

Activity 1

Take some anhydrous copper (II) sulphate powder and place it in a watch glass. Add water drop by drop to the anhydrous copper (II) sulphate. Do you notice any colour change in the powder? You can notice the powder turning blue. It is a test for water.

Anhydrous copper (II) sulphate

4.1.2 Preparation of Water

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

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

$$2H_2 + O_2 \longrightarrow 2H_2O$$

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

$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \longrightarrow \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{\mathbf{6H_2O}} + \text{Energy}$$

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

Laboratory preparation of water

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

By burning of hydrogen

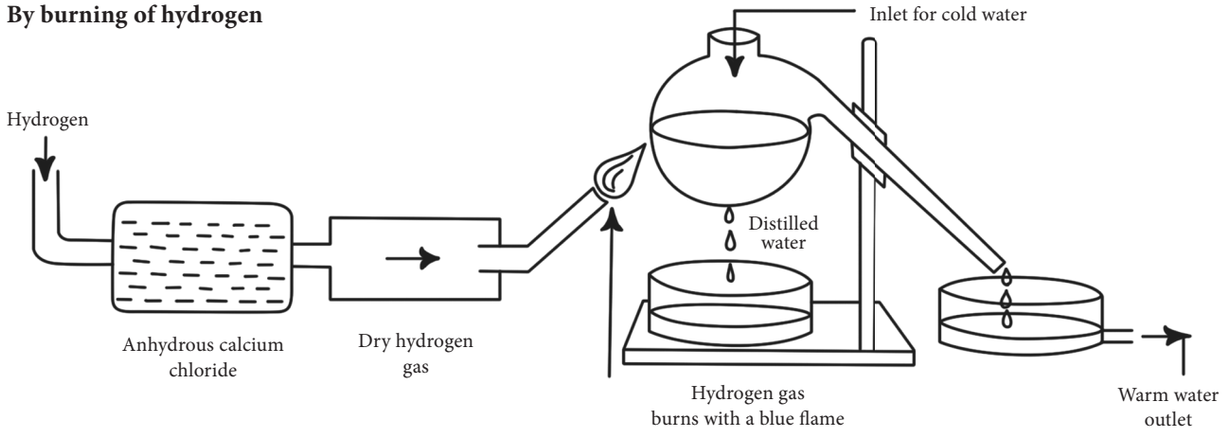


Figure 4.2 Preparation of Water

4.2 Properties of Water

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

4.2.1 Physical properties

a. Nature

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

b. Boiling point

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

DO YOU KNOW?

Pure water has the following physical properties.

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

c. Freezing point

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

DO YOU KNOW?

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

d. Density

When ice cubes are put in a glass of water at room temperature, they float on the surface of the water. This is because ice

is lighter than water. It means that the density of ice is lower than that of water.When the winter temperature is below 0°C, the water in the lake will start freezing. The frozen ice will float at the top and cover the lake. Since ice is a bad conductor of heat it does not allow heat to pass through it. So, the water below the ice remains in liquid form, where most of the aquatic life lives. This enables the aquatic animals and plants to survive even in extreme cold conditions. Density of water at different temperature is given in Table 4.1.

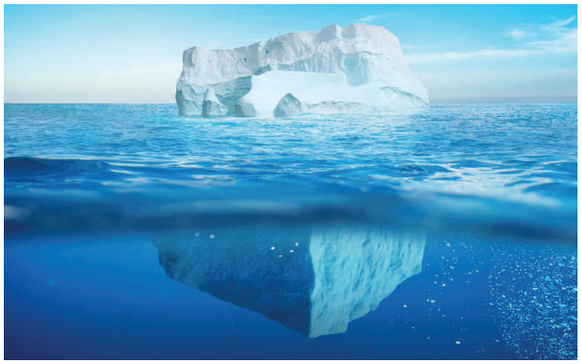


Figure 4.3 Ice floating on water

Table 4.1 Density of water at different temperature

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

e. Anomalous expansion of water

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

f. Latent heat of fusion of ice

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

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

g. Latent heat of vaporization of water

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

h. Specific heat capacity

The amount of heat that is needed to raise the temperature of a unit mass of a substance by 1°C is called specific heat capacity of that substance.

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

Figure 4.4 Water as coolant in car engines

4.2.2 Chemical properties

a. Action towards litmus paper

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

b. Stability

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

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

c. Catalytic nature

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

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

d. Reaction with metals

Water reacts with some metals. Metals such as sodium, potassium and calcium react vigorously with water at room temperature.

Sodium reacts with water to form hydrogen gas and sodium hydroxide solution. Due to the heat evolved in this reaction the hydrogen (gas) catches fire and burns.

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

Activity 2

Fill a trough with water. Cut a small piece of sodium with a knife and drop it in the water. Sodium reacts with water and darts across the surface of water. A flame produced is also seen near the surface.

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

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

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

DO YOU KNOW?

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

e. Reaction with non-metals

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

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

Chlorine gas dissolves in water and produces hydrochloric acid.

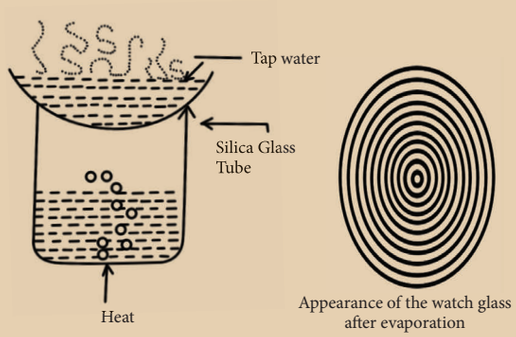
$$2Cl_2 + 2H_2O \xrightarrow{\text{Sunlight}} 4HCl + O_2$$

4.3 Water - A Universal Solvent

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

Activity 3

Place a sample of tap water on a clean watch glass and place it over a beaker containing water, as shown in the figure. Boil the water in the beaker. When all the water has evaporated from the watch glass, remove it from the burner and let it cool. What do you see on the watch glass?



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

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

DO YOU KNOW?

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

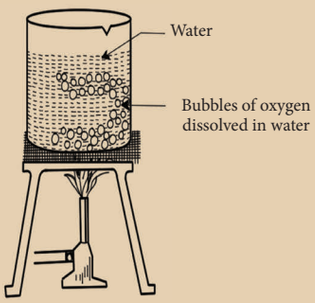
Apart from solids and minerals, air is also dissolved in water. Air is present in dissolved state in all natural sources of water. The solubility of oxygen in water is higher than the solubility of nitrogen. Air dissolved in water contains approximately 35.6% oxygen along with nitrogen and carbon dioxide.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

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

Figure 4.5 Aquatic organisms

Activity 4

Take a beaker and fill it half with fresh tap water and heat it. You will see small bubbles appearing on the side of the beaker long before the water reaches its boiling point. These bubbles are oxygen gas dissolved in water.



4.4 Potable Water

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

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

DO YOU KNOW?

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

4.4.1 Characteristics of Potable Water

The following are the characteristics of potable water.

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

Activity 5

Take two pots with similar plants. Water one of the plants with tap water and the other with sea water. Record your findings and note the difference observed.

4.4.2 Purification of Water

Out of the total fresh water available on the earth, only 1% is present in water bodies such as rivers and lakes and the rest is frozen in glaciers and polar-regions.

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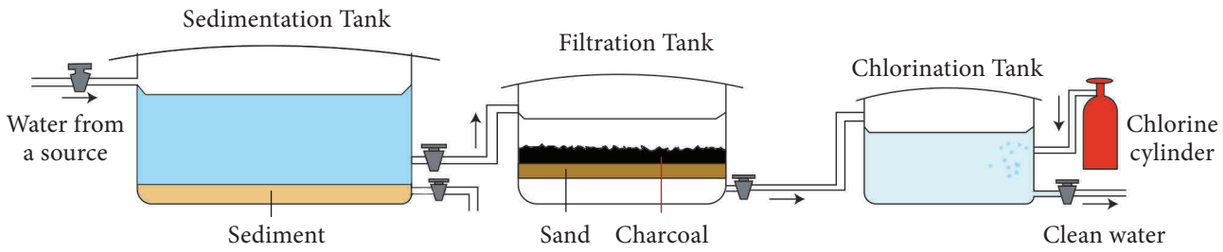


Figure 4.6 Water treatment stages

Water from these water bodies is unfit for drinking, cooking, washing or bathing because it contains suspended and dissolved impurities. It also contains micro-organisms such as bacteria. If this water is consumed without purifying, it can cause water-borne diseases such as typhoid and cholera. Therefore, before water reaches our homes, it is treated and purified to make it potable. In conventional water treatment plants (Figure 4.6), water is subjected to different processes for purification. These processes are discussed here.

DO YOU KNOW?

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

Sedimentation

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

Filtration

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

Sterilisation

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

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

DO YOU KNOW?

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

4.4.3 Hardness of Water

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

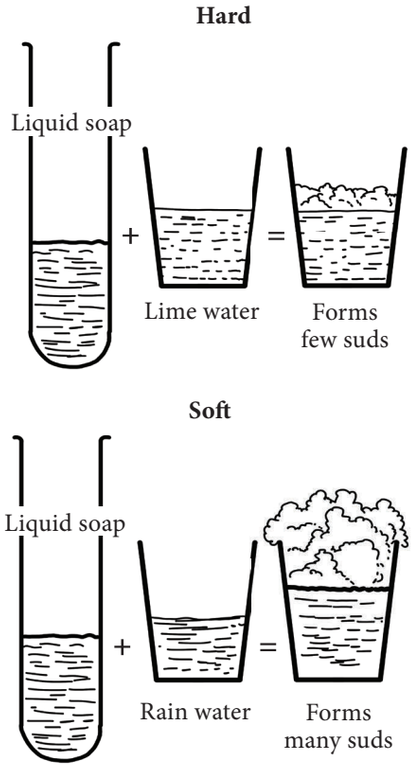


Figure 4.7 Hard water forming foam

it is called soft water. In this water, soaps or detergents form lather easily.

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

a. Disadvantages of Hard water

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

Figure 4.8 Scales on the machine pipes

Activity 6

Take samples of water from different sources (like a tube well, a lake, a pond or a river) and pour equal quantities of each sample of water into different test tubes. Measure the height of water in each test tube with a scale. Add one or two drops of liquid soap to each test tube.

Shake each test tube five times and observe the height of the lather in each sample. Record your observations in the table. Which water is soft? Which water is hard? Can you say why?

Samples of water (Source)	Height of lather
Tap water	
Well water	
Pond water	
River water	

b. Removal of hardness

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

Boiling

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

Adding washing soda

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

Ion – exchange

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

Distillation

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

DO YOU KNOW?

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

4.5 Water Pollution

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

Figure 4.9 Polluted water body

4.5.1 Water Resource in Tamil Nadu

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

DO YOU KNOW?

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

4.5.2 Sources of Water Pollution

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

man-made sources. Some of the sources of water pollution are explained below.

Household Detergents

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

Activity 7

Take a shampoo, shower gel or other product you think might have micro-beads in it. Mix two tablespoons of this in a glass of water and stir it well. Pour the water in a black t-shirt filtering the micro-beads out.

Domestic Sewage

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

DO YOU KNOW?

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

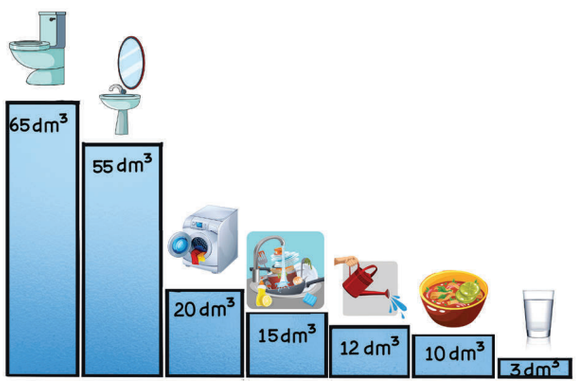


Figure 4.10 Domestic water consumption

Domestic waste and plastics

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

Figure 4.11 Plastics in domestic wastes

DO YOU KNOW?

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

Agricultural activities

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

Figure 4.12 Agricultural waste

Industrial waste

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

Figure 4.13 Waste water from industries

Oil spills

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

Figure 4.14 Oil spills

Thermal pollution

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

4.5.3 Common pollutants

Pollutants are generally classified as domestic pollutants, agricultural pollutants and industrial pollutants. The sources and effects of various water pollutants are shown below in Table 4.1.

Table 4.1 Types of Pollutants

Pollutants	Sources	Effects
Domestic		
Sodium sulphates and phosphates	Detergents	In humans they cause developmental, reproductive and neuro toxicity and endocrine disruption. Phosphates make bacteria and algae grow faster, and use up all the dissolved oxygen. This leads to a decrease in animal and plant diversity.
Plastic fibres and microbeads	Plastic clothing and hair, beauty and skin products	These end up in water bodies such as lakes, rivers and the ocean. Here they attract toxic chemicals. Marine animals often eat them as they confuse them as their natural source of food and the toxins can move up the food chain.
Agriculture		
DDT	Insecticides	If affects the central nervous system of insects, animals and humans. It accumulates in the food chain and impacts the top predators the most.
Nitrates and phosphates	Fertilisers	Bacteria and algae grow faster and they use up all the dissolved oxygen and this leads to a decrease in animal and plant diversity.
Industrial		
Lead, Mercury, Cadmium, Chromium and Arsenic	Chemical, textile and leather industries and leachate from open dumping of solid waste	Toxic to animals, plants and bacteria in the water. Pollutes potable ground water. Negatively impacts human health.

DO YOU KNOW?

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

4.6 Controlling Water Pollution

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

- Use detergents that are biodegradable and avoid those that contain toxic chemicals.
- Wear clothing that is made from natural fibres such as cotton and avoid wearing synthetic fibres such as nylon.
- Do not throw waste such as plastics into water bodies. Always separate your

waste into recyclable, non-recyclable and biodegradable so that it does not cause pollution.

- Domestic waste water should be treated properly, and all harmful substances should be removed from it, so it can be reused for flushing toilets and gardening.
- Use bio-pesticides (natural pest control) instead of chemical pest control.
- Use compost made from cow dung, garden waste and kitchen waste as a fertiliser.
- Water released from industries should be treated before being discharged.

Points to Remember

- Next to air, water is the most important resource for our survival.
- Water contains hydrogen and oxygen as its constituent elements. Its molecular formula is H_2O.
- Water is broken down into its constituent elements by electrolysis. During electrolysis hydrogen and oxygen are obtained in the ratio 2:1
- Water has a maximum density of 1 g/cc at 4°C. At temperatures below and above 4°C, water has a density of less than 1 g/cc. This unique property of water helps in the survival of aquatic life in winters and summers.
- Sea water contains many minerals and salts dissolved in it and so it is said to be saline.
- Water freezes at 0°C and boils at 100°C.
- Water is a universal solvent as it can dissolve many substances.
- Water that is used for drinking is called potable water.
- Water has dissolved gases which are used by aquatic life for respiration and photosynthesis.
- Hardness of water is due to the presence of dissolved salts of calcium and magnesium.
- Water pollution is the result dumping untreated domestic solid waste and sewage, agricultural waste, industrial effluents into lakes, rivers, etc.

A-Z GLOSSARY

Electrolysis	Breaking down of substances by the passage of electric current.
Potable water	Water used for drinking.
Saline water	Water containing sodium chloride (common salt).
Sterilization	Addition of chemicals to kill the microorganisms present in water.
Eutrophication	Over growth of algae in water bodies due to excessive fertilizers.
Specific heat capacity	Amount of heat that is needed to raise the temperature of a unit mass of a substance by 1°C.
Latent heat of fusion	Amount of heat energy required by ice to change into water.
Aeration	The process in which air under pressure is blown into filtered water.
Water pollution	Addition of unwanted materials to the water.
Domestic sewage	Wastewater that is disposed of from households.
Water conservation	Saving water for the use in future.

TEXT BOOK EXERCISES

V7H1P7

I. Choose the correct answer.

1. Water changes to ice at
   a) 0^0C b) 100^0C
   c) 102^0C d) 98^0C
2. Solubility of carbon dioxide in water is high when the
   a) pressure is low
   b) pressure is high
   c) temperature is high
   d)None of the above
3. The gas collected at the cathode on electrolysis of water is
   a) oxygen b) hydrogen
   c) nitrogen d) carbon dioxide
4. Which of the following is a water pollutant?
   a) Lead b) Alum
   c) Oxygen d) Chlorine
5. Permanent hardness of water is due to the presence of _____
   a) Sulphates and Chlorides
   b) Dust particles
   c) Carbonates and Bicarbonates
   d) Other soluble particles

II. Fill in the blanks.

1. Water is colourless, odourless and _____
2. The boiling point of water is _____
3. Temporary hardness of water can be removed by _____ of water.
4. The density of water is maximum at _____
5. Loading speeds up the process of _____

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

1. Sewage should be treated well before being discharged it into water bodies.
2. Sea water is suitable for irrigation as it contains dissolved salts.
3. Excessive use of chemical fertilizers depletes the soil and causes water pollution.
4. Water unfit for drinking is called potable water.
5. Soap lathers well in hard water.

IV. Match the following.

1.	Universal solvent	-	Water pollutant
2.	Hard water	-	Kills germs
3.	Boiling	-	Ozonisation
4.	Sterilization	-	Water
5.	Sewage	-	Stomach ailments

V. Give reasons for the following.

1. Alum is added to water in sedimentation tanks.
2. Water is a universal solvent.
3. Ice floats on water.
4. Aquatic animals can breathe in water.
5. Sea water is unfit for drinking.
6. Hard water is not good for washing utensils.

VI. Define the following.

1. Freezing point
2. Boiling point
3. Specific heat capacity
4. Latent heat of fusion
5. Potable water

VII. Answer in brief.

1. Name the gas evolved at cathode and anode when water is electrolysed. State their ratio by volume.
2. State the importance of dissolved oxygen and carbon dioxide in water.
3. What are the causes of temporary hardness and permanent hardness of water?
4. Define specific latent heat of vaporization of water.
5. What are the methods of removing hardness of water?

VIII. Answer in detail.

1. How is water purified at a water purification plant?
2. What is permanent hardness of water? How can it be removed?
3. What is Electrolysis? Explain the electrolysis of water.
4. Explain the different ways by which water gets polluted.

REFERENCE BOOKS

1. Water science fair projects – Madeline Goodstein.
2. Basic chemistry – Karen C. Timberlake & William Timberlake.
3. Chemistry of water treatment – Samuel D. Faust Osman M.Aly.
4. Textbook of Environmental Chemistry – Balarampani.

INTERNET RESOURCES

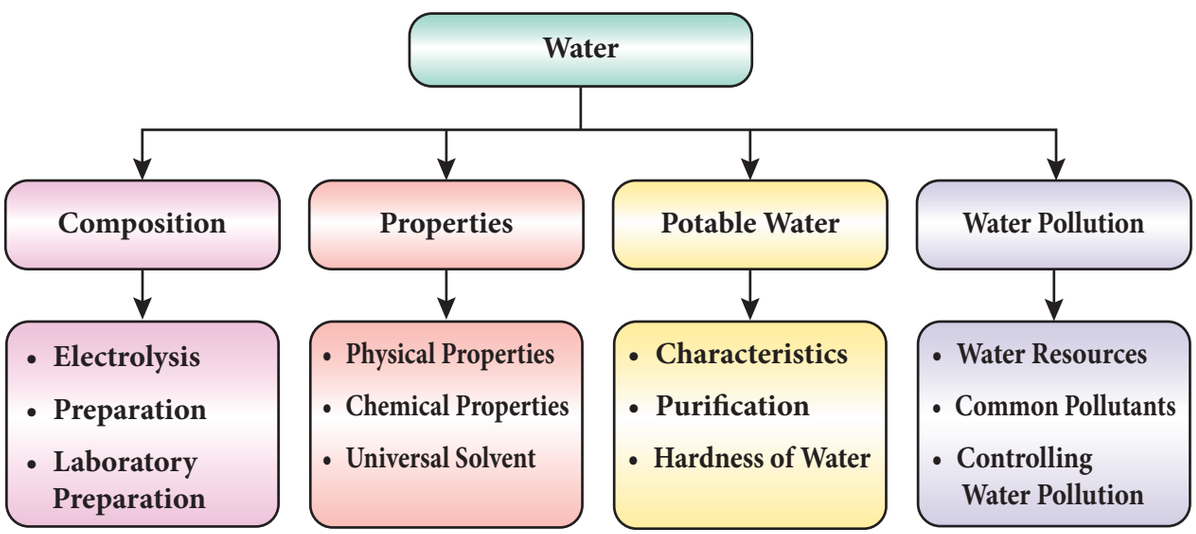
http://www.youtube.com/watch?v=bZHymnnrSzc

http://www.un.org/cyberschoolbus/waterquiz/waterquiz4/index.asp

http://www.explainthatstuff.com/waterpollution.html

WATER IS PRECIOUS. DO NOT WASTE IT, RECYCLE IT, TREAT IT, SAVE EVERY DROP THAT YOU CAN!

Concept Map



UNIT 5

ACIDS AND BASES

Learning Objectives

F1M5L1

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

- Define acids and bases.
- Understand the properties of acids and bases.
- Distinguish between acids and bases.
- List out the uses of acids and bases.
- Understand the neutralisation reaction between acids and bases.
- Know about acid – base indicators.

Introduction

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

5.1 Acids

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

Hydrochloric acid + Water → Hydrogen ion + Chloride ion

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

Sulphuric acid + Water → Hydrogen ion + Sulphate ion

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

DO YOU KNOW?

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

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

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

Table 5.1 Organic acids and their sources

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

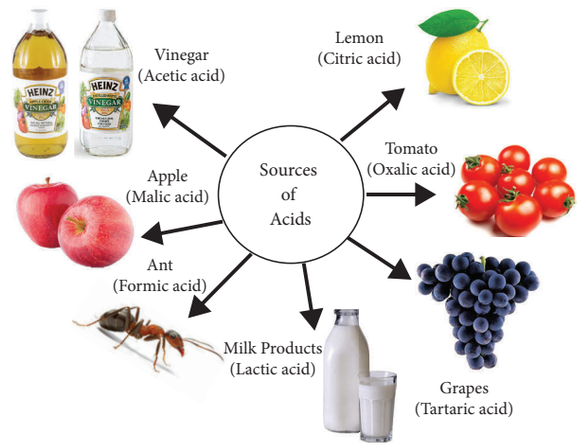


Figure 5.1 Acids and their sources

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

5.1.1 Properties of Acids

a. Physical properties

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

Figure 5.2 Benzoic acid

DO YOU KNOW?

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

b. Chemical properties

i. Reaction with metals

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

Metal + Dilute acids → Metal salt + Hydrogen

Example:

Zinc + Hydrochloric acid → Zinc chloride + Hydrogen

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

Iron + Sulphuric acid → Ferrous sulphate + Hydrogen

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

Activity 1

Take a clean test tube with holder and pour some dilute hydrochloric acid. Add few pieces of magnesium ribbon slowly. What do you observe? Now show a burning match stick near the mouth of the test tube. Do you hear any sound? The gas burns with a pop sound. From this it is observed that hydrogen gas is formed due to the reaction between acid and metal.

DO YOU KNOW?

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

ii. Reaction with metal carbonates and bicarbonates

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

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

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

Activity 2

Take some lemon juice in a tumbler and add baking soda slowly. What do you see? What do you infer from this?

iii. Reaction with metal oxide

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

Metal oxides + dilute Acid → Metal salts + Water

Example:

Calcium oxide + Hydrochloric acid → Calcium chloride + Water

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

5.1.2 Uses of Acids

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

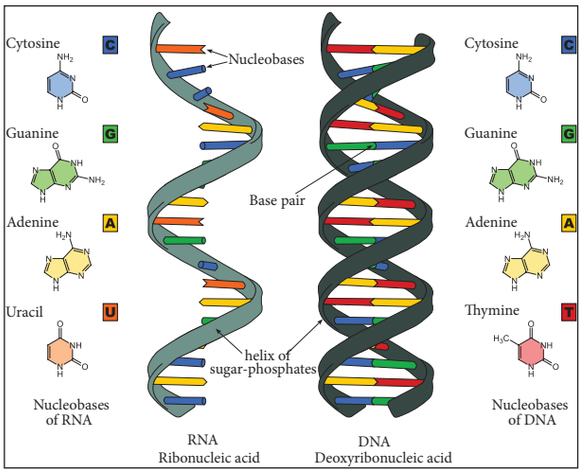


Figure 5.3 Nucleic acid

DO YOU KNOW?

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

5.2 Bases

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

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

Sodium hydroxide → Sodium ion + Hydroxide ion

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

Potassium hydroxide → Potassium ion + Hydroxide ion

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

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

Table 5.2 Common bases in some products

Base	Formula	Products
Magnesium hydroxide	$Mg(OH)_2$	Milk of magnesia
Sodium hydroxide	NaOH	Detergent
Ammonium hydroxide	NH_4OH	Solution for cleaning windows
Calcium hydroxide	$Ca(OH)_2$	Lime water
Potassium hydroxide	KOH	Soap

Sodium carbonate (Na_2CO_3) is commercially called washing soda. Similarly sodium bicarbonate ($NaHCO_3$) is commercially called baking soda. Caustic soda is sodium hydroxide (NaOH) and caustic potash is potassium hydroxide (KOH).

Activity 3

Classify the following substances.

Sodium oxide, Potassium hydroxide, Calcium oxide, Copper oxide, Calcium hydroxide, Ammonium hydroxide, Ferric hydroxide, Zinc oxide

Base	Alkali	Oxide

5.2.1 Properties of Bases

a. Physical properties

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

b. Chemical properties of bases

i. Reaction with metals

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

Aluminum + Sodium hydroxide + Water → Sodium aluminate + Hydrogen

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

ii. Reaction with metal oxides

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

Sodium hydroxide + Carbon dioxide → Sodium carbonate + Water

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

iii. Reaction with ammonium salts

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

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

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

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

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

Some of the differences between acids and bases are given in Table 5.3.

Table 5.3 Difference between acids and bases

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

5.2.2 Uses of Bases

i) Potassium hydroxide is used to make bathing soaps.
ii) Sodium hydroxide is used to make washing soaps.
iii) Sodium hydroxide is also used in paper industries, textile industries and in the preparation of medicines.
iv) Calcium hydroxide is used for white washing.
v) Aluminum hydroxide and magnesium hydroxides are used in antacids to cure acidity problems.
vi) Ammonium hydroxide is used to manufacture fertilizers, nylon, plastics and rubber.

Figure 5.4 Uses of bases in daily life

5.3 Neutralisation Reaction

When neutrality is achieved between two different chemical substances with different chemical properties through a reaction then it is called neutralization in chemistry. Thus neutralization is a chemical reaction in which

an acid and a base react with each other to form salt and water. Neutralization reaction between an acid and a base can be written as:

Acid + Base → Salt + Water

In this reaction, H^+ and Cl^- ions are produced by the hydrochloric acid and Na^+ and OH^- ions are produced by the base sodium hydroxide. When these ions combine together sodium chloride (NaCl) salt and water are produced.

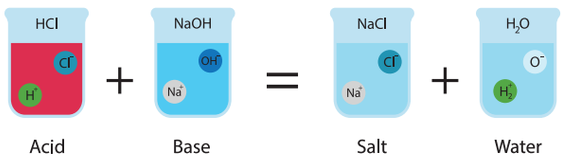


Figure 5.5 Acid – Base reaction

Similarly some other acids also produce their salts when they react with some bases. Some of the salts produced by neutralization reaction are given below in Table 5.4.

Table 5.4 Salts produced by neutralisation

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

5.3.1 Neutralisation reactions in our daily life

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

Ant bite

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

Figure 5.6 Bee bite

Wasp bite

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

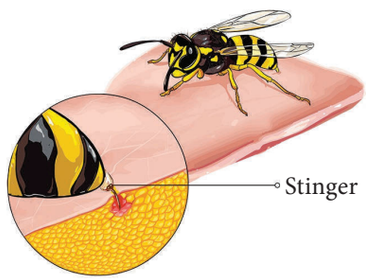


Figure 5.7 Wasp bite

Tooth decay

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

Acidity

As we know, hydrochloric acid present in our stomach helps the digestion of food material along with the enzymes secreted by liver, gallbladder and pancreases. Sometimes

due to excessive production of hydrochloric acid in our stomach we feel burning sensation in food pipe and in chest area. If this happens again and again ulcer will be formed in stomach and food pipe, which further aggravates the conditions. In order to neutralize, antacids which are nothing but weak bases like aluminum and magnesium hydroxides are used. As a result the acidity is removed.

Agriculture

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

Figure 5.8 Acidic soil

Industries

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

Figure 5.9 Industrial Effluents

5.4 Indicators

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

F3Q7Z7

5.4.1 Natural indicators

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

Turmeric indicator

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

Figure 5.10 Turmeric indicator

Activity 4

Take a shirt with turmeric powder stain. Wash the shirt with washing soap. Do you observe any change in the colour? Why?

Hibiscus flower indicator

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

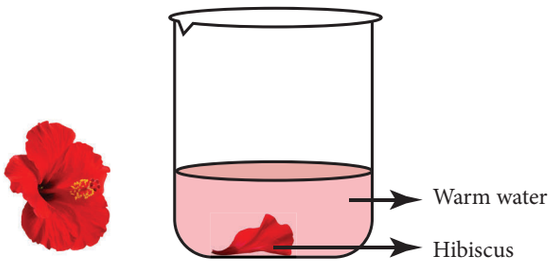


Figure 5.11 Hibiscus solutions as indicator

Beet root juice indicator

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

Activity 5

Take a small beet root vegetable and cut it into pieces. Boil them in hot water and filter the extract. Take two test tubes. Take sodium hydroxide solution in one test tube and vinegar or lemon juice in another test tube. Add beet root extract slowly. Observe the colour change. What do you infer?

Litmus

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

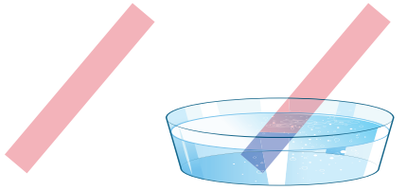


Figure 5.12 Litmus paper

Activity 6

Find out the nature of the solution.

Sample solution	Change of colour in litmus paper		Acid / Base
	Red litmus	Blue litmus	
Lemon juice			
Vinegar			
Calcium hydroxide solution			
Bathing Soap solution			
Orange juice			

5.4.2 Synthetic indicators

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

Phenolphthalein

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

Methyl orange

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

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

Table 5.5 Colour Changing Indicators

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

Points to Remember

- Acids produce H^+ ions when they are dissolved in water.
- Acids are generally corrosive in nature and sour in taste
- All dilute acids react with metallic oxides to form respective metallic salts and water.
- Natural acids and organic acids are the two types of acids.
- Acetic acid and benzoic acid are used as food preservatives.
- Sulphuric acid is known as king of chemicals.
- Bases are the substances that give hydroxide ions (OH^-) on dissolving in water.
- Bases which are soluble in water are called alkalis. All alkalis are bases but all bases are not alkalis.
- Bases are generally corrosive in nature. They give soapy touch only in aqueous media not in dry nature.
- Bases are used in paper industries, textile industries and in the preparation of medicines. They are used to manufacture fertilizers, nylon, plastics and rubber.
- When acids and bases are mixed together in aqueous solution, they react chemically to produce salt and water. This is known as neutralisation reaction.
- An indicator is a chemical substance (either natural or artificial) which indicates the end of a chemical reaction by a suitable colour change.
- Extracts of turmeric powder, hibiscus, beet root and vegetables are used as natural indicators. Phenolphthalein and methyl orange are artificial indicators.

A-Z GLOSSARY

Acid	A substance which contains one or more replaceable hydrogen atoms.
Alkali	Water soluble bases.
Base	A substance that releases hydroxide ions when dissolved in water.
Indicator	Chemical substance which indicates the acidic or basic nature of a solution by suitable colour change.
Inorganic acid	Acids produced artificially in industries.
Natural indicators	Substances obtained from plants and used as indicators.
Neutralisation reaction	Reaction between an acid and a base which produces water and salt.
Organic acid	Acids which occur naturally in fruits and vegetables.
Synthetic indicators	Artificially produced indicators .

TEXT BOOK EXERCISES

H4F8G4

I. Choose the best answer.

1. Acids are _____ in taste.
   a) sour b) sweet
   c) bitter d) salty
2. Aqueous solutions of _____ conduct electricity.
   a) acid b) base
   c) salt d) salt and base
3. In acidic solutions blue litmus changes into _____ colour.
   a) blue b) green
   c) red d) white
4. Base is a substance that gives _____ on dissolving in water.
   a) OH^- b) H^+ c) OH d) H
5. Sodium hydroxide is a _____
   a) acid b) base
   c) oxide d) alkali
6. Red ant sting contains _____
   a) acetic acid b) sulphuric acid
   c) oxalic acid d) formic acid
7. Magnesium hydroxides are used for treating_____
   a) acidity b) head pain
   c) teeth decay d) None of these
8. Acid mixed with base forms _____
   a) salt and water b) salt
   c) water d) No reaction
9. We brush our teeth with tooth paste because it is _____ in nature.
   a) basic b) acidic
   c) Both a and b d) None of these
10. In basic solution turmeric indicator paper changes from yellow to _____
    a) blue b) green c) yellow d) red

II. Fill in the blanks.

1. Benzoic acids are used for _____
2. The word sour refers to _____ in Latin.
3. Bases are _____ in taste.
4. Chemical formula of calcium oxide is _____
5. Wasp sting contains _____
6. Turmeric is used as a_____
7. In acidic solution the colour of the hibiscus indicator paper will change to _____

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

1. Most of the acids are not soluble in water.
2. Acids are bitter in taste.
3. Bases are soapy to touch when they are dry.
4. Acids are corrosive in nature.
5. All bases are alkalis.
6. Hibiscus flower is an example for natural indicator.

IV. Answer briefly.

1. Define acid.
2. Write any four physical properties of acids.
3. What are the similarities between acids and bases?
4. State the difference between acids and bases.
5. What is an indicator?

6. What is a neutralization reaction?
7. Write any four physical properties of base.

VII. Answer in detail

1. What are the uses of acids?
2. What are the uses of bases?
3. Explain the neutralization reactions in our daily life.
4. How will you prepare natural indicator from turmeric powder.

VIII. Higher Order Thinking Questions.

1. Vinu and Priyan take their lunch at school. Vinu eats lemon rice and Priyan eats curd rice. Both lemon rice and curd rice are sour in taste. What is the reason?
2. Heshna and Keerthi are friends. Keerthi's teeth are white without caries, but Heshna has teeth with caries. Why? How is it formed?

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INTERNET RESOURCES

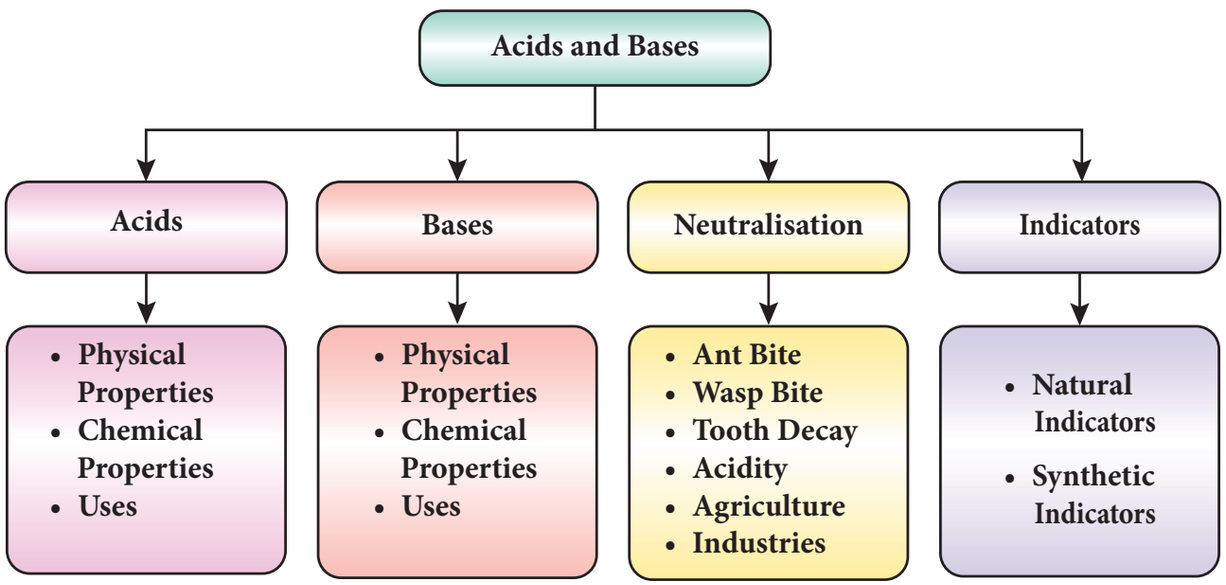
https://www.chem4kids.com

https:// www.khanacademy.org/science/chemistry/acids-and-bases-topic

https:// www.khanacademy.org/science/chemistry/neutralization

https://courses.chemistry/chapter/acids-and-bases

Concept Map



UNIT 6

CHEMISTRY IN EVERYDAY LIFE

E5A1A5

Learning Objectives

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

- know about different types of hydrocarbons.
- understand the fomation of fossil fuels.
- list out the properties and uses of different gases.
- understand the process involved in the refining of petroleum.
- know about the types and uses of coal.
- know about the characteristics of ideal fuel.
- list out the applications of solar energy.

Introduction

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

6.1 Hydrocarbon

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

6.1.1 Sources of Hydrocarbons

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

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

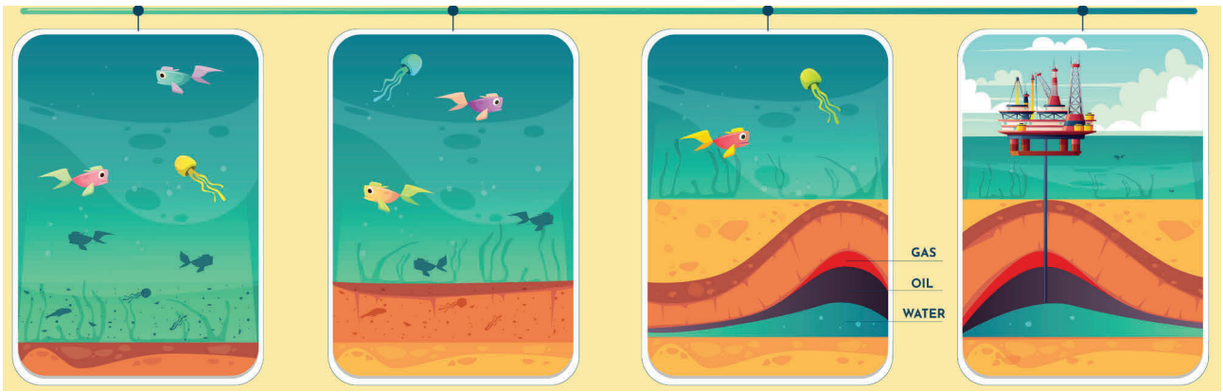


Figure 6.1 Formation of Hydrocarbons

6.1.2 Properties of Hydrocarbons

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

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

6.1.3 Types of Hydrocarbons

In hydrocarbons carbon and hydrogen atoms are linked together through different chemical bonds. Depending on the bond between these atoms there are number of hydrocarbons. The four general classes of hydrocarbons are: alkanes, alkenes, alkynes and arenes. Some of the common hydrocarbons are methane, ethane, propane, butane and pentane.

Methane is the simplest hydrocarbon in which four hydrogen atoms are linked with one carbon atom. It is a colourless, odourless and inflammable gas. It is an eco-friendly fuel because it does not produce any harmful products. It is used as a fuel in electricity generation. Methane is also known as marsh gas as it is present in marshes. Dead and decaying plants and animals release methane gas. It is a renewable source of energy. Sewage sludge can also be decomposed by microorganisms to produce methane gas along with impurities like carbondioxide and hydrogen sulphide. After removing these impurities, methane gas can be used as an efficient fuel.

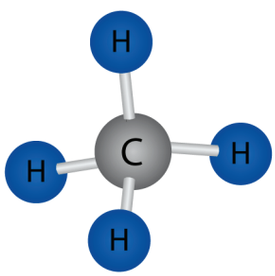
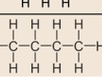
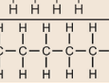


Figure 6.2 Structure of methane

Activity 1

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

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

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

Figure 6.3 LPG Cylinders

DO YOU KNOW?

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

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

6.2 Natural Gas

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

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

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

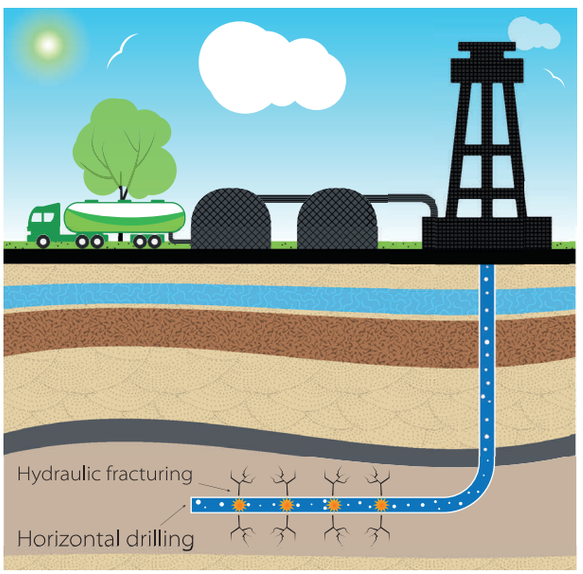


Figure 6.4 Natural Gas

Activity 2

Take a glass bottle and put some leaves, twigs, waste paper and saw-dust in it. Pour some water in it and keep it for 20 days. Open the bottle and bring a glowing splinter near the mouth. You can see a gas burning near the mouth showing its combustible nature. It is due to the evolution of natural gas.

6.2.1 Uses of Natural Gas

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

Figure 6.5 Uses of natural gas

DO YOU KNOW?

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

6.2.2 Advantages of Natural Gas

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

6.2.3 Compressed Natural Gas

When the natural gas is compressed at high pressure, it is called Compressed Natural Gas (CNG). Nowadays it is used as fuel in automobiles. The primary hydrocarbon present in CNG is methane (88.5%). Natural gas is liquefied for shipping in large tankers. This is called Liquefied Nitrogen Gas (LNG). CNG is stored at high pressure whereas LNG is stored in ultra cold liquid form. CNG has the following properties.

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

More to Know

The average composition of CNG.

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

6.3 Fuel Gases

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

Producer Gas

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

DO YOU KNOW?

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

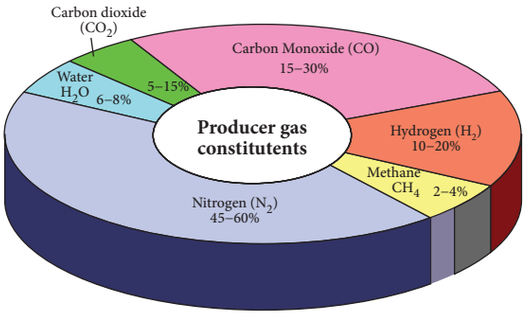


Figure 6.6 Composition of Producer Gas

Coal Gas

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

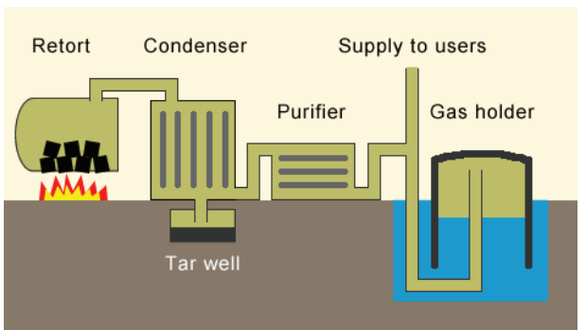


Figure 6.7 Production of coal gas

Water Gas

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

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

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

Bio Gas

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

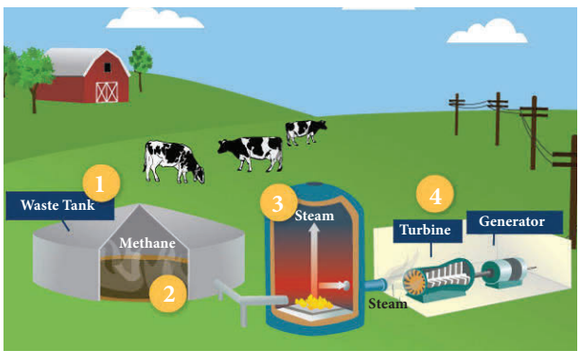


Figure 6.8 Bio-gas

Activity 3

Visit a bio gas plant in your area with your teacher. Find out how it is prepared. Discuss about the uses and advantages of bio gas. In what way it will be helpful to the people in rural area?

6.4 Coal and its types

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

6.4.1 Extraction of Coal

Coal is extracted from the coal beds found below the surface of the earth. Coal found inside the earth is broken into pieces by explosives

and brought above. Depending on the depth of the coal bed, coal is extracted in two ways.

Surface mining

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

Figure 6.9 Surface mining of coal

Underground mining

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

Figure 6.10 Underground mining of coal

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

6.4.2 Types of Coal

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

Lignite

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

Sub bituminous

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

Bituminous

With more chemical and physical changes, sub-bituminous coal is developed

Figure 6.11 Types of Coal

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

Anthracite

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

Activity 4

In an outline map of India mark the places where coal mines are found. Also identify the type of coal found in those areas.

6.4.3 Uses of coal

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

Figure 6.12 Uses of Coal

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

6.4.4 Products obtained from coal

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

Destructive Distillation of Coal

The destructive distillation of coal can be carried out in the laboratories. The apparatus is as shown in Figure 6.13.

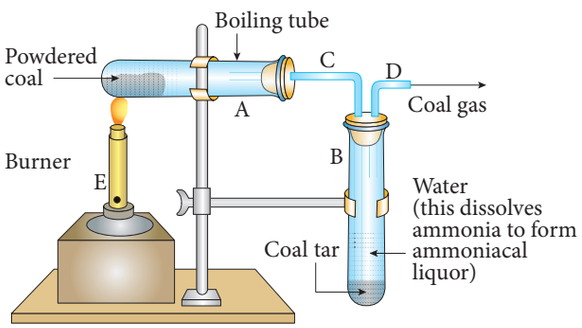


Figure 6.13 Fractional Distillation

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

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

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

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

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

DO YOU KNOW?

It is also known as **Black Diamond** owing to its precious nature. On destructive distillation, 1000 kg of coal gives 700 kg of coke, 100 litres of ammonia, 50 litres of coal tar and 400 m^3 of coal gas.

6.5 Petroleum

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

G5Z1R2

Figure 6.14 Petroleum Extraction

DO YOU KNOW?

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

6.5.1 Occurrence of Petroleum

The chief petroleum producing countries are U.S.A, Kuwait, Iraq, Iran, Russia and Mexico. In India, petroleum is found in

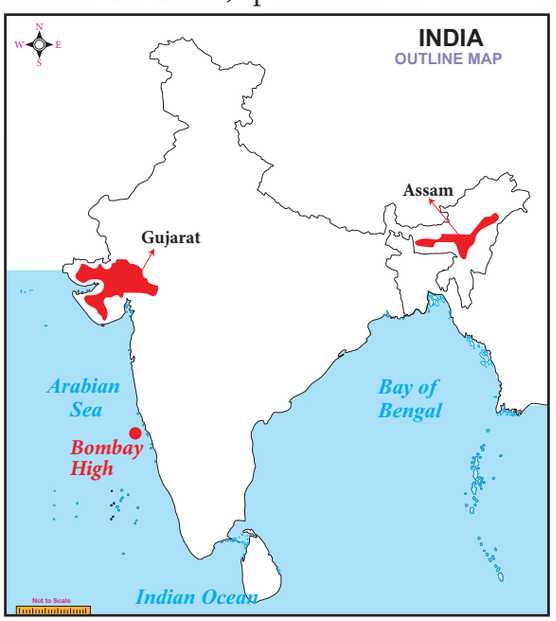


Figure 6.15 Places where petroleum is extracted

Assam, Gujarat, Maharashtra (Mumbai), Andhra Pradesh (Godavari and Krishna basin) and Tamil Nadu (Cauveri Basins). By drilling through the earth the crude oil is pumped out from the well as a black liquid.

DO YOU KNOW?

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

6.5.2 Refining of crude petroleum

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

Figure 6.16 Crude Oil

Separation of water

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

Removal of sulphur compounds

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

Fractional distillation

Petroleum is a mixture of various constituents such as petroleum gas, petrol, diesel, kerosene, lubricating oil, paraffin wax, etc. The process of separation of various constituents or fractions of petroleum is done by fractional distillation in fractionating columns. The process of heating a mixture of liquids having different boiling points and then separating them by cooling is called fractional distillation.

Crude petroleum is first heated to about 400°C in a furnace. As the vapours of crude oil move up the tower, the various fractions condense according to their boiling point ranges. The various fractions of petroleum obtained are tabulated below. Many useful substances are obtained from petroleum and natural gas. These are termed 'petrochemicals'. These are used in the manufacture of detergents, fibres, and other man-made plastics like polythene. Hydrogen gas obtained from natural gas, is used in the production of fertilizers. Due to its great commercial importance, pertoleum is also called 'black gold'.

6.5.3 Uses of Petroleum

Products obtained from crude oil have a number of uses.

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

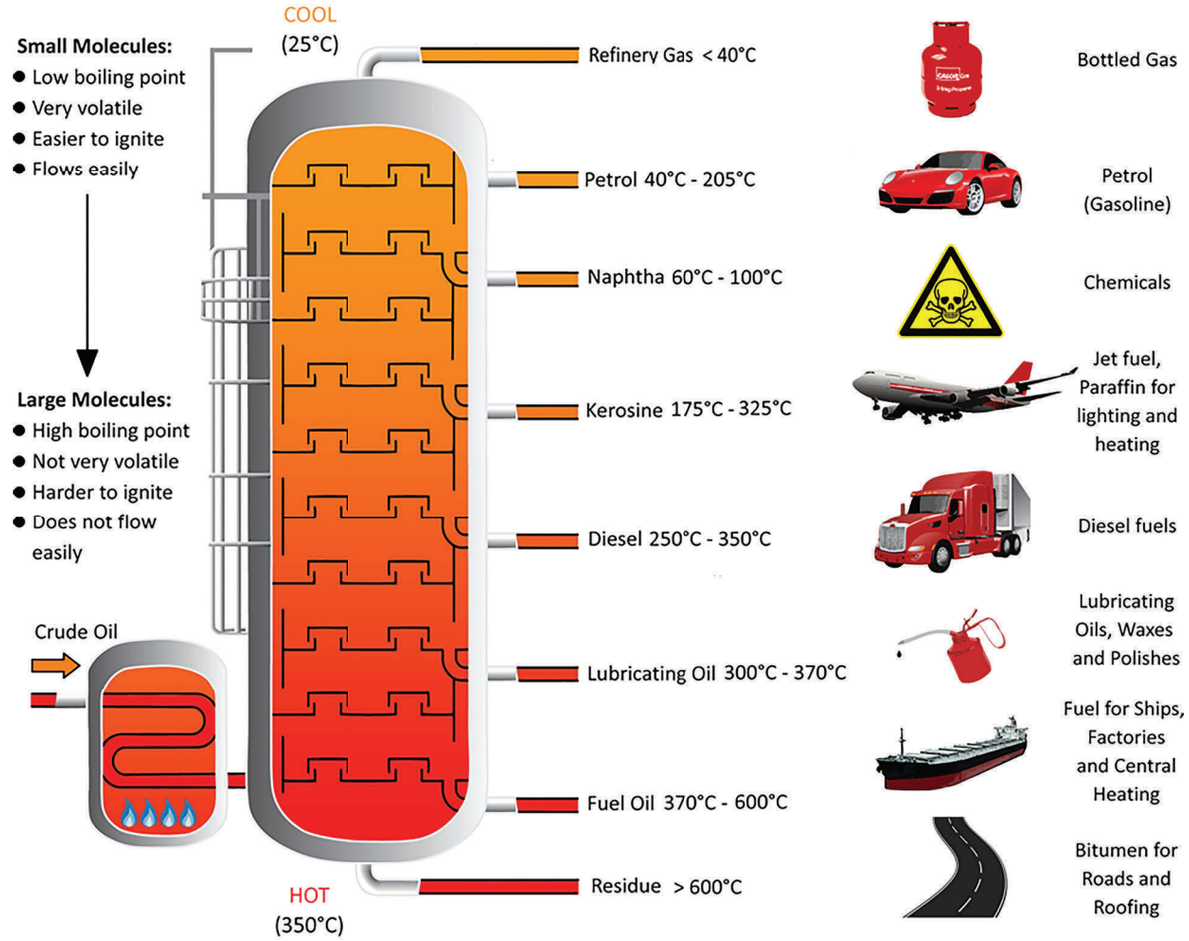


Figure 6.17 Extraction of Petroleum

Activity 5

Find out where petroleum is extracted on a large scale in India. Also list out the petroleum refineries in India.

6.6 Fuel

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

6.6.1 Types of fuel

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

Solid fuels

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

Liquid fuels

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

Gaseous fuel

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

6.6.2 Characteristics of fuel

An ideal fuel should have the following characteristics.

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

6.6.3 Efficiency of Fuel

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

Specific Energy

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

Calorific Value

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

Table 6.1 Calorific value of fuel

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

Octane Number

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

Cetane Number

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

Table 6.3 Difference between Octane number and Cetane number

Octane Number	Cetane Number
Octane rating is used for petrol	Cetane rating is used for diesel
It measures the amount of octane present in petrol.	It measures the ignition delay of the fuel in diesel engine.
Octane number of petrol can be increased by adding benzene or toluene.	Cetane number of diesel can be increased by adding acetone.
The fuel with high octane number has low cetane number	The fuel with high cetane number has low octane number.

6.7 Alternative Fuel

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

Bio diesel

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

Hydrogen - The future fuel

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

Wind energy

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

Figure 6.18 Wind Mill

Gobar Gas

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

6.8 Solar Energy

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

6.8.1 Applications of Solar Energy

Figure 6.19 Solar energy

Solar energy has wider applications in various fields.

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

Points to Remember

- Methane is the simplest hydrocarbon in which four hydrogen atoms are linked with one carbon atom.
- Natural gas is a naturally occurring hydrocarbon gas mixture consisting primarily of methane.
- CNG is the cheapest and cleanest fuel. Vehicles using this gas produce less carbon dioxide and hydrocarbon emission. It is less expensive than petrol and diesel.
- Producer gas is a gaseous mixture of carbon monoxide and nitrogen.

- Water is a gaseous mixture of carbon monoxide and hydrogen. It is also called as syngas or synthesis gas.
- The term 'petroleum' is derived from the latin words 'petra' meaning rock and 'oleum' meaning oil.
- Any substance that can produce heat and energy on burning is called fuel.
- Specific energy is defined as the energy per unit mass. It is used to measure the stored energy in certain substances. Its unit is Jkg^{-1}.
- Cetane number measures the ignition delay of the fuel in diesel engine.
- Solar energy is the energy derived from the sun in the form of solar radiation.

A-Z GLOSSARY

Bio Gas	Mixture of the gases methane and carbon dioxide.
Calorific Value	The quantity of heat produced by the complete combustion of fuel at constant pressure and normal conditions.
Catenation	The property of carbon atom to form bonds with itself resulting in a single large structure or chain.
CNG	Compressed natural gas obtained at high pressure.
Destructive distillation	The process of heating coal in the absence of air.
Fractional distillation	The process of heating a mixture of liquids having different boiling points and then separating them by cooling.
Hydrocarbons	Organic compounds consisting of hydrogen and carbon atoms.
LPG	Liquefied Petroleum Gas
Octane Number	The number which denotes the amount of octane present in petrol.
Water Gas	Gaseous mixture of carbon monoxide and hydrogen.

TEXT BOOK EXERCISES

D1L5L5

I. Choose the correct answer.

1. The chemical mixed with LPG that helps in the detection of its leakage is _____
   a. methanol b. ethanol
   c. camphor d. mercapton
2. Which is known as syn gas?
   a. Marsh gas b. Water gas
   c. Producer gas d. Coal gas
3. The unit of calorific value of fuel is _____
   a. kilo joule per mole
   b. kilo joule per gram
   c. kilo joule per kilo gram
   d. joule per kilo gram
4. _____ is the coal of superior quality.
   a. Peat b. Lignite
   c.Bituminous d.Anthracite

5. The main component of natural gas is _____

a. methane b.ethane
c.propane d.butane

II. Fill in the blanks

1. Producer gas is a mixture of _____
2. _____ is known as marsh gas.
3. The term petroleum means _____
4. Heating coal in the absence of air is called _____
5. An example for fossil fuel is _____

III. Match the following

1. Octane rating	-	Diesel
2. Cetane rating	-	Methane
3. Simplest hydrocarbon	-	Petrol
4. Peat	-	Bown in colour
5. Lignite	-	First stage coal

IV. Answer briefly.

1. What do you mean by catenation?
2. Mention the advantages of natural gas.
3. Expand CNG. List out its uses.
4. Identify the gas known as syngas. Why is it called so?
5. Anthracite is known as the highest grade coal. Give reason.
6. Distinguish between octane number and cetane number.
7. Name the places in Tamilnadu harnessing wind energy from wind mills.
8. Solar energy is a non depleting energy. Justify.

V. Answer in detail.

1. Explain the different types of coal.
2. What is known as destructive distillation? Write about the products obtained from petroleum.
3. What are the different types of fuels?

REFERENCE BOOKS

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2 Chemistry in action: The molecules of everyday life by Nina Morgan.

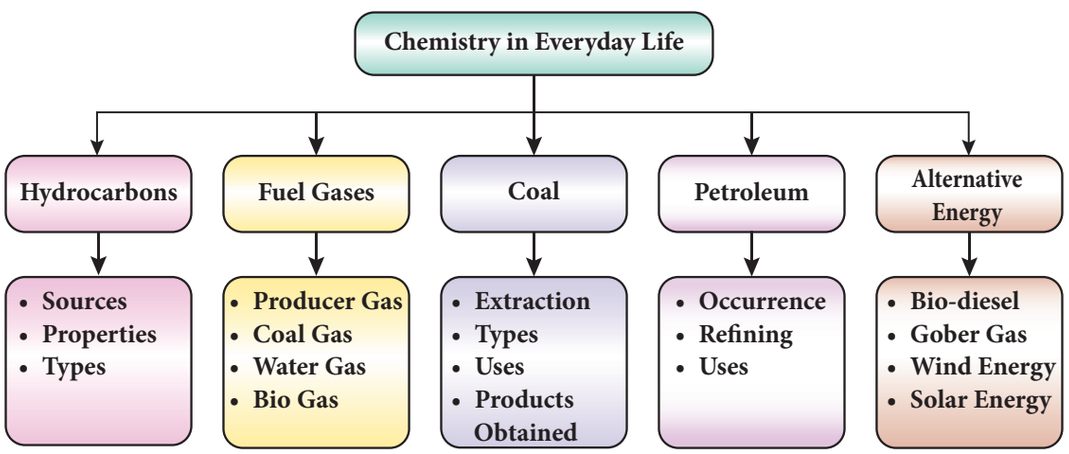
3 Engineering Chemistry by Dr. A. Ravi krishnan.

INTERNET RESOURCES

www.learnchem.net

https://edu.rsc.org/resources

Concept Map



UNIT 7

CROP PRODUCTION AND MANAGEMENT

Learning Objectives

K8T4L1

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

- Know about agricultural practices.
- Understand the basic practices of crop production.
- Know about the importance of rotation of crops.
- Recognise the importance of seed bank, seed balls and preservation of seeds.
- Know about the role of agriculture research institutions IARI, ICAR and KVK.
- List out the importance of bio control methods.

Introduction

All over the human history, we have been motivated to search and seek food. Green plants make their own food using a process called photosynthesis. Animals and humans cannot make their own food, Thus, humans and animals are directly or indirectly dependent on plants. Energy from the food is used by the organisms for carrying out their various body functions. Plants and animals are the main source of food for all the organisms. In order to provide food for a larger population production, proper planning, management and distribution is needed. Farmers are faced with the challenge of producing sufficient crops to meet the growing demand while maintaining the quality and quantity of resources for future generations. Agriculture research institutions are developing new technologies to help the farmers to increase productivity both in terms of quality or quantity. In this lesson we are going to learn about agricultural practices, rotation of crops, seeds, bio-fertilisers and the functions of agricultural research institutions.

7.1 Agricultural Practices

Agriculture has always been the backbone of our country's economy. Ever since the Green Revolution, we have been cultivating different types of crops to cater the increasing demand. In our country the following three categories of crops are grown.

- **Kharif Crops:** The crops which are sown in the rainy season (i.e., from June to September) are called kharif crops. Paddy, maize, soya bean, groundnut, cotton etc., are kharif crops.
- **Rabi Crops:** The crops grown in winter season (i.e., from October to March) are called rabi crops. Examples of rabi crops are wheat, gram, pea, mustard, linseed.
- **Zaid Crops (Summer Crops):** The crops which are grown in summer season are called zaid crops. Muskmelon, watermelon and cucumber are examples for zaid crops.

According to utility, crops are classified as below.

- **Food crops** – Paddy and maize are cultivated for human consumption.

Figure 7.1 Crops according to utility

- **Fodder crops** – These are useful for livestock consumption. E.g. Sorghum, millets
- **Fabre crops** - These crops are used for cordage and textile. E.g. Cotton, hemp
- **Oil crops** - Oil crops are useful in a large scale for consumption or industrial uses. E.g. Ground nut, sesame.
- **Ornamental crops** - These are utilized for landscape gardening. E.g- Croton, Euphorbia.

DO YOU KNOW?

Our country is the largest producer of bananas and mangoes in the world. It is also the second largest producer of wheat and rice.

Activity 1

Mention few examples for Kharif, Rabi and Zaid crops cultivated in your area.

Kharif	Rabi	Zaid

7.2 Basic Practices of Crop Production

Growing crops in the field is a skilful job. Physical and mental skills are involved in this practice. Different activities in crop production are ploughing, sowing, applying fertilizers, harvesting and seed storage. All these activities collectively have an effect on the yield of crops.

7.2.1 Soil preparation

Soil preparation is the first step in the crop production practice. The most important aspect in agricultural process is to loosen the topsoil. The loosened soil helps in the growth of earthworm and soil microbes. These organisms add humus to the soil and are friendly to farmers. Plants absorb water, minerals, nutrients and air from the soil through their roots. Hence it is essential to prepare the soil in a proper way before starting the cultivation practice. The soil is prepared by the following methods.

a. Ploughing
b. Levelling
c. Basal manuring

a. Ploughing

Ploughing or tilling is the process of loosening and turning the soil up and down to facilitate the availability of nutrients in the root zone of the cultivating crop.

Man ploughing Machine ploughing

Figure 7.2 Ploughing

The following are the few important agricultural implements generally used in the field preparation.

Plough Hoe Cultivator

Figure 7.3 Agricultural implements

Plough

Plough is mainly used for tilling the soil, to add fertilisers to the crop, remove weeds and other waste materials from the field and also to turn the soil. A plough is made of wood and is drawn by a pair of bulls or horses. It contains a strong and a sharp triangular iron strip known as ploughshare. The main part of the plough is a long log of wood which is called plough shaft. The other end is attached to a beam which is placed on the bull's neck.

Hoe

It is a simple agricultural tool which is used to till the land, remove weeds and dig up soil. It has a long wooden rod with a bent iron plate at one end. The other end may be attached to an animal.

Cultivator

It involves the use of a tractor to drive the cultivator. Cultivators also kill weeds and dig up unwanted vegetation available in the field. Nowadays ploughing is done by tractor-driven cultivator. The use of cultivator saves labour and time.

b. Levelling

Once the field is ploughed, the topsoil is quite loose. The levelling of soil is done with an implement called the leveller, which is a heavy wooden or iron plank. Levelling of the field also helps in uniform distribution of water during irrigation.

c. Basal Manuring

Manuring means adding manure to the soil. Manure contains many nutrients required for the growth of crop plants. To increase the fertility of the soil, we add manure to the soil even before we begin the sowing because it gets properly incorporated into the soil. Application of green manure and farm yard manure will always enhance the growth and yield of the crops.

7.2.2 Sowing of Seeds

This is the second step in crop production. Once the soil preparation is over, sowing of the seeds can be done. Sowing is the actual process of planting the seeds in the soil. The seeds that are sown have to be selected very carefully to have high quality. Various methods are followed for sowing the seeds.

a. Sowing by hand

The scattering of seeds by hand is the simplest method of sowing seeds. This method is also called broadcasting. This is the most economical method of sowing seed.

Figure 7.4 Sowing by hand

b. Seed Drill

This is a modern method of sowing seeds. It is a better and more efficient method than sowing by hand. It is usually done by attaching iron drills to a tractor. Seed drills ensure that the seeds are planted at equal intervals and at the correct depth in the soil.

Figure 7.5 Seed Drill

c. Dibbling

It is the placement of seed material in a furrow, pit or hole at predetermined spacing with a dibble, more commonly by hand. Soil around the hole is pressed with hand or leg for moist soil contact.

Figure 7.6 Dibbling

Sowing seeds is essentially the most important part of crop production. The following precautions should be taken while sowing seeds.

- Seeds must be sown in proper distance and the distance is varied from one crop to other crop. This is to ensure that all plants get their fair share of light, water and nutrients for the growth and development. Planting seeds at equidistance have been proved to increase the yield of the farm.

More to know

Transplanting is removal of an actively growing seedling from one place (usually nursery bed) and planting it in the main field for further growth till harvest. Transplanting makes use of pre grown plants, seedlings or vegetative propagated clones.

- If seeds are simply scattered on the top they are likely to be blown away or eaten by animals or birds. At the same time, if we sow them too deep into the ground, they will not germinate due to lack of air. So, seeds must be sown at the correct depth in the soil.
- The seeds that are sown should be of the highest quality. They should be free from all diseases.

7.2.3 Adding Manure and Fertilisers

The substances which are added to the soil in the form of nutrients to enhance the growth of plants are called manure and fertilisers. The term fertility refers to the inherent capacity of a soil to supply nutrients to crop plants in adequate amounts and in suitable proportions. These nutrients are essential for the growth of plants.

Manure is an organic substance obtained from the decomposition of plants or animal wastes. Farmers dump plant and animal waste in pits at open places and allow it to decompose. The decomposed matter is used as organic manure. Regular addition of organic manures helps to maintain the soil fertility,

protecting them from wind and water erosion and preventing nutrient losses through runoff and leaching. This also increases water-holding capacity, soil aggregation, soil aeration and permeability.

Activity 2

Set up a compost pit within your school compound. Put all the organic wastes like food waste, plant leaf etc. in your school campus Cover it with soil. Wait for three weeks and then you can use this as manure for the plants in your school.

Fertilizer is a substance which is added to the soil to improve plants' growth and yield. Fertilizers are composed mainly of urea, ammonium sulphate, super phosphate, potash, NPK (Nitrogen, Phosphorus, Potassium). The use of synthetic fertilizers has significantly improved the quality and quantity of the food available today, although their long-term use is debated by environmentalists.

Manure Fertilizer

Figure 7.7 Manure and Fertiliser

7.2.4 Irrigation

Water is important for the proper growth and development of plants. Plants absorb water from their surrounding with the help of the root system. The supply of water to crops at regular intervals is called irrigation. The time and frequency of irrigation varies from crop to crop, soil to soil and season to season. Fertilizers can also be applied through the irrigation. The various sources of irrigation are wells, tube wells, ponds, lakes, rivers, dams and canal. Effective irrigation is the controlled and uniform supply to water to crops in the required amount at the right time with the minimum expenditure. Irrigation can be carried out by two different methods.

a. Traditional Methods
b. Modern Methods

a. Traditional Methods

In these methods, irrigation is done manually. Here, a farmer pulls out water from wells or canals by himself or using cattle and carries to farming fields. Pumps are also commonly used for lifting water from various sources. Diesel, biogas, electricity and solar energy are the few important sources of energy needed to run these pumps. The method of pulling water may vary from one place to other place. The main advantage of this method is that it is cheaper. But its efficiency is poor because of the uneven distribution of water. It also leads to heavy water loss.

b. Modern Methods

The modern irrigation methods help to overcome the problems exist in the traditional methods. It also facilitates the even distribution of moisture in the field.

Figure 7.8 Traditional Methods

The modern methods involve two systems.

- Sprinkler system
- Drip system

Sprinkler System

A sprinkler system, as its name suggests, sprinkles water over the crop and helps in an even distribution of water. This method is much advisable in areas facing water scarcity. Here a pump is connected to pipes which generate pressure and water is sprinkled through the fine nozzles of pipes.

Figure 7.9 Sprinkler Irrigation System

Drip System

In drip system, water is released drop by drop exactly at the root zone using a hose or pipe. This method is considered as the effective one in regions where the availability of water is less.

Figure 7.10 Drip Irrigation System

Activity 3

Find out the irrigation system followed in your area. Also, organise a debate on the advantages and disadvantages of modern irrigation systems like sprinkler system and drip system.

DO YOU KNOW?

The global population is expected to be 9 billion by the year 2050. So, efficient and sustainable water use is needed for our own generation and future generations. Agriculture activities alone utilize 70% of the available fresh water resources. So, drip irrigation is a better solution for economical use of water.

7.2.5 Weeding

In an agriculture field many other undesirable plants may grow naturally along with the main crop. These undesirable plants are called weeds. The removal of weeds is called weeding. Weeding is an important process because weeds compete with the crop plants for the nutrients, sunlight, water, space and other resources. It results in the undernourishment of crops and leads to low yield. It is mandatory to remove seeds from the field to achieve the expected yield. Farmers adopt many ways to remove weeds and control their growth. Some of them are explained below.

Mechanical methods

This is the most common method in which weeds are destroyed physically. Hand pulling or weeding with the help of weeding hole is the oldest and most efficient method for controlling weeds.

Tillage methods

It is one of the practical methods of destroying weeds of all categories. Weeds are buried in the soil and also exposed to sun heat by deep ploughing.

Crop rotation

In this method, proper rotation of crops is followed for controlling crop associated and parasitic weeds.

Summer tillage

Deep ploughing after harvest of Rabi crop and exposing underground parts of weeds

Figure 7.11 Hand weeding

to strong sunlight during summer months is useful for destroying many annual and perennial weeds.

Biological weed control

In this method, bio agents like insects and pathogens are used to control weeds. The objectives of biological control are not eradication, but reduction and regulation of the weed population.

Chemical methods

Chemical methods are very effective in certain cases and have great scope in weed control. The chemicals used for killing the weeds or inhibiting their growth are called herbicides. These chemicals are mixed with water and sprayed over the crops.

Integrated weed management

Integrated weed management combines different agronomic practices and herbicides use to manage weeds, so that the reliance on any one weed control technique is reduced. Mechanical, biological, cultural and chemical methods are included in integrated weed managements.

DO YOU KNOW?

There are over 30000 species of weeds around the world. Out of these 18000 species cause serious losses to crops. The continuous use of the same method leads to building up of tolerant species. Therefore, a suitable combination of different methods of weed control should be practiced for minimizing the losses caused by weeds in different crops and also for preventing `environmental pollution.

7.2.6 Harvesting of Crops

Harvesting of a crop is an important task. The process of cutting and gathering a crop is called harvesting. Different methods are used for harvesting.

Manual harvesting

This is the major method of harvest in India. Certain crops are harvested without using tools. Ground nut crop can be harvested by uprooting with hand, provided soil moisture is adequate for hand pulling. The same method is used in the case of green gram, black gram and horse gram.

Mechanical method

Harvesting in our country is generally done by employing the labours with the help of farm instruments like sickle. This method is a laborious and time-consuming one and it is suitable for small-sized farms only.

Figure 7.12 Mechanical method

Machine harvesting

This harvesting method is used in large sized agriculture fields.

Figure 7.13 Harvesting methods

The term harvesting also includes the immediate post-harvest practices such as threshing and winnowing.

Threshing: The process of separating the grains from their chaffs or pods is threshing.

Figure 7.14 Threshing

Winnowing: After threshing, we must separate the grains from the chaffs. Winnowing is the process of separating the grains.

Figure 7.15 Winnowing

There are various factors to be considered before harvesting the crops. The crops need close examination to ensure that harvesting is not premature. Premature harvesting leads to shedding of seeds and loss of crop. And if the crops are over ripened, they lose their value in the market and it becomes inconsumable in certain cases.

7.2.7 Storage

Storage is an important aspect of post-harvest technology, because the crop is seasonally produced but consumed through out the year. Therefore, supply of the produce has to be maintained by proper storage. Before storing, harvested grains should be made free from moisture. Any moisture in the stored grins will lead to the growth of microorganism. So they need to be dried in the sun before storing. Food grains are collected in gunny bags and then stored in godowns. Silos and granaries are used for the storage of grains on large scale. Chemical vapors are sprayed to minimize pest and insets in godowns. This is called fumigation. The stored grains are

DO YOU KNOW?

Food Corporation of India (FCI) was set up on 14th January 1965 at Chennai with the objective of distribution of food grains throughout the country for Public Distribution System (PDS) and maintaining a satisfactory level of operational and buffer stocks of food grains to ensure National Food Security. Its capital is in New Delhi now.

Mud Bin Jute bags Silos

Figure 7.16 Storage of foodgrains

inspected from time to time to make sure that they are free from diseases and pests. In our country, grains are stored on a large scale in government-owned godowns. The different categories of agricultural produce needing storage are food grains, oil seeds, seeds and folder.

Activity 4

Visit a food storage godown in your area and know about the methods followed to preserve the food. Also discuss in the class room about the importance of preserving and protecting food grains.

7.3 Rotation of Crops

Crop rotation is planting a series of different crops in the same field following a defined order. Mono cropping and mixed cropping are the two methods used in crop production. Mono cropping is the repeated planting of the same crop in the same field year after year. Mixed cropping is the cultivation of two or more than two crops simultaneously on the same land without any pattern.

Figure 7.17 Monocropping

Crop rotation has many advantages. Many crops like legumes may have positive effects on succeeding crops in the rotation, leading to greater production over all. A shallow rooted grain crop, deep rooted cash crop and restorative crop (legume crop) should be included in the rotation for maintaining soil productivity. The leguminous crops should follow non leguminous crops to have atmospheric nitrogen to succeeding crops. It helps in maintaining a better balance of nutrients in the soil. Weed problem is less in intercropping system compared to their sole crops.

Figure 7.18 Intercropping (Maize + Black Gram)

DO YOU KNOW?

Leguminous plants have symbiotic relation with the Rhizobium bacteria found in the root nodules of these plants. These plants have the ability to fix atmospheric nitrogen in their roots with the help of these bacteria. The fruits of this plant are called legumes. Examples of legumes include alfalfa, clover, peas, beans, lentils, lupins, mesquite, carob, soy, and peanuts. These plants are used in crop rotation to multiply soil nitrogen.

7.4 Seed Bank

Seed bank is a place where seeds are stored in order to preserve genetic diversity. Seeds may be viable for hundreds and even thousands of years. Seed banks are like seed libraries that contains valuable information about evolution strategies of plants.

The Royal Botanical Gardens located in Kolkatta first started collecting seeds formally as seed bank. Seed banks were created to store native varieties of seeds. With this initiative farmers have started preserving indigenous seeds and reducing their dependence on hybrid seeds from seed companies. The simple and healthiest method of seed storage is in the air tight earthen pots. Navadanya

seed bank, a nongovernmental organization located in New Delhi conserve around 50,000 crop varieties, with the primary focus on preservation of grain species.

Figure 7.19 Navadanya seed bank

DO YOU KNOW?

Acharya Jagadish Chandra Bose Indian Botanic Garden located in Kolkatta was earlier called Royal Botanic Garden . This garden exhibits a wide variety of rare plants and a total collection of over 12,000 specimens. The area of this garden spreads over 109 hectares.

7.4.1 Seed balls

Seed balls are a mixture of soil, compost and plant seeds. These balls are thrown into land areas. With the monsoon set in, these planted seed balls will germinate into seedling. Making seed ball is a step towards conserving the natural ecosystems. Seed balls are prepared by non-government organization and enthusiastic school children to grow tree for ecosystem restoration. The concept of seed ball has potential to increase tree cover and also to improve the awareness among the people about conserving plants.

Figure 7.20 Seed ball

Activity 5

Take some seeds of the fruits you eat and mix it with compost. Add some clay with them and roll them into small balls. Allow them to dry under the sun for two or three days. Take these balls and drop them in dry and arid areas. This will help new plants to grow. You can throw those balls while you are travelling. This will help grow plants in areas where there is no plant cover.

7.4.2 Heirloom seed

An heirloom seed is the seed of plant that has been carefully cultivated and passed down through many generations. Heirlooms are usually planted in small, isolated communities and they generally offer something of value to the grower. Heirloom seeds are also called organic seeds. These seeds are generally produced from open-pollinated plants and they transfer their unique characteristics to the descendants. Heirloom seed are harvested, dried and stored so that one can replant them in the following season.

The goal of preserving heirloom seed is to prevent any type of change due to outside influence. Most vegetable and flower varieties must be kept protected or isolated from other similar varieties during flowering to avoid cross pollinating plants and mixing their genes. Some vegetable varieties are self-pollinated and are grown with virtually no danger of crossing. Synthetic fertilizers, herbicides or pesticides are not used for organic seeds but conventional fertilizer, herbicides and pesticides are used.

7.5 Bio-Indicators

A bioindicator or biological indicator is any species or group of species whose function or status reveals the qualitative status of the environment. Biological indicators are used to

document and understand changes in earth's living systems especially changes caused by the activities of an expanding human population. Bio-indicators of soil health give us information about soil structure, development, nutrient storage and biological activities.

Biological indicator characterises the state of an ecosystem and brings its modifications. Lichen is a natural bio-indicator of climate change and air pollution effect. It is a combination of an alga and a fungus which live together in symbiotic association. Lichen is a sensitive environmental parameter like temperature humidity, wind and air pollutants. It gives information about changes in climate, air quality and biological process.

Figure 7.21 Lichen

7.6 Agriculture Research Institutions

Agricultural research institutions formulate the agricultural practices based on recent research results and farmers' needs. They disseminate those information for the welfare of the people using suitable media and methods. Indian Agricultural Research Institute and Indian Council of Agricultural Research are some of the institutions which are involved in agricultural research.

7.6.1 Indian Agricultural Research Institute (IARI)

The Indian Agricultural Research Institute is a national institute for agricultural research, education and extension. IARI is commonly known as the Pusa Institute. It is financed and administrated by the ICAR (Indian Council of Agricultural Research). This was responsible for research leading to the green revolution in India during 1970s. The policies, plans and programs of IARI have helped to meet the needs of the nation. Several popular high yielding varieties of major crops have been developed by IARI.

Figure 7.22 The Indian Agricultural Research Institute

7.6.2 Indian Council of Agricultural Research (ICAR)

The Indian Council of Agricultural Research is an autonomous body responsible for co-ordinating agricultural education and research in India. The union minister of agriculture serves as its president. It functions under the Department of Agricultural Research and Education, Ministry of Agriculture. It is the largest network of agricultural research and education institutes in the world.

Figure 7.23 Indian Council of Agricultural Research

7.6.3 Krishi Vigyon Kendra

Krishi Vigyan Kendra is a farm science centre. These centres serve as the ultimate link between ICAR (Indian council of Agricultural research) and farmers. Their aim is to apply agricultural research findings in practical localized settings. The first KVK was established in 1974 in Pondicherry. Since then, KVKs have been established in all states and the number continues to grow. KVKs are expected to undertake their own projects. They are also expected to serve as a resource center for extending government initiative to local areas. KVKs can be formed under a variety of host institutions, including agricultural universities, state departments, ICAR institutes, other educational institutions or non government organisations.

a. Responsibilities of KVK

Each KVK operates a small farm to test new technologies, such as seed varieties or innovative farming methods developed by ICAR institutes. This allows new technologies to be tested at the local level before being transferred to farmers. It also organizes programs to show the efficacy of new technologies on farmer's fields. KVKs organise workshops to discuss modern farming techniques with groups of farmers. KVKs provide advisory service to the farmers about weather and market pricing through radio and mobile phones. It focuses on crops and cultivation methods. It also facilitates rapport between the institution and the local community.

Activity 6

Visit a Krishi Vigyon Kendra in your area with your teacher. Find out the activities carried out in those centres.

7.7 Foliar Sprays

Foliar feeding is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Plants are able to absorb essential elements through the stomata in their leaves. But total absorption takes place through epidermis. Sea-based plant mixes from kelp contains trace nutrients and some hormones which are useful for the development of plant leaves, flowers and fruit. Foliar feeding is generally done in the early morning or late evening.

Figure 7.24 Foliar spraying on trees

DO YOU KNOW?

Plant shows quick response to the nutrients applied by foliar feedings. The efficiency of nutrients uptake is considered to be 8-9 folds higher when nutrients are applied to the leaves, when compared with nutrients applied to soil. A foliar feeding is recommended when environmental conditions limit the uptake of nutrients by roots.

7.7.1 EM (Effective Microorganisms) Technology

Effective microorganisms are a culture of different effective microbes, commonly occurring in nature. Nitrogen fixers, phosphate stabilizers, photosynthetic micro organisms, lactic acid bacteria, yeast, Rhizo bacteria and various fungi and actinomycetes are used as effective microorganisms. In this consortium, each mocro organisms has its own beneficial role in nutrient recycling, plant protection and soil health and fertility enrichment.

7.7.2 Vermiwash

Vermiwash is a liquid that is collected after the passage of water though a column of worm action. It is a collection of excretory product and mucus secretion of earthworms along with micronutrients from the soil organic molecules. Vermiwash is used as a foliar spray for crops.

7.7.3 Panchagavya

Panchgavya is a promoter with a combination of five products obtained from the cow, which includes cow dung, cow's urine, milk, curd and ghee. All the five products are collectively termed as panchgavya. Panchgavya has the potential to play the role of promoting growth and providing immunity booster. It provides resistance to pests and increases the overall yield. It can be prepared by the farmers themselves with the materials available on the farm.

Pachgavya can be used for seed treatment also. For this, seeds are soaked for 20 minutes before sowing. The present form of panchgavya is a single organic input which can act as a potentialator. The products of local breed of cow is said to have more potency than the products of exotic breeds.

7.8 Biocontrol Methods

Bio-control or biological control is a method of controlling pests such as insects, mites, weed and plant diseases using other organisms. Bio predators, bio-pesticides, bio-repellents' and bio-fertilizers are used for controlling microorganisms which cause damage to the crops, pests and insects.

I4C3S5

Bio-predators

These are naturally occurring insects that use pests for feeding or multiplication. By introducing large numbers of predators in a greenhouse we can destroy the pest. Predators like Chrysopa spp. and Menochilus spp. are highly useful in controlling a wide variety of pests like aphids, white flies, cotton bollworms, leaf insects etc.

DO YOU KNOW?

The black kneel capsid is an insect found on fruit trees. It eats more than 1000 fruit tree red spider mites per year.

Figure 7.25 Ingredients of Panchagavya

Figure 7.26 Predatory Lady bird beetle feeding on Aphid

Bio-pesticide

Bio-pesticides are living organism or their derived parts which are used as bio-control agents to protect crops against insect pests. Entomopathegenic viruses, bacteria insecticides, particularly bacillus thuringiensis, entamofungal pathogens, protozoans and insect parasitic nematodes have been found to control important pests which affect crops. These bio-pesticides are commercially available but quite difficult to formulate in field conditions. Bio-pesticides are of different types based on their origin.

Fungal bio-pesticides: Trichodermaviride is a fungus used as a biological pesticide. It is useful to control various disease caused by fungi such as wilt, rusting of leaves and root disease.

Bacterial bio pesticide: A culture of bacillus thuringiensis bacteria is effectively used to control the pest Lepidoptera that attack cotton, maize plants. Panchagavya and leaves decoction of some plants are also used as bio-pesticides.

Bio - repellant

Compound Azadiractin obtained from seeds of neem serves as a good insect-repellant. One of the earliest pesticides used by man was margosa leaves. The dried leaves repel the pests from stored grains.

Bio-fertilizer

Bio fertilizers are organisms which can bring about soil nutrient enrichment. Nitrogen fixing microorganisms have the capability of converting free nitrogen into nitrogenous compounds and make the soil fertile. The main source of bio-fertilizers is cyano bacteria and certain fungi. Although the chemical fertilizers increase food production, they degrade the natural habitat. Free living bacteria live freely in the soil and fix atmospheric nitrogen and make it available to the crops like cereals, millets, fruits and vegetables. Eg. Azosprillum. Free living cyano bacterium involves in nitrogen fixation along with photosynthesis. Eg. Anabeana, Nostoc. Symbiotic bacteria fix atmospheric nitrogen. eg. Rhizobium

Figure 7.27 Bio fertilizer

Activity 7

Take a leguminous plant like pea and find out if there are any nodes. Rhizobium bacteria live in such nodes.

Points to Remember

- Kharif, Rabi and Zaid are the main crops cultivated in our country.
- Ploughing, sowing, applying fertilizers, harvesting and storage are the different activities in crop production.
- Sowing by hand, seed drill and dibbling are the methods of sowing seeds.

- The various sources of irrigation are wells, tube wells, ponds, lakes, rivers, dams and canal.
- Sprinkler and drip system are the modern methods of irrigation.
- The process of cutting and gathering a crop is called harvesting.
- The term harvesting also includes the immediate post-harvest practices such as threshing and winnowing.
- Mono cropping and mixed cropping are the two methods used in crop production.
- Seed bank is a place where seeds are stored in order to preserve genetic diversity.
- A bio-indicator or biological indicator is any species or group of species whose function or status reveals the qualitative status of the environment.
- Bio predators, bio-pesticides, bio-repellents' and bio-fertilizers are used for controlling microorganisms which cause damage to the crops, pests and insects.

GLOSSARY

Ploughing	The process of loosening and turning of the soil.
Broadcasting	The process of scattering of seeds on soil surface with hand.
Dibbling	Placement of seed material in a furrow, pit or hole at predetermined spacing.
Sprinkler irrigation	Method of applying irrigation water which is similar to natural rainfall.
Monoculture	Planting of the same crop in the same field year after year.
Seed bank	A place where seeds are stored in order to preserve genetic diversity.
ICAR	Indian Council of Agricultural Research
KVK	Krishi Vigyan Kendra
Vermiwash	A liquid that is collected after the passage of water though a column of worn action.
Panchgavya	A promoter with a combination of five products obtained from the cow, which includes cow dung, cow's urine , milk , curd and ghee.
Bio fertilizers	Organisms which can bring about soil nutrient enrichment.

TEXT BOOK EXERCISES

Z5V3Q6

I. Choose the best answer

1. The process of placing seeds in the soil is called as

   a. ploughing b. sowing

   c. crop production d. crop rotation

2. Organism that control insects and pests of plant crops is

   a. bio-pesticides b. bio-fertilizers

   c. earthworms d. neem leaves

3. The method in which water flows over the soil surface and allow it to infiltrate is
   a. irrigation b. surface irrigation
   c. springler irrigation d. drip irrigation
4. Effective microorganism preparation is not used in
   a. seed treatment b. foliar spray
   c. soil treatment d. bio-predators
5. Which of the following is not present in Panchagavya?
   a. Cow dung b. Cow's urine
   c. Curd d. Sugar

II. Fill in the blanks

1. The process of actively growing seedling from one place and planting in the main field for further growth is called _____.
2. _____ is a plant growing in a place where it is not wanted.
3. The chemicals used for killing the weeds or inhibiting their growth are called as _____
4. _____ seeds transfers its unique characteristics to the descents.
5. _____ centers serve as the ultimate link between ICAR and farmers.
6. Several popular high yielding varieties of major crops have been developed by _____

III. Match the following.

1.	Bio-pesticide	-	Neem Leaves
2.	Bio-predators	-	Bacillus thuringiensis
3.	Bio-fertilizer	-	Control white flies
4.	Bio-indicators	-	Improve soil fertility
5.	Bio-repellants		Quality of environment

IV. Answer briefly.

1. Define ploughing.
2. Name the methods of sowing.
3. What is foliar spray?
4. Give a brief account on Krishi Vigyon Kendra.
5. What is bio-indicator ? How does it help human beings?
6. What do you mean by weeding?
7. What is crop rotation?
8. What is green manure?

V. Answer in detail.

1. Explain the agricultural practices.
2. Give a detailed account on irrigation.
3. What is weed? Explain the different methods of weed control.

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INTERNET RESOURCES

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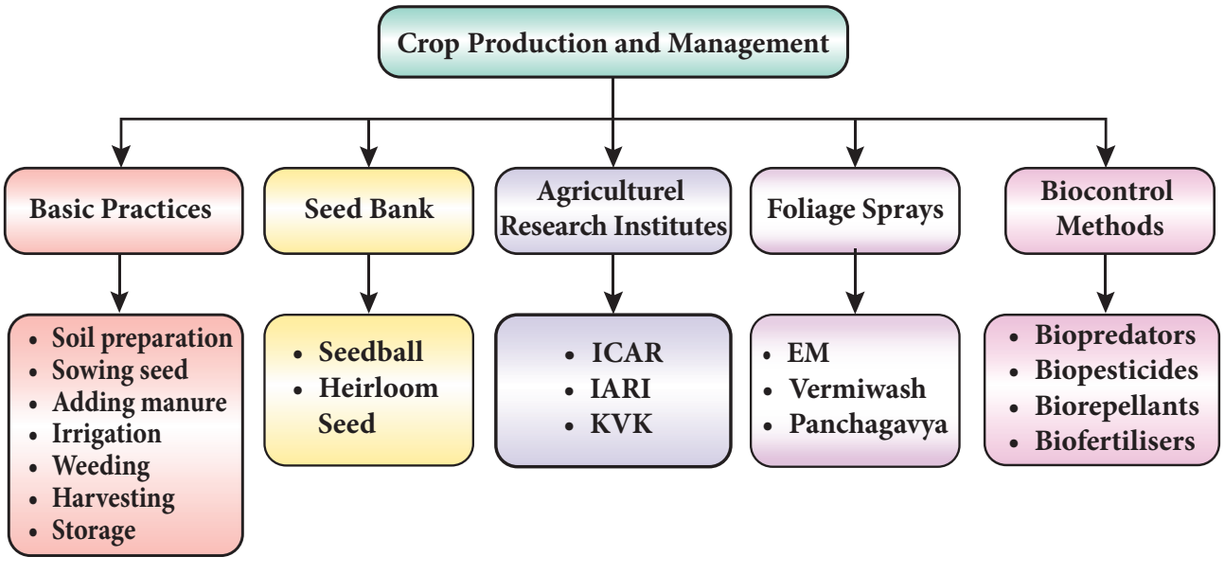
Concept Map



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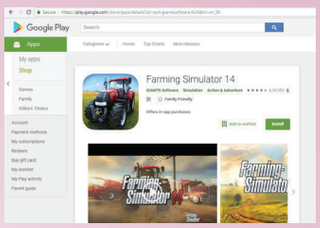
Crop Protection

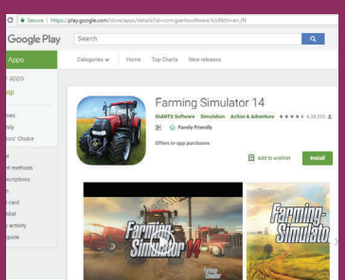
Lets enjoy and do agriculture in your mobile



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

Step 2 click on the INSTALL icon displayed in the screen to install the game in your mobile.

Step 3 Click the button TOUCH TO BEGIN and enjoy doing agriculture.



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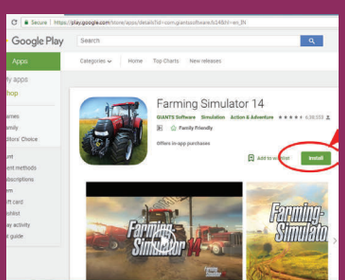

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B359_8_SCIENCE_EM

UNIT 8

CONSERVATION OF PLANTS AND ANIMALS

Learning Objectives

W1H7K9

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

- understand deforestation, afforestation and reforestation.
- list out the endangered species.
- understand the importance of conservation of wildlife.
- know about Red Data Book and its advantages.
- list out the importance of Peoples' Biodiversity Register.
- know about the functions of animal welfare organisations.

Introduction

Our planet earth is filled with so many species of plants and animals. According to the scientists there are about 70 – 100 lakh species on the earth. The sum total of all these animals is called biodiversity. Bio means life, diversity means variety or different. Thus bio-diversity means variety of life forms on the earth and the essential interdependence of all living things. When you travel through the forests in the mountain ranges you can see variety of life forms. Forests are abundant with fruit trees and flowers and inhabited by chirping birds, prancing deer and plenty of other animals. All through the literature of ages, it has been mentioned that India is full of forests filled with wildlife. Unfortunately, from then to now, most of these forests have been cut down. This phenomenon is seen all across the world. Forests as a natural resource are decreasing in area in the recent years. In this lesson we are going to learn about deforestation, endangered species, conservation of plants and animals and wildlife sanctuaries and national parks.

8.1 Deforestation

Forests are the important renewable resources. They cover about 30 percent of the world's land surface. They produce oxygen and maintain the level of carbon dioxide in the atmosphere. Forests provide many important goods such as timber, paper and medicinal plants. They control water runoff, protect soil, and regulate climate changes. But the forests all around the world are being destroyed. Destruction of forests in order to make the land available for different uses is known as deforestation. Deforestation has resulted in several ecological imbalances such as increase in temperature, deficiency in rainfall etc. It has also resulted in the extinction of several species of animals and plants.

8.1.1 Causes of Deforestation

Deforestation may be caused by nature or it may be due to human activities. Fires and floods are the natural causes for deforestation. Human activities which are responsible for deforestation include agricultural expansion, cattle breeding, illegal logging, mining, oil extraction, dam

construction and infrastructure development. Let us study about some of them in this section.

a. Agricultural Expansion

With increasing population, there is an overgrowing demand for food production. Hence, large amount of trees are chopped down for crops and for cattle grazing. More than 40% of the forests are cleaned to obtain land and to meet the needs of agriculture.

b. Urbanization

Increase in population necessitates the expansion of cities. With the expansion of cities more land is needed to establish housing and settlement. Requirements like construction of roads, development of houses, mineral exploitation and expansion of industries also arise due to urbanisation. Forests are destroyed to meet all these needs.

c. Mining

Mining of coal, diamond and gold require a large amount of forest land. So, a large number of trees is cut down to clear the forest area. Moreover, the waste that comes out from mining pollutes the environment and affects the nearby plants.

d. Construction of dams

To provide water supply to the increasing population, large size dams are constructed. Hence, a great extend of forest area is being cleared.

Figure 8.1 Dam

e. Timber Production

We need wood to meet the needs of our daily life. Wood-based industries like paper, match-sticks, furniture need a substantial amount of wood supply. Wood is the most commonly used fuel. Thus, a large number of trees are being cut down for fuel supplies. Some people are involved in illegal wood cutting and destroy more number of trees. This is the main reason for the destruction of some valuable plants.

Figure 8.2 Destruction of trees

DO YOU KNOW?

Chipko Movement is primarily a forest conservation movement. The word 'Chipko' means 'to stick' or 'to hug'. Sunderlal Bahuguna was the founder of this movement. It was started in 1970s with the aim of protecting and conserving trees and preserving forest from being destroyed.

f. Forest fire

In many forests, fires are usually expected from time to time. They may be caused by humans, accidents or natural factors. Forest fires wipe out thousands of acres of forest land each year all over the world. This has tremendous effects on biodiversity and the economy as well.

Figure 8.3 Forest fire

g. Cyclones

Cyclones destroy the trees on a massive scale. They not only destroy the trees but also affect the livelihood of so many people who depend on them.

More to know

Name of the Cyclone	State	Year
Fani	Orissa	2019
Gaja	Tamil Nadu	2018
Phethai	Andhra Pradesh	2018
Ockhi	Tamil Nadu	2017
Vardah	Tamil Nadu	2016

8.1.2 Effects of Deforestation

There has been a long history of interdependence between man and the forests. Our survival without forest will be very difficult. They supply us the oxygen we need, cause rainfall and provide so many things needed for our life. But increase in population has resulted in the destruction of forests. Every year 1.1 crore hectares of forests has been cut down around the world. In India alone 10 lakh hectares of forests are destroyed which has resulted in so many harmful effects. Let us study about some of them.

a. Extinction of species

Deforestation has resulted in the loss of many wonderful species of plants and animals and many are on the verge of extinction. More than 80% of the world's species remain in the tropical rainforest. Reports say that about 50 - 100 species of animals are being lost each day as a result of destruction of their habitats.

b. Soil Erosion

Widespread trees in the forests protect the soil from the heat of the sun. When the trees are cut down, soils are exposed to the sun's heat. Extreme temperature of the summer dries up the moisture and makes the nutrients to evaporate. It also affects the bacteria that helps in the breakdown of organic matter. The roots of the trees retain the water and the top soil which provides nutrients to the plants. When the trees are cut down, soil is eroded and washed away along with the nutrients.

DO YOU KNOW?

Long distance travel by birds to escape severe environmental conditions is called migration. Many birds and many other animals migrate long distances during unfavourable season. Siberian Crane migrates from Siberia to India during winters to escape harsh conditions in Siberia and to get comfortable conditions and food in India. Siberian crane can travel average of 200 miles on a single day.

c. Water cycle

Trees suck the water from the roots and release the water into the atmosphere in the form of vapour during transpiration. When trees are cut down the amount of water vapour released decreases and hence there is a decrease in the rainfall.

d. Floods

Trees absorb and store a large amount of water with the help of their roots. When the trees are cut down, the flow of water is disrupted and it leads to flooding in some areas.

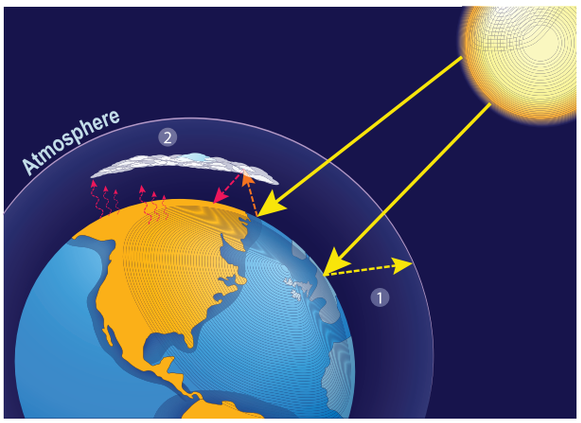


Figure 8.4 Global warming

DO YOU KNOW?

Amazon forest is the largest rain forest in the world, located in Brazil. It covers 6000000 square km. It helps to stabilize the earth's climate and slow global warming by fixing Co_2, and producing 20% of the world's oxygen in the process. It has about 390 billion trees. It is the lungs of the planet.

e. Global warming

We inhale oxygen present in the atmosphere and release carbon dioxide as waste. In turn trees absorb the carbon dioxide and provide us the oxygen during photosynthesis. Deforestation reduces the number of trees and hence the amount of carbon dioxide accumulates in the atmosphere. Carbon dioxide along with water vapor, methane, nitrous oxide and ozone forms the green house gases. These gases are responsible for global warming.

The solar energy falling on the earth's surface is reflected into the atmosphere. A part of this energy is reflected by the green house gases back to the earth to keep it warm and a part goes into the space. But gases such as methane and carbon dioxide accumulating in the atmosphere trap the heat energy inside the atmosphere leading to increase in temperature. This is called global warming. This results in the melting of glaciers in the polar region and affects the living organisms like polar bear.

f. Destruction of home land

Indigenous people live in and depend on forests for their survival. They get their food and many other resources from the forests. Destruction of forests affects their livelihood .

Activity 1

Make a field visit to a nearby forest with your teacher. Collect some rare specimen of plants. Also try to view some uncommon animals and list them. Collect some picture of plants and animals which you do not find around you and prepare an album.

8.2 Afforestation

Afforestation is the process of planting trees, or sowing seeds, in a barren land to create a forest. As we all know due to deforestation the climate is changing alarmingly in these days and there is no seasonal rainfall. Because of this many cities are facing water scarcity and many of the lands are becoming barren. Water is needed for life to exist on the earth.

DO YOU KNOW?

The term social forestry was first used in 1976 by the then National Commission on Agriculture, Government of India. It means the management and protection of forests and afforestation on barren land with the purpose of helping the environment, social and rural development. It is to raise the plantations thereby reducing the pressure on the traditional forest area.

Afforestation helps us to create the forests differently from natural forests.

Figure 8.5 Afforestation programme

8.2.1 Importance of Afforestation

The world is experiencing a great change in the climate in the recent years than ever before. These changes in the climate have given an alarming signal to everyone. To protect our planet earth afforestation would be a better solution. Importance of afforesatation is given below.

- Afforestation helps the wild animals and even humans to have shelter and to find their food source.
- Through afforestation we can increase the supply of oxygen. Trees planted can increase the water vapour in the atmosphere to get the rainfall.
- By planting trees the amount of carbon dioxide in the atmosphere can be reduced and thus the effects of air pollution, green house gases and global warming can be controlled.
- Afforestation enables us to avoid desertification of land.

Wangari Maathai founded the Green Belt Movement in Kenya in the year 1977. GBM has planted over 51 million trees in Kenya. She was awarded the Nobel Peace Prize for 2004.

- Barren lands experience strong winds and it causes soil erosion. Top soil is washed away during rainfall. Afforestation helps to grow more trees so that they can hold the top soil along with the nutrients.
- Creating forests provides us fodder, fruits, firewood and many other resources.
- Industries need specific type of trees. Afforestation helps us to grow a particular type of trees.

Activity 2

Discuss about afforestation in the class and write a brief report in your note book.

8.3 Reforestation

Reforestation is the natural or intentional replanting of the existing forests that have been destroyed through deforestation. Reforestation may sound similar to afforestation but both of them are not same. Reforestation is replanting of trees in a land area which had lost its forest cover for some reason. But afforestation is growing forest in an area which originally had no tree cover. Reforestation is an effective strategy to fight global warming. In addition to benefiting the climate, reforestation helps in protecting important species of animals. Reforestation helps to rebuild habitats and degradation which are the leading threats to the health and endangerment of species.

Activity 3

Observe the important days related to conservation of nature. Also organise a ralley on protecting forest.

8.3.1 Importance of Reforestation

Both afforestation and reforestation are important for protecting the habitat, increasing the supply of forest products,

finding solution to climate changes and for many other reasons. Importance of reforestation is given below.

- Reforestation improves the quality of air we breathe by reducing carbon dioxide in it.
- The effects of deforestation can be checked and global warming can be reduced.
- Reforestation restores habitat loss and degradation and threats to species.
- Forest restoration can reverse the damage done by soil erosion. Reforestation will revive the watersheds which are important aspects of environmental well-being.
- Reforestation maintains the water cycle of the area as trees absorb moisture through the leaves and roots.
- Transpiration of trees helps to restore the moisture of the atmosphere and to maintain the temperature in the local environment.

Table 8.1 Difference between Deforestation and Reforestation

Deforestation	Reforestation
When the plants or trees are cut down, it is called deforestation.	When the plants or trees are grown or planted, it is called reforestation.
Deforestation has a negative effect on the environment.	Reforestation has a very good effect on the nature, as it builds the environment.

Table 8.2 Differences between Afforestation and Reforestation

Afforestation	Reafforestation
Trees are planted in new areas where there was no forest cover.	It is practiced in areas where forests have been destroyed.
One sapling is planted to get one tree.	Two saplings are planted to replace every felled tree.
It is practiced to bring more area under forest.	It is practiced to avoid deforestation.

8.4 Endangered Species

Our country is a home for variety of species and rich flora and fauna. Flora is the plant life occurring in a particular area. Fauna is the animal life occurring in a particular area.The Royal Bengal Tigers, the Asiatic Cheetah and several other birds are found in India. But due to various reasons like

P9Y9H7

Figure 8.6 Endangered Animals

DO YOU KNOW?

Each year, 22nd May is celebrated as World Biodiversity Day. Biodiversity is a term used to describe the different plants, animals, marine life, microorganisms, insects, habitats, ecosystem etc. that make our planet so unique and so fascinating.

Activity 4

Observe the following days in your school

World Forest Day	-	March 21
World Water Day	-	March 22
Environmental Day	-	June 5
World Nature Conservation Day	-	July 28
Ozone Day	-	September 16

environmental pollution, deforestation, loss of habitat, human interference, poaching and hunting many animals in India are extinct and many are endangered. Species which no longer exist on earth are called extinct species. e.g. Dinosaurs, Dodo. An endangered species is an animal or a plant that is considered to be at the risk of extinction. It means that there are only few of them left on the earth and soon they might extinct. It is reported that nearly 132 species of plants and animals are critically endangered in India. Snow leopard, Bengal tiger, Asiatic lion, Purple frog and Indian giant squirrel are some of the endangered animals in India.

Many algae, fungi, bryophytes, ferns and gymnosperms are disappearing with the destruction of forests. And, each disappearing species may take away with it many species of animals and microbes which depend on them for food and shelter. Similarly, list of animals on the verge of being lost is endless. Prawns, oysters, lobsters, crabs, squid, octopus, cuttlefish, beetles, dragonfly, grasshoppers, fish and even frogs are dying of absorbing poisonous gases through their skin. Locust is one insect which has almost disappeared from India. Following animals are getting rare these days.

- Reptiles: Some lizards, turtles, crocodiles and gharials.
- Birds: Falcon, eagle, hawk, vulture, peacock-peahen, pigeon, duck.
- Mammals: Wild cats such as tigers, lions, deer such as chinkara and blackbuck, chiru (Tibetan goat), musk deer, rhino, elephants, blue whale, flying squirrel.

Activity 5

Collect as many pictures of wild plants and wild animals as possible. Prepare a poster showing the endangered species separately.

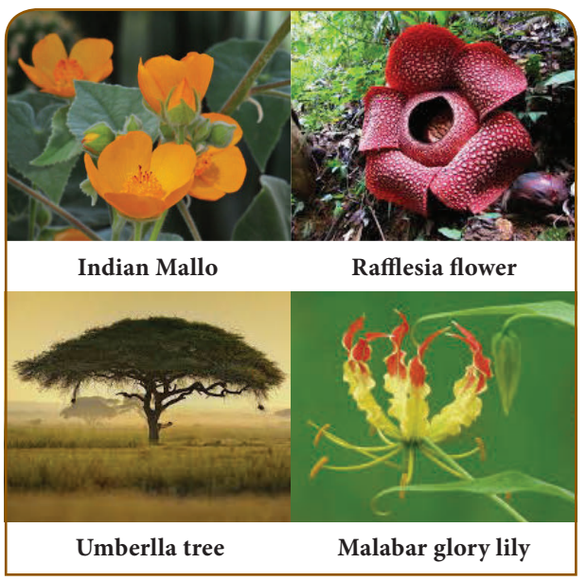


Figure 8.7 Endangered plants

Table 8.3 Endangered plants and animals.

Endangered Plants	Endangered Animal
Umbrella tree	Snow Leopard
Malabar lily	Asiatic Lion
Rafflesia flower	Lion tailed macaque
Indian mallo	Indian Rhinoceros
Musli plant	Nilgiri Tahr

8.4.1 Determination

Whether a particular species is endangered or not is determined by the following ways.

- When the geographical range of the species is limited.
- The population of the species is limited i.e., less than 50 adult individuals.
- When the population has decreased or will decrease by more than 80% in 10 years.
- If the population is less than 250 individuals and is continuously declining at 25% for the past three years.
- There is a high possibility of extinction in the wild.

DO YOU KNOW?

Yeoman Butterfly has been declared state butterfly of Tamil Nadu. This species is endemic to Western Ghats. It is among 32 butterfly species found in Western Ghats.

8.4.2 Causes for Endangerment

There are various reasons why a species may become endangered or extinct. Some of them are explained below.

a. Loss of habitat

Trees that provide food and shelter to so many species are destroyed due to human intervention.

b. Over hunting and poaching

Large number of animals is hunted for their horns, skin, teeth and many other valuable products.

c. Pollution

Number of animals are affected by pollutions like air pollution and water pollution. In the recent years more number of animals is affected by wastes in the form of plastic.

d. New habitat

Sometimes animals are taken by people to new habitat where they do not naturally live. Some of them may extinct and some may survive. The new ones may also get attacked by the species already living there and cause their extinction.

e. Chemicals

We use pesticides and other chemicals to get rid of damaging insects, pests or weeds. But they can also poison desired plants and animals if we do not use them correctly.

DO YOU KNOW?

At one time Dinosaur, ferns and some gymnosperms were wide spread on the earth. They disappeared from the earth, may be due to shortage of space and food or due to climatic change.

f. Diseases

Diseases due to various unknown reasons may affect the animals and make them extinct.

g. Natural calamities

Animals may also be destroyed due to natural disasters like flood and fire.

8.4.3 Saving Endangered Species

Nature is beautiful and it is filled with different plants and animals. For maintaining healthy ecological balance on the earth, animal and plant species are important. They have medicinal, scientific, ecological and commercial value. Each organism on the earth has a unique place in food chain that contributes to the ecosystem. But they are endangered mainly due to human activity. We need to take certain measures to protect them and preserve them.

- Some of the animal species are endangered mainly because of hunting and poaching. If it is controlled there can be a significant change in the number of endangered animals.
- Controlling pollution can have a positive impact on animals, fish and birds all over the world.
- When we consume more, more pollutants are put into the environment. By consuming less, we can protect the ecosystems.
- Animals often mistake plastic for food and hence plastics harm and cause endangerment of many species. Limiting the amount of plastic and recycling it can save the endangered animals.
- Recycling things and buying eco friendly products will preserve the environment resources and hence the animals.
- Pesticides and chemicals which cause damage to the environment should be avoided.
- Planting native trees will provide food to the animals.

DO YOU KNOW?

Planting the native trees like Neem tree, Umbrella tree and Banyan tree in our surrounding will be helpful for the animals. Many birds and animals find shelter in those trees.

8.4.4 Government Initiatives

In order to preserve the plants and animals, government has taken lot of initiatives and some acts have been passed to protect them. For example, Project Tiger is a wildlife conservation project initiated in India in 1972 to protect the Bengal Tiger. It was launched on 1st April 1973 and has become one of the most successful wildlife conservation ventures. Corbett National Park was the first National Park in India to be covered under project Tiger. Due to 'Project Tiger' the population of Tiger has increased in India from 1400 in 2006 to 2967 in 2018. The government has enacted the following Acts.

1. Madras Wildlife Act, 1873.
2. All India Elephant Preservation Act, 1879.
3. The Wild Bird and Animal Protection Act, 1912.
4. Bengal Rhinoceros Preservation Act, 1932.
5. All India Wildlife Protection Act, 1972.
6. Environmental Protection Act, 1986.

8.5 Red Data Book

The Red Data Book is the file for recording rare and endangered species of animals, plants and fungi. Even some local sub-species that exist within the territory of a state or country are recorded in red data books. Red data book gives important data for observational studies and monitoring programmes on habits and habitats of rare and endangered species. This book is created to identify and protect the species which are about to extinct.

Red Data Book is maintained by the International Union for Conservation of Nature. It is an international organization working in the field of nature conservation and sustainable use of natural resources. It was founded in 1964 with the aim of maintaining a complete record of every species that ever lived. The Red Data Book classifies species mainly into three categories namely, threatened, not threatened and unknown. This Book also has information as to why a species has become extinct along with the population trends and its distribution.

The Red Data Book contains colour-coded information sheets like black for species which are extinct, red for species that are endangered and so on. They are arranged according to the extinction risk of many species and subspecies. The following figure gives the colour coded information.

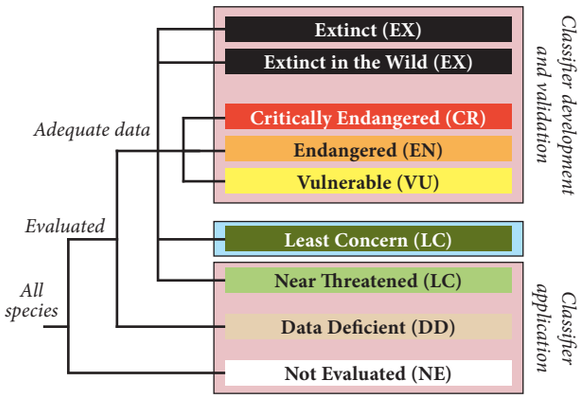


Figure 8.8 IUCN Red List Categories

DO YOU KNOW?

WWF – World Wildlife Fund
ZSI – Zoological Survey of India
BRP – Biosphere Reserve Programme
CPCB – Central Pollution Control Board
IUCN – International Union for Conservation of Nature

8.5.1 Advantages of the Red Data Book

- It helps to evaluate the population of a particular species.
- The data given in this book can be used to evaluate the species at the global level.
- The risk of a species becoming globally extinct can be estimated with the help of this book.
- It provides guidelines for implementing protective measures for endangered species.

8.5.2 Disadvantages of the Red Data Book

- The information available in the Red Data Book is incomplete. Many extinct species are not updated in this book.
- The source of the book's data has been speculated.

- This book maintains the complete record of all animals, plants, other species but it has no information about the microbes.

World Wildlife Day is observed on March 3rd every year.

8.5.3 Red Data Book of India

India, a mega-diverse country with only 2.4% of the world's land area, accounts for 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals. The country's diverse physical features and climatic conditions have resulted in a variety of ecosystems such as forests, wetlands, grasslands, deserts, coastal and marine ecosystems which harbour and sustain high biodiversity and contribute to human well being. Four out of 34 globally identified biodiversity hotspots, the Himalayas, the Western Ghats, the North-East, and the Nicobar Islands, can be found in India.

India became a State Member of IUCN in 1969, through the Ministry of environment, Forest and Climate Change (MoEFCC). The IUCN India Country Office was established in 2007 in New Delhi. Red Data Book of India contains the conservation status of animals and plants which are found in the Indian subcontinent. Surveys conducted by the Zoological Survey of India and the Botanical Survey of India under the guidance of the Ministry of Environment, Forest and Climate Change provide the data for this book.

8.6 CONSERVATION

According to WWF (World Wildlife Fund) there has been 60% decrease in the size of population of animals, birds, fish, reptiles and amphibians over the past 40 years. In order to leave something for the future generation, we need to conserve it now. Conservation is the protection, preservation, management of wildlife and natural resource such as forest and water. Conservation of biodiversity helps us to protect, maintain and recover endangered animals and plant species. Conservation is of two types. They are:

- In-situ conservation (within habitat)
- Ex-situ conservation (outside the habitat)

8.6.1 In-situ conservation

It is nothing but conservation of living resources within the natural ecosystem in which they occur. This is achieved by protection of natural habitat and maintenance of endangered species in certain protected areas such as national parks, wildlife or bird sanctuaries and biosphere reserves. In India, there are about 73 national parks, 416 sanctuaries and 12 biosphere reserves.

a. National Parks

A National park is an area which is strictly reserved for the betterment of the wildlife. Here, activities like forestry, grazing or cultivation are not permitted. Even private ownership rights are not allowed in these areas. The national parks cover an area of 100 – 500 square kilometers. In these parks a single plant or animal species are preserved.

Table 8.4 National Parks in India

Name	State	Established year
Jim Corbett National Park	Uttarakhand	1936
Dudhwa National Park	Uttar Pradesh	1977
Gir National Park	Gujarat	1975
Kanha National Park	Madhyapradesh	1955
Sundarbans National Park	West Bengal	1984

Figure 8.9 Corbett National Park

Table 8.5 National Parks in Tamil Nadu

Name	Established year	District
Guindy National Park	1976	Chennai
Gulf of Mannar National Park	1980	Ramanathapuram
Indira Gandhi National Park	1989	Coimbatore
Mudumalai National Park	1990	The Nilgiris
Mukurthi National Park	1990	The Nilgiris

b. Wildlife sanctuaries

A sanctuary is a protected area which is reserved for the conservation of animals only. Human activities like harvesting of timber, collection of forest products and private ownership rights are allowed here. Controlled interference like tourist activity is also allowed. The differences between national parks and wildlife sanctuaries are given in Table 8.6

Table 8.6 Difference between National Parks and Wildlife Sanctuaries

Wildlife Sanctuary	National Parks
Human activities are allowed.	No human activities are allowed.
Main aim is to protect a particular flora or fauna.	Can include flora, fauna or any other objects of historical significance.
There are no fixed boundaries.	Boundaries are fixed and defined.
It is open to the general public	Not usually open to the public.
Sanctuaries are usually formed by the order of Central or the State Government	National Parks are formed by the State or Central Legislature.
A sanctuary can be upgraded to a national park	A national park cannot be downgraded to a sanctuary.

Table 8.7 Wildlife Sanctuaries in Tamil Nadu

Name	Established year	District
Meghamalai Wildlife Sanctuary	2016	Theni
Vandaloor Wildlife Sanctuary	1991	Chennai
Kalakad Wildlife Sanctuary	1976	Thirunelveli
Grizzled Squirrel Wildlife Sanctuary	1988	Virudhunagar
Vedanthangal Wildlife Sanctuary	1936	Kanchipuram

Figure 8.10 Vedanthangal wildlife sanctuary

c. Biosphere reserves

Biosphere is a protected area where human population also forms the part of the system. The area of these places will be around 5000 square kilometers. They conserve the eco system, species and genetic resources. These areas are set up mainly for economic development.

Table 8.8 Biosphere Reserves in India

Name of Biosphere	State
Nanda Devi	U.P
Nokrek	Meghalaya
Manas	Assam
Sunderbans	West Bengal
Gulf of Mannar	Tamil Nadu
Nilgiri	Tamil Nadu
Great Nicobars and Similipal	Orissa

Activity 6

Find out the national parks and wildlife santuaries in Tamil Nadu. Visit those places and collect more information about them.

Advantages of In-situ conservation

- Species can be adapted to their habitat.
- Species can interact with each other.
- Natural habitat is maintained.
- It is less expensive and easy to manage.
- Interests of indigenous people are protected.

8.6.2 Ex-situ Conservation

It is the conservation of wildlife outside their habitat. Establishing zoos and botanical gardens, conservation of genes, seedling and tissue culture are some of the strategies followed in this method.

a. Botanical gardens

It is a place where flowers, fruits and vegetables are grown. These places provide a healthy and calm environment.

b. Zological parks

Zological parks are the areas where wild animals are conserved. In India there are about 800 zological parks.

The oldest zoo is Schoenbrunn Zoo in Vienna, established in the year 1759. In India the first Zoo was established in Barrachpur in the year 1800.

c. Tissue Culture

It is a technique of growing plant cells, tissues, organs, seeds or other plant parts in a sterile environment on a nutrient medium.

d. Seed bank

The seed bank preserves dried seeds by storing them in a very low temperature. The largest seed bank in the world is the Millennium Seed Bank in England.

e. Cryo Bank

It is a technique by which a seed or embryo is preserved at a very low temperature. It is usually preserved in liquid nitrogen at –196ºC. This is helpful for the conservation of species facing extinction.

Advantages of Ex-situ conservation

- It prevents the decline of species.
- Endangered animals can be breeded in these ways.
- Threatened species are breeded and released in natural environment.
- It is useful for conducting research and scientific work.

Activity 7

Make a field trip to a nearby zoological park or a botanical garden. List out the different species found there.

8.7 PBR (PEOPLE'S BIO DIVERSITY REGISTER)

People's Biodiversity Register is a document which contains comprehensive information on locally available bio-resources including landscape and demography of a particular area or village. Bio-resources mean plants, animals and microorganisms or parts thereof, their genetic material and by-products with actual or potential use or value. A Biodiversity Management Committee is set up in each local body according to the provisions of Biological Diversity Act, 2002. This committee prepares the People's Biodiversity Registers with the guidance and technical support of National Biodiversity Authority and the State Biodiversity Boards.

Preparation of this register promotes conservation, preservation of habitats and breed of animals and gathering of knowledge relating to biological diversity. The register entails a complete documentation of biodiversity in the area related to the plant, food source, wildlife, medicinal source, traditional knowledge etc.

8.8 BIOMAGNIFICATION

Biomagnification is the increase in contaminated substances due to the intoxicating environment. The contaminants might be heavy metals such as mercury, arsenic, and pesticides such as polychlorinated biphenyls and DDT (Dichloro Diphenyl Trichloro ethane). These substances are taken up by the organisms through the food they consume. When the organisms in the higher food chain feed on the organisms in the lower food chain containing these toxins, these toxins get accumulated in the higher organisms.

8.8.1 Causes of Bio-magnification

Following are the major causes of bio-magnification:

a) The agricultural pesticides, insecticides, fertilizers and fungicides are very toxic and are released into the soil, rivers, lakes, and seas. These cause health issues in aquatic organisms and humans.

b) Organic contaminants cause adverse impact on the health of humans, animals, and wildlife.

c) Industrial activities release toxic substances which enter into the food chain leading to bio-magnification.

d) Mining activities generate a large amount of sulphide and selenium deposits in water. These toxic substances are absorbed by the aquatic organisms in the food chain.

8.8.2 Effects of Bio-magnification

Following are the effects of bio-magnification on living organisms and the environment:

a) It has more impact on humans causing cancer, kidney problems, liver failure, birth defects, respiratory disorders, and heart diseases.

b) It also affects the reproduction and development of marine organisms

c) The destruction of coral reefs affects the lives of many aquatic animals.

d) The chemicals and toxins which are released into the water bodies disrupt the food chain.

8.9 ANIMAL WELFARE ORGANISATIONS

Animal welfare organizations are the group of people concerned with the health, safety and psychological wellness of animals. They include animal rescue groups which help animals in distress, and others which help animals suffering from some epidemic. In this section we will study about some of them.

8.9.1 Blue Cross

Blue Cross is a registered animal welfare charity in the United Kingdom, founded in 1897 as 'Our Dumb Friends League'. The vision of this charity is that every pet will enjoy a healthy life in a happy home. The charity provides support for pet owners who cannot afford private veterinary treatment, helps to find homes for unwanted animals, and educates the public in the responsibilities of animal ownership.

The organisation was founded to care for working horses on the streets of London, UK. It opened its first animal hospital, in Victoria, London, on 15 May 1906.

Captain V. Sundaram founded the Blue Cross of India, the largest animal welfare organization of Asia in Chennai in the year 1959. He was an Indian pilot and animal welfare activist. Now, Blue Cross of India is country's largest animal welfare organizations and it runs several animal welfare events like pet adaptation and animal right awareness. Blue Cross of India has received several international and national awards. This organization is entirely looked after by volunteers. The main office is located at Guindy, Chennai, with all amenities like hospitals, shelters, ambulance services and animal birth controls, etc. Activities of the organization include, providing shelters, re-homing, adoption, animal birth control, maintaining hospitals and mobile dispensary and providing ambulance services.

8.9.3 CPCSEA

CPCSEA stands for 'The Committee for the Purpose of Control and Supervision of Experiments on Animals'. It is a statutory committee set up under the Preservation of Cruelty to Animals Act, 1960. It has been functioning since 1991 to ensure that animals are not subjected to unnecessary suffering during experiments on them.

Objectives of CPCSEA

i) To avoid unnecessary pain before and after experiment.

ii) To promote the human care of animal used in experiments.

iii) To provide guidelines for animal Housing, breeding and maintenances.

iv) To promote the human care of animal used in biomedical and behavioural research and testing.

Functions of CPCSEA

i) Approval of animal house facilities.

ii) Permission for conducting experiments involving usage of animals

iii) Action against establishments in case of established violation

iv) Registration of establishments conducting animal experimentation or breeding of animals for this purpose.

Points to Remember

- Human activities which are responsible for deforestation include agricultural expansion, cattle breeding, illegal logging, mining, oil extraction, dam construction and infrastructure development.
- Afforestation helps the wild animals and even humans to have shelter and to find their food source.
- Reforestation will revive the watersheds which are important aspects of environmental well-being.
- Snow leopard, Bengal tiger, Asiatic Lion, Purple frog and Indian giant squirrel are some of the endangered animals in India.
- For maintaining healthy ecological balance on this earth, animal and plant species are important.
- Red Data Book gives important data for observational studies and monitoring programmes on habits and habitats of rare and endangered species.
- Conservation of biodiversity helps us to protect, maintain and recover endangered animals and plant species.
- When the organisms in the higher food chain feed on the organisms in the lower food chain containing these toxins, these toxins get accumulated in the higher organisms.

A-Z GLOSSARY

Biodiversity	Variety of life forms.
Bio magnification	Increasing concentration of substances such as toxic chemical in the tissues of organism at successively higher level in a food chain.
Deforestation	Removal of forest.
Extinct species	Species which have disappeared completely from the earth.
Endangered species	A species of plant or animal that is in immediate danger of biological extinction.
Endemic species	Plants and animals species that are found only in a particular area.
Flora	Plant life occurring in a particular region.
Fauna	Animal life occurring in a particular region.
National Park	Protected area of land in which a typical ecosystem with all its wild plants and animals are protected and preserved in natural surroundings.

Reforestation	Replanting of trees.
Red Data Book	Recording about endangered species.
Wildlife Sanctuary	Protected area of land, wetland or sea reserved for the conservation of wild animals, birds and plants.

TEXT BOOK EXERCISES

A8G9J2

I. Choose the correct answer.

1. The plants found in a particular area are known as _____
   a) fauna b) flora
   c) endemic d) rare
2. Deforestation means _____
   a) cleaning of forest b) to grow plants
   c) to look after plants d) None of these.
3. The Red Data Book gives a list of _____
   a) endemic species b) extinct species
   c) natural species d) None of these
4. Insitu conservation is_____
   a) off site conservation
   b) on site conservation
   c) Both a and b d) None of these
5. Wildlife Protection Act was implemented in _____
   a) 1986 b) 1972 c) 1973 d) 1971

II. Fill in the blanks

1. WWF stands for _____.
2. The animal found in a particular area is known as _____.
3. Red Data Book is maintained by _____.
4. Mudhumalai Wildlife Sanctuary is located in _____ district.
5. _____ is observed as 'World Wildlife Day'

III. Match the following

Gir National Park	-	Madhya Pradesh
Sundarabans National Park	-	Uttarangal
Indira Gandhi National Park	-	West Bengal
Corbett National Park	-	Gujarat
Kanha National Park	-	Tamil Nadu

IV. Answer very briefly

1. What is global warming?
2. What is known as extint species?
3. Give few example for extinct species.
4. Name two endangered animals.
5. What is ICBN?

V. Answer briefly

1. What is biosphere reserve?
2. What is tissue culture?
3. What is endangered species? Give two examples.
4. Write the advantages of the Red Data Book.
5. Mention four main reasons for the conservation of forests.
6. What do you understand by the term bio magnification?
7. What is PBR?

VI. Answer in detail

1. What is Deforestation? Explain the causes and effects of Deforestation.

2. Discuss the advantages of Insitu and exsitu conservation..
3. Write about the types of conservation.
4. Write a note on Blue Cross.

VI. HOT

1. Is it possible to find Dinosaurs today? Why?
2. Animals are affected by Deforestation. How?
3. Why did the numbers of Tiger and Black buck decrease?

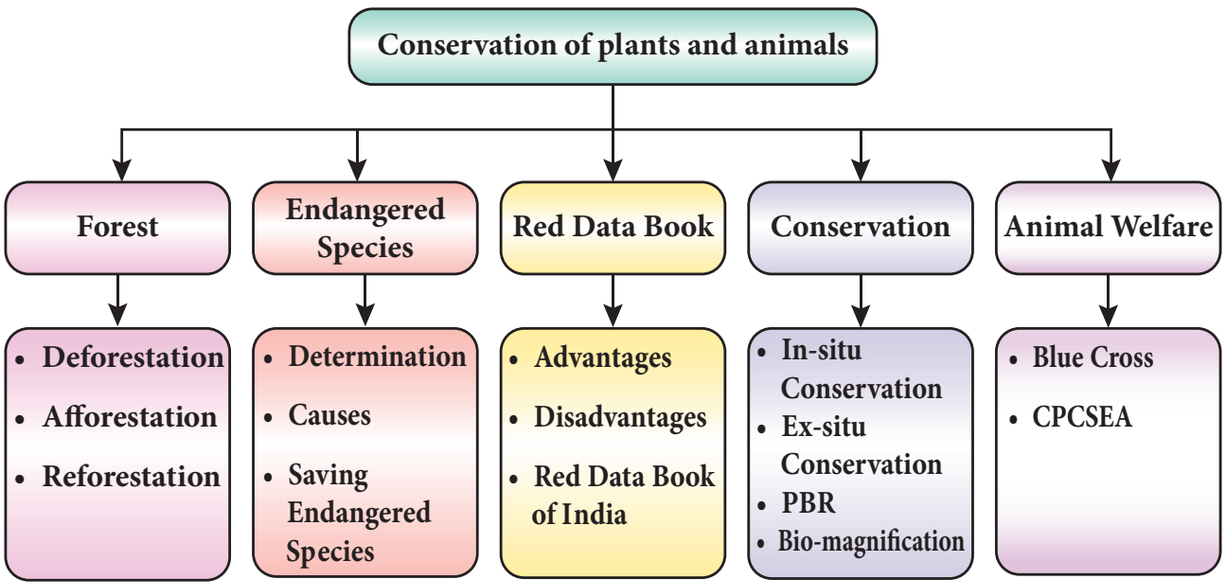
REFERENCE BOOKS

1. Environmental biology- Verma P S – S Chand & co publisher
2. Indian wildlife –The great wildlife series- APApublication
3. Endangered Animals of India – S M Nair – National book trust India

INTERNET RESOURCES

www.Bluecrossofindia.org
www.cpcsea.nic.in
www.pbr.com

Concept Map



ICT CORNER

Conservation of Plants and Animals

Watch the wild animals lively from your screen

Step 1 Open the browser and type the URL or scan the QR code given below. click on the LIVE ANIMAL YARD which is on the left of the page displayed.

Step 2 The page will open with icons showing animals click on the animal you wish.

Step 3 Click on the play button diplayed on the screen.

Step 4 Repete the action again by selecting the other animals or birds.

Web URL: https://www.aazp.in/

B359_8_SCIENCE_EM

UNIT 9

VISUAL COMMUNICATION

Learning Objectives

I3N3B4

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

- know how to create a document through the LibreOffice software.
- explore their creative thinking.
- learn how to align and format the document.

Introduction

LibreOffice is a powerful and free office suite, used by millions of people around the world. Its clean interface and feature-rich tools help you unleash your creativity and enhance your productivity. In this chapter, you will learn to use the software LibreOffice.

9.1 LibreOffice Components

LibreOffice includes the following components.

9.1.1 Text Document

Writer (word processor) is a feature-rich tool for creating letters, books, reports, newsletters, brochures, and other documents.

9.1.2 Calc (spreadsheet)

Calc has all of the advanced analysis, charting, and decision making features expected from a high-end spreadsheet. It includes over 300 functions for financial, statistical, and mathematical operations, among others.

9.1.3 Impress (Presentations)

Impress provides all the common multimedia presentation tools, such as special effects, animation, and drawing tools.

9.1.4 Drawing (Vector graphics)

Draw is a vector drawing tool that can produce everything from simple diagrams or flowcharts to 3D artwork.

9.1.5 Base (Database)

Base provides tools for day-to-day database work within a simple interface. It can create and edit forms, reports, queries, tables, views, and relations, so that managing a relational database is much the same as in other popular database applications.

9.1.6 Math (Formula editor)

Math is the LibreOffice fo rmula or equation editor. You can use it to create complex equations that include symbols or characters not available in standard font sets.

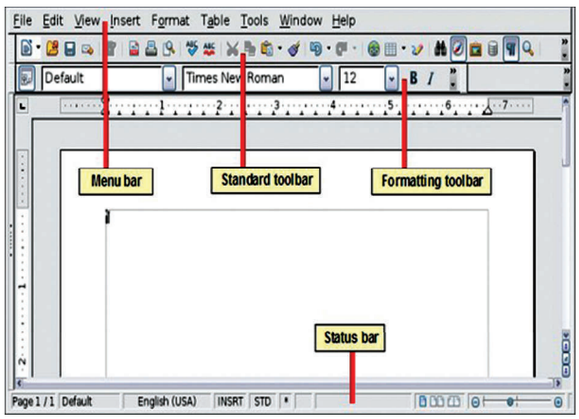
DO YOU KNOW?

How to get the software

Versions of LibreOffice for Windows, Linux, and Mac OS X can be downloaded free from http://www.libreoffice.org/download.

9.2 Text Document

In this section, we will discuss about the word processing. You can use it to type letters, reports and other documents. This lesson introduces you to the Word window. You use the Word window to interact with Text Document.



9.2.1 Managing Documents

This section of the lesson explains how to open a new/existing document, save a document, renaming a document and closing an opened document. There are several ways to create a new document, open existing documents and save documents in Word.

9.2.2 Create a New Document

To create a new document, do any one of the following methods:

1. Click the New Document button on the menu bar.
2. Choose File→New command from the menu bar.
3. Press CTRL+N keys on the keyboard.

9.2.3 Open an Existing Document

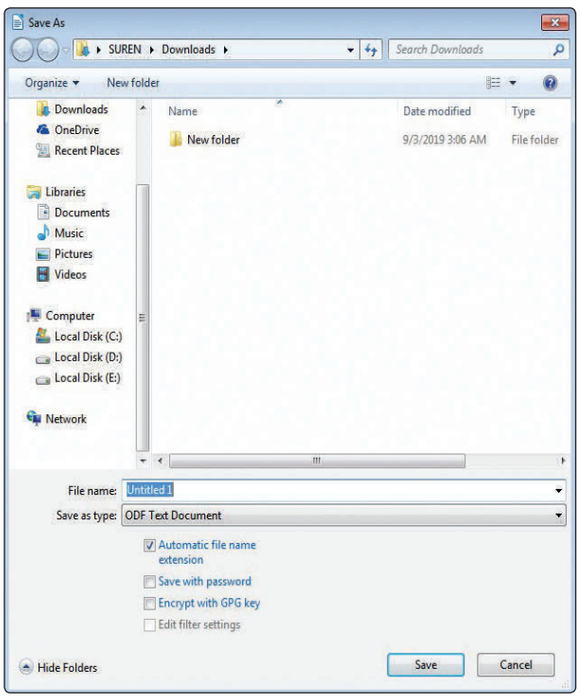
To open an existing document, do any one of the following methods:

1. Click the Open File button on the menu bar.
2. Choose File→Open command from the menu bar.
3. Press CTRL+O keys on the keyboard. Each of the above method will show the Open dialog box. Choose the file and click the Open button.

9.2.4 Save a New/Existing Document

To save a new/existing document that is opened, follow any one of the following methods:

1. Click the Save button on the menu bar.
2. Select File→Save commands from the menu bar.
3. Press CTRL+S keys on the keyboard.



If the document is already named and saved earlier, it will simply save the document. On the other hand, if the file is a new document then it will prompt you by opening 'Save As' dialog box. Select the folder where you want to place your document. Type the name of the document in File Name and then click OK. You can also save a new document by choosing File→Save As commands on the menu bar and then selecting the above actions in 'Save As' dialog box.

9.2.5 Close the Document

Close the current document by selecting File→Close command on the menu bar or click the Close icon if it is visible on the Standard toolbar.

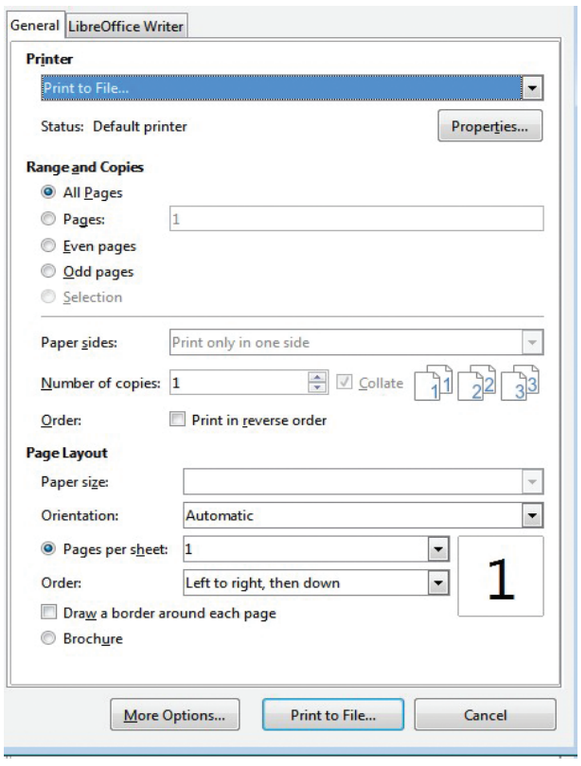
9.2.6 Printing a Document

To print a document or selected pages follow the steps given below:

1. Open the document to be printed.
2. Choose File → Print command on the menu bar.

The Print dialog box will open. Select the Options like print range, Number of copies, Printer name etc. See that printer is switched on and the paper is available in the printer tray.

3. Click OK.



9.2.7 Print Preview

Print preview provides a way to see how your document will look when printed. You can see several pages at once. It is similar to Print Layout View. An advantage of Print preview is that it has its own toolbar. The toolbar allows you to easily view multiple pages and change the magnification of the screen. You can also edit your document in print preview mode. To switch to print preview, use one of these methods:

1. Click on the Print preview in the file menu.

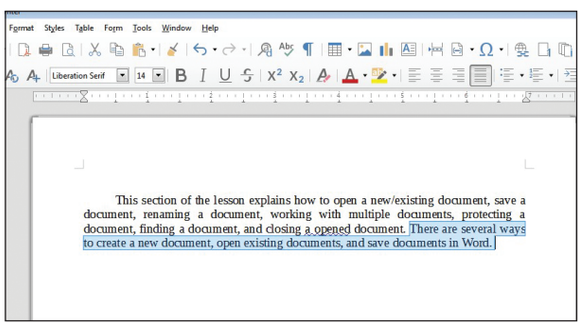
   Or Press CTRL+Shift+ O keys.

9.2.8 Exit Text Document

When finished you can close all the files, and quite the Word program by selecting File→Exit command on the File menu bar.

9.3 Selecting Text

Even though the document is built up by typing one character at a time, while editing and formatting one always work with words, lines, paragraphs and sometimes with the whole document. For this purpose one should learn how to select the text. Once the text is selected, change can be made to that text. The text can be moved, copied and made as bold. The font and colour of the text can also be changed. For selecting text, the mouse or the keyboard can be used.



9.3.1 Selecting Text with Mouse

Here, the following steps are to be followed.

1. Insertion point is moved to the start of the text to be selected.
2. The left mouse button should be clicked, held down and dragged across the text to be selected.

3. When the intended text is selected, the mouse button should be released.

9.3.2 Selecting Text with Keyboard

The following are the steps to be followed here.

1. Insertion point is moved to the start of the text to be selected.
2. The Shift key is pressed down and the movement keys are used to highlight the required text.
3. When the Shift key is released, the text is selected.

Cut and Copy

The main difference between Cut and Copy is that cut removes the selected data from its original position while copy creates a duplicate of the original content.

9.3.3 Moving the Text

The selected text can be easily cut and pasted in the required location. Following steps are to be followed.

1. The text to be moved to a new location is selected.
2. Edit → Cut is selected or in the tool bar is selected to cut the selected text.
3. Insertion point is moved to the place where the text is to be pasted.
4. Edit → Paste is selected or in the tool bar is selected to paste the text in the new location. The text can also be pasted in this way to another or another type of document.

The following keyboard shortcuts can be used to move text.

Ctrl + X → to Cut

Ctrl + V → to Paste

9.3.4 Copying the Text

1. The text to be copied is selected.
2. Edit → Copy is selected or is clicked.
3. The insertion point is selected where the copy of the text should appear and is clicked.

The following keyboard shortcuts can also be used for copy and paste:

Ctrl + C → to Copy

Ctrl + V → to Paste

9.4 Formatting Options

Almost all the formatting options are available under Format menu. LibreOffice Writer also conveniently provides buttons for the most commonly used options. But before these options can be used, the text on which they are to be used has to be selected. Once the desired portion of the text is selected then depending on the need any one of the following buttons are clicked:

Click **B** to make text Bold.

Click *I* to make text Italic.

Click U to make text Underlined.

The same can also be achieved by clicking on Format → Character

Alternatively Ctrl + B, Ctrl+I and Ctrl+U keys can be used to make the selected text bold, italic and underlined respectively.

9.4.1 Changing the Fonts

A font is a set of characters and numbers in a certain style. Each font looks different from other fonts.

Click the down arrow in the Fonts Combo box of font tab in Character dialog box.

Use Format → Character to open the Character dialog box.

From the list of available fonts, click the required one.

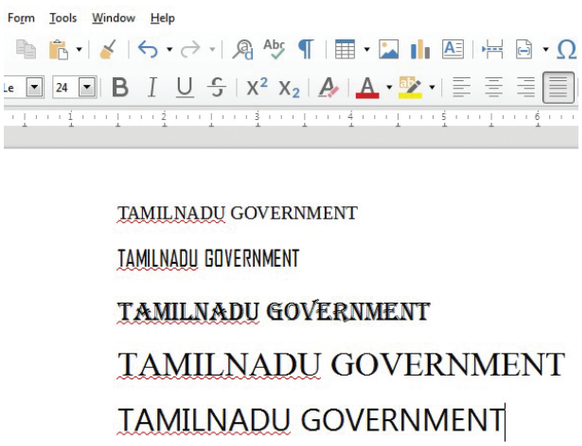
The text changes to the selected font.

Font Size

The size of the text is also important. The same size of the text cannot be used for a legal document, and an advertisement material.

Click the down arrow in the Size combo box of Fonts tab in Character dialog box.

The text changes to the selected font size.



9.4.2 Changing the Font Colour

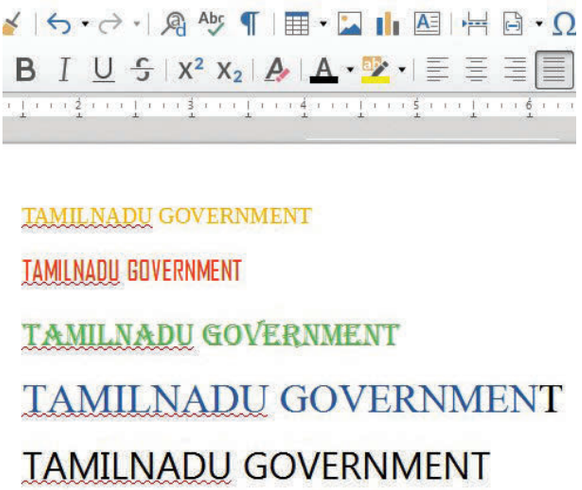
A different colour for selected text can be used. Colour printers are becoming more and more popular. With the help of a colour printer, some splash can be added to the documents by changing the colour of text.

To use a different text color, select the text and click the arrow in the

Font Colour icon

A colour palette is displayed from which the required colour can be selected.

Alternatively, select the text and click on the Font color icon, to apply the current colour of the Font Colour.



9.5 Alignment

Paragraph Alignment

Paragraph alignment refers to the appearance of the left and right sides of the paragraph. By default, Word aligns paragraphs to the left. You can align paragraphs in Word so the right sides are symmetrical. This is called right alignment. You can also align them so you center the lines with even space on both sides. This is called center alignment. Finally, you can justify the alignment, which aligns both the left and right sides.

Four types of alignment can be selected, and the best way to make a change is to use the Formatting toolbar.

The following steps are used here:

- To change the alignment of one paragraph, first click within that paragraph.
- To change the alignment of several paragraphs, select the ones needing change.

9.6 Page Orientation

Changing Page Orientation

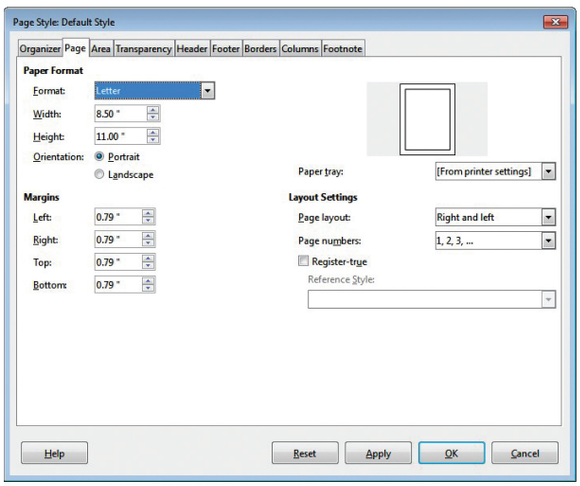
Usually the length of a document will be more than the width. This orientation is called

portrait. But in some of the documents the width will be more than the length. This type of orientation is called landscape. The default orientation is portrait.

To change the orientation or paper size, the following steps are used:

- The Format Page option is clicked.

Click the Page tab, if necessary.



- Select the necessary paper format from the Format drop-down list in the Page. Format section. Or enter the values in the Width and Height spin boxes.
- For changing the orientation Portrait or Landscape radio buttons are used.

Changing Margins Using Rulers

If the user is not having the exact value for the margins then the Ruler option on the View menu can be used to change the margins.

Following steps are used in this method:

- If the ruler is not displayed in the screen, View → Ruler option is clicked.
- The gray area of the ruler indicates the margin's top area.
- The mouse pointer is then moved in between the gray and white area of the ruler.
- When the pointer is in the right spot, it changes into a line with arrows on both sides
- The margin guide is dragged to a new location.

TEXT BOOK EXERCISES

I. Choose the best answer.

1. The Keyboard shortcut is used to copy the selected text

   a) Ctrl + C b) Ctrl + V
   c) Ctrl + X d) Ctrl + A

2. The Keyboard shortcut is used to cut the selected text

   a) Ctrl + C b) Ctrl + V
   c) Ctrl + X d) Ctrl + A

3. If the ruler is not displayed in the screen, _____ option is clicked.

   a) View-> ruler
   b) View-> task
   c) File-> save
   d) Edit->paste

4. How many types of page orientation are there in Libre office Writer?

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

5. The menu used to save the document is

   a) File-> open b) File-> print
   c) File-> save d) Edit->close

II. Answer briefly.

1. What is the use for Text document software?
2. What is selecting text?
3. How to close a document?
4. What is right alignment?
5. How to open an existing document?

GLOSSARY

Afforestation	-	காடுவளர்ப்பு
Acid	-	அமிலம்
Antacid	-	அமிலநீக்கி
Artificial Indicator	-	செயற்கை நிறங்காட்டி
Astronaut	-	விண்வெளி வீரர்
Amplitude	-	வீச்சு
Agronomy	-	உழவியல்
Agriculture	-	வேளாண்மை
Bio Diesel	-	உயிரி டீசல்
Biosphere	-	உயிர்க்கோளம்
Botanical garden	-	தாவரவியல் பூங்கா
Base	-	காரம்
Boiling point	-	கொதிநிலை
Bio fertilizer	-	உயிர்உரம்
Bio pradators	-	உயிரி கொன்றுண்ணிகள்
Bio pesticide	-	உயிரி பூச்சிக்கொல்லி
CNG	-	அழுத்தப்பட்ட இயற்கைவாயு
Coal gas	-	நிலக்கரி வாயு
Conservation	-	பாதுகாப்பு
Craters	-	பள்ளங்கள்
Compressions	-	இறுக்கங்கள்
Crop production	-	பயிர்ப் பெருக்கம்
Curved pattern	-	வளைவான அமைப்பு
Dimensions	-	பரிமாணங்கள்
Deforestation	-	காடு அழிப்பு
Density	-	அடர்த்தி
Electrolysis	-	மின்னாற்பகுத்தல்
Endangered species	-	ஆபத்தான இனங்கள்
Fuel	-	எரிபொருள்
Freezing point	-	உறைநிலை
Foliar spray	-	இலையில் தெளிப்பு
Galaxy	-	விண்மீன்திரள்
Global warming	-	உலக வெப்பமயமாதல்
Geological	-	புவியியல்
Geographic north	-	புவி வடமுனை
Horizontal	-	கிடைமட்டம்
Hard water	-	கடின நீர்
Heirloom seed	-	பாரம்பரியவிதை
Indicator	-	நிறங்காட்டி
Inorganic acid	-	கனிம அமிலம்
Latent heat	-	உள்ளுறை வெப்பம்
longitudinal wave	-	நெட்டலை
Infrasonic	-	குற்றொலி
Irrigation	-	நீர்ப் பாசனம்
Iron ores	-	இரும்புத் தாதுக்கள்
Ingeste	-	உட்கொள்ள
Larynx	-	குரல் வளை
Metals	-	உலோகங்கள்
Mineralogy	-	கணிமவியல்
Mechanical wave	-	எந்திரவியல்
Manuring	-	உரமிடுதல்
Magnetic Field	-	காந்தப்புலம்
Magnetic power	-	காந்தத்திறன்
Natural gas	-	இயற்கைவாயு
National park	-	தேசியபூங்கா
Neutralisation	-	நடுநிலையாக்கல்
Natural Indicator	-	இயற்கை நிறங்காட்டி
Organic Acid	-	கரிமஅமிலம்
Oscillate	-	அலைவுறுதல்
Potable water	-	குடிப்பதற்கு உகந்தநீர்
Propulsion	-	உந்துவிசை
Propellant	-	எரிபொருள்
Ploughing	-	உழுதல்
Refining	-	சுத்திகரிப்பு
Red Data Book	-	சிவப்பு தரவுப் புத்தகம்
Rarefactions	-	தளர்ச்சிகள்

Suspended	-	தொங்கவிடப்பட்ட
Solar energy	-	சூரிய ஆற்றல்
Sour Taste	-	புளிப்புச்சுவை
Soapy touch	-	வழவழப்புத்தன்மை
Specific heat	-	தன்வெப்பம்
Saline water	-	உவர் நீர்
Space probe	-	விண்வெளி ஆய்வுக்கலம்
Sowing	-	விதைத்தல்
Unaltered	-	மாற்றஇயலாத
Universe	-	அண்டம் (ம) பேரண்டம்
Ultrasonic	-	மீயொலி
Vibrations	-	அதிர்வுகள்
Vertical	-	செங்குத்து
Water gas	-	நீர்வாயு
Wind energy	-	காற்றாற்றல்
Wildlife	-	வனஉயிரி
Wave Length	-	அலைநீளம்
Weed	-	களை

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