Contents

1 Scientific Study

Fig. 1.1

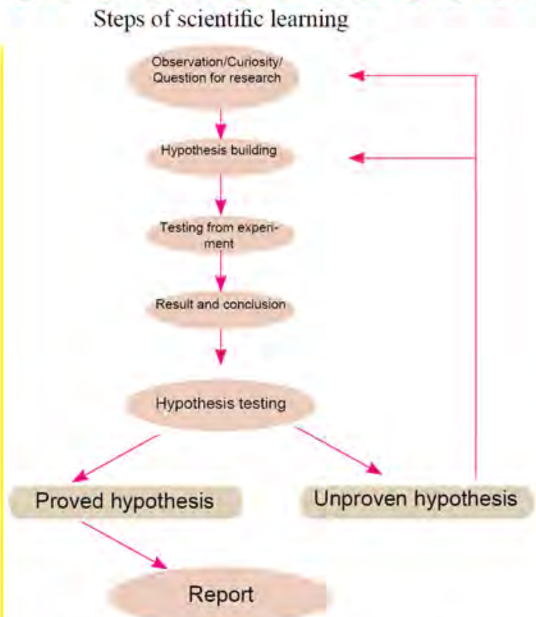


Fig. 1.2 Steps of scientific learning

What are the questions, hypothesis, experimental work and data collection method in scientific study of acidic, basic and neutral properties of fruits and chemicals given in figure 1.1?

The steps of scientific learning are given in above figure 1.2. The different types of experimental works are performed for data and evidence collection in scientific learning. The essential data (PH value) are collected from experimental work in scientific study about acidity, basicity and neutral properties of fruits and chemicals given in figure 1.2. In scientific study, the experimental works are performed in the laboratory or in the outer environment. The measurements of small or large quantities must be taken in data collection and study of various disciplines of science for scientific study. These types of measurement are written in the scientific system. The average measurement is taken to minimize the error in measurement.

1.1 Scientific process skills

Scientific skill provides the basis of scientific learning. We require scientific process skill and scientific attitude beside the knowledge of science. The scientific process skill includes observation, questioning, classification, prediction, interpretation, measurement, concluding, communication etc. Do the given activities for the exercise of scientific process skill.

Activity 1.1

Objective: To practice the scientific process skill

Apparatus required: Paper, scissors

Procedure:

1. Study the various models of paper aeroplanes shown in the diagram.
2. Which model of aeroplane flies at long distance and exists long time in air? Predict it.
3. Take an A4 size paper sheet and select one appropriate model you want. Prepare a model of plane from your selection.

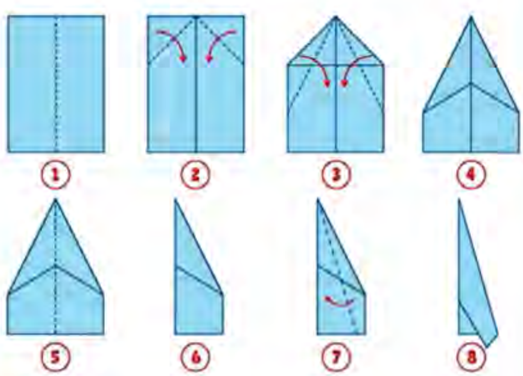


Fig. 1.3 Sample A of paper airplane

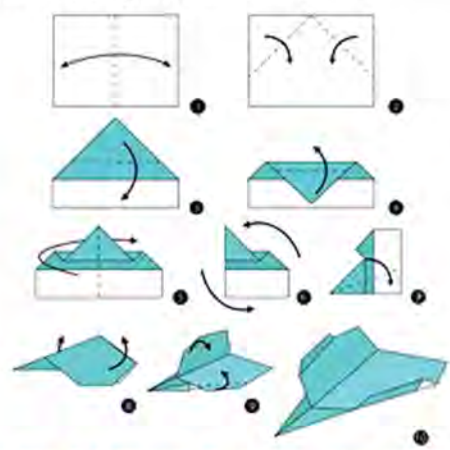


Fig. 1.4 Sample B of paper airplane

4. Fly your aeroplane and compare it with aeroplanes made by your friends.

Discussion and conclusion : Think about how you can modify the selected model into the best one. What are the scientific process skills used in these activities? Discuss.

1.2 Scientific learning

Fig. 1.5 Observation of evaporation and distillation

Fig. 1.6 Natural event (Water cycle)

While making tea, water vapour comes from the spout of the kettle which strikes on the bottom of a cold metal plate and falls in the form of a drop. If the hot plate is placed instead of cold plate, the process of formation of the amount of water drop will be decreased. From this observation, we can conclude that the temperature of the striking surface plays a role in the rate of formation of water droplets. In the same way, the temperature of air plays an important role in the process of cloud formation and rainfall. So, the department of weather forecast collects the data on how temperature decreases with increase in the height of the earth's surface and predicts the amount of rainfall by analysis of this data.

Science is taken as the process of knowledge building. It is an organized method used to discuss natural events on the basis of fact. We use our sense organs and different kinds of instruments to collect evidences for the knowledge building process. There are various steps of scientific learning shown in figure 1.2. The first step of scientific learning is observation of some events or problems and makes curiosity or making questions for research. Hypothesis is built in the second step and data are collected after experiment in the third step. In the fourth step, the result and conclusion is made from the analysis of collected data. The hypothesis is tested either right or wrong at the fifth step. If the hypothesis is verified, then the report is prepared and communicated to others. This is the last step of scientific learning. If hypothesis is not justified, then hypothesis can be modified and all the above steps are repeated.

Fig. 1.7 Main steps of development of vaccine of Corona virus from scientific method.

Let us discuss:

The figure 1.7 shows the procedures adopted to develop the vaccine for CoronaVirus. What steps of scientific study such as questions, estimations, practical works and data collections might be followed in this process?

The effect of the virus in mice was observed during its development of the vaccine as in figure 1.7. The essential data were collected and analyzed for the study of effect in mouse. The sample of vaccine was developed on the basis of these facts and it was first injected to the selected animals for testing the estimated result by the researcher. Then, it was applied to selected human beings after its complete success in animals. Finally, it was permitted for mass application in humans.

Scientists have studied natural phenomena like force, energy, matter, origin of life, structure of earth, universe and other different fields by following the above steps of scientific learning. They have discovered the principles and theories from the conclusion of scientific learning. For example, Sir Issac Newton discovered the law of gravitation acted between any two masses.

1.3 Fields of science

The main fields of science are biology, physics, chemistry, geology, astronomy, environmental science etc.

Fig.1.8 Maize variety develop by NARC

(A) Biology

The maize plants (Nutritive maize) shown in figure 1.8 are the varieties of maize developed by the scientists of Nepal Agricultural Research Council (NARC). The genes of organisms are studied for the development of these types of varieties. Biology is the field that studies the fact about organisms. The scientists who study biology are biologists. The biologists are involved in the study of properties of living beings, reproduction, excretion, respiration, behavior of life, body structure and interaction with environment and other organisms. Under this, microbes to advanced multicellular mammals are studied.

New inventions are being made in the field of biology. The eye surgeon (Ophthalmologist) of Nepal Sanduk Ruit discovered the intraocular lens after continuous work on the related field. This invention makes treatment of eye cataract more reliable and cheap.

(B) Physics


Fig. 1.10 Sir Issac Newton)

The law of gravitational force and law of motion were invented by Sir Issac Newton. Similarly, Stephen Hawking studied the details of the universe. The field that studies the physical phenomena like force, motion, energy etc. is called physics. The scientists who study physics are physicists. Under physics, the phenomena of the atom to the universe are studied.

(C) Chemistry

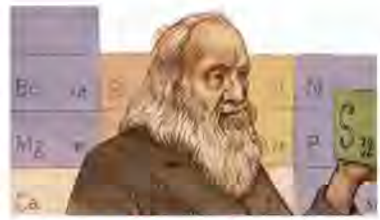


Fig. 1.12 Dmitri Mendeleev

The theory of atomic structure was invented by John Dalton. Similarly, Dmitri Mendeleev studied the properties of elements and classified them on the basis of atomic weight. The field that studies the matter and how their properties change, is chemistry and the scientist who studies chemistry is the chemist. Under chemistry, the properties of matter on the basis of atom and molecule are studied. It includes the study of simple chemical reactions to nuclear reactions.

There are some other specific fields of science which come under the above three main fields. They are considered as interdisciplinary field. Geology, astronomy, agriculture, environment science etc. are the examples of interdisciplinary field.

Activities 1.2

Write the related work from the study and discussion on the basis of the field of science, their branches, and professional opportunities given in the table.

Field	Branch	Professional opportunity	Work
Biology	Zoology, Botany, Genetics, Microbiology, Medical science, Biotechnology	Biologist, Doctor, Genetic engineer	
Physics	Nuclear physics, Atomic physics, Modern physics, Engineering, Radiography,Measurement	Engineer, Radiologist, Expert in measurement, Physicist	

Chemistry	Organic chemistry, Inorganic chemistry, Physical chemistry, Biochemistry, Nano chemistry	Pharmacologist, Chemist, Chemical engineer	
Interdis ciplinary fields	Geology, Astronomy, Environment science, Agriculture	Geologist, Astronomer, Environmentalist	

Project work

Collect the description of a person in community who studied any one field of science and present it as in the given table.

Name	Studied field of science	Professional name	Work

Some important achievements from the study of various fields of science

Field	Important achievements
Biology	Surgery, Cloning, Organ transplantation, Vaccine, Test tube baby, Development of hybrid varieties etc.
Physics	Electric engine, Microscope, X-Ray, Communication technology, Transportation technology
Chemistry	Medicine, Industrial chemicals(fuel, plastics, metal, cement, chemical fertilizer, insecticides)

Activities 1.3

After the study of important achievement in various fields of science, which field of study are you interested in? What is your possible research after the study on that field? Discuss in class.

1.4 Safety measures of scientific experiment

Discuss the following questions about safety measures that are to be followed during scientific experiments.

1. How is diluted acid made from the concentrate acid?
2. What happens when alcohol is heated in beaker?

The experimental works are conducted in scientific study.

Precaution must be followed while conducting various experimental works in laboratory or in outer environment. Accident may happen when precaution is not followed properly.

Fig. 1.14

Alcohol may burn while heating in the beaker and may cause accident. To prevent this, it is safe to heat it by keeping it in hot water which is called a water bath. Similarly, the water is not directly added in acid for its dilution. Instead, the acid is kept slowly on the water. So, any experiment has to be done carefully. The following are the safety measures to be followed during the experiment.

1. The experiment is done only in the presence of a teacher.
2. The safety instruments like lab coat, safety glass, gloves etc. are used while working in the lab.
3. If any accident happens, it should be immediately informed to the teacher.
4. The need to know the information about any device before using it.
5. The chemicals must be taken in adequate amounts while doing experiments.
6. Safety measures are to be followed while using chemicals.
7. The door and window must be opened during the experiment.
8. The teacher should be informed if concentrate acid is required.
9. The experimental place should be cleaned after experiment and instruments are kept in their respective place.
10. The hand should be washed with soap and water after finishing the experiment.

Marie Curie died of leukemia disease as a result of radiation exposure from radioactive substances during unsafe experiment in radioactive substance.

Fig. 1.15 Marie Curie

1.5 Achievements and challenges of science and technology

In the course of scientific developments various efforts have been made to make work faster and easier. The technology related instruments are invented by scientists as a result of scientific study. For example, James Watt discovered the steam engine. The discovery of steam engine led to an outstanding transformation in transportation technology. Another important invention is the generation of electricity from a steam engine. In this process, the turbine of the generator is rotated with the help of water vapour in the electricity production plant.

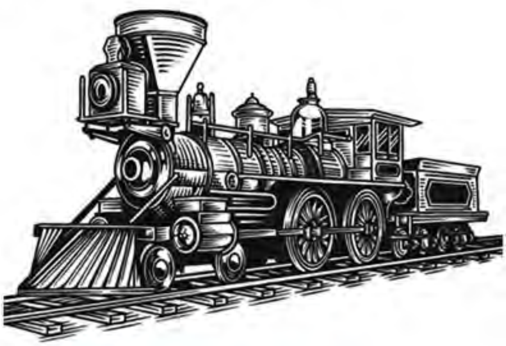


Fig. 1.16 Steam engine

Fig. 1.17 The nuclear power plant in Russia

Along with the development of technology, its proper management is also essential. The coal used for heating of water in the steam engine caused excessive air pollution. Similarly, the security and management of byproducts of nuclear power plants is too challenging. For example, in 2021 the atomic power plant was damaged in Fukushima of Japan by Tsunami and toxic radiation was released in the environment. So, the challenges are also connected with achievement in science and technology.

In 1986, the explosion of the atomic power plant in Chernobyl of Ukraine released the radiation which caused the destruction of human health and death in and around Ukraine. 86

Activities 1.4

The achievement of science and technology and its challenges are given in table. Study and discuss it and search and add more achievement and challenges.

S.N.	Fields	Achievements	Challenges
1.	Health	Easy for diagnosis of disease, development of effective treatment system, Some diseases (Malaria) are eradicated, organ transplantation in human body, development of testing technology (X-ray, city scan, ultrasound)	Destruction of cell by over radiation, possibility of cancer
2.	Transportation	Access in water, land and air transportation	The smoke release causes air pollution and noise pollution
3.	Agriculture	Insecticides, fertilizer, scientific agriculture system, improved seed, increase in productivity, reduction in hunger	The smoke release causes air pollution and noise pollution
4.	Education	ICT, distance education, research, increase access in communication	Increase of different types of health hazard, aloneness, enjoy in virtual word due to excessive use of ICT, disruption in socialization
5.	Industries	Access in consumption, use of modern instruments	Chemical pollution, environmental degradation, global warming
6.	A.I. (Artificial Intelligence)	Development of automatic technology, comfortable in human life	Violation of Personal Privacy, increase of unemployment

1.6 Scientific Measurement

Measurement is of great importance in science. The physical quantity is expressed in scientific notation.

Scientific notation

The measurement of an object is taken while conducting different scientific experimental work. The conclusion was drawn after analysis of data collected from the experiment.

According to the field of scientific study, the data related from very small microorganisms like bacteria, viruses to the size of large objects like the mass of earth, mass of sun etc. should be collected. The number of small and large scales should be used in this process. For example, It is difficult to write the size of virus 0.00000000001 meter and the distance between earth and sun 15, 00,00,000 meter. It is written in the power of ten which is called scientific notation. It is easy to express the small or big numerals by scientific notation. In scientific study, it is easy to denote the distance between heavenly bodies as well as the size of small micro objects (atomic size). Example;

$10^1 = 10$	$10^{-1} = 0.1$
$10^2 = 100$	$10^{-2} = 0.01$
$10^3 = 1000$	$10^{-3} = 0.001$
$10^6 = 1000000$	$10^{-6} = 0.000001$
$10^9 = 1000000000$	$10^{-9} = 0.000000001$

1.7 Way of scientific notation

For example, the length of the east-west highway is 1030 km = 1030 × 1000 m = 1030000 m. When it is written in a scientific notation, it is written as 6 in power 10 of the left 6 place of decimal at the end.

Length of east -west highway $= 1.030 \times 10^6$ m

indices

base

coefficient

mantissa)

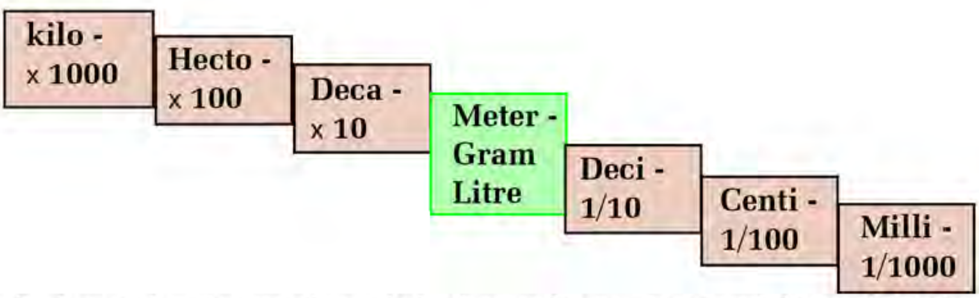
Numerals(measurement)	Steps of conversion	Scientific notation
83000 MW = 83 000000000 W	The place value of the decimal have to move 10th place left.	8.3×10^{10} W
Distance between earth and sun= 15 0000000 km	....	.... 1.5×10^8 km
Size of Corona virus= 0.0000001 m	The place value of the decimal have to move 7th place left.	$= 1 \times 10^{-7}$ m

Rules of scientific notation

1. The base is always 10.
2. The power is not zero and it is (+) or (-).
3. The coefficient is always 1 to 9 integral numbers.
4. If the given number is multiple of 10, the place value of decimal is moved to left side and the power of ten is positive. Example the scientific notation value of 600000 is 6×10^5.
5. If the given number is less than 1, the decimal point moves to the right side and the value of power of 10 is negative. Example, the scientific notation of 0.00006 is 06×10^{-5}.

Metric prefix

Question: Howcanyouidentifythemultipleordivisiblecoefficienttoconvertthe unit?



It is shown that the metric scale is changed into a large unit by multiplying 10 and a small unit by dividing 10. Example, 1 kilogram = 1000 g = 103 g.

Some examples of prefix used in small and big unit of measurement

Small unit	Prefix used	Big unit	Prefix used
Amount of medicine	500 Milligram	Mass of gas in cylinder	14.5 kilogram
Diameter of human hair	17-181 Micrometer	Estimated hydropower of Nepal	83,000 Megawatt

In the above table, the small and big units are expressed in the metric system where notation used in front of small units like milli, micro and kilo, mega in big units are the metric prefixes. The metric prefixes for big and small units are given in the table.

Multiples			Fractions		
Prefix	Notation	Multiplier	prefix	Notation	Multiplier
deca	da or D	10^{1}	deci	d	10^{-1}
hecto	h	10^{2}	centi	c	10^{-2}
kilo	k	10^{3}	milli	m	10^{-3}
mega	M	10^{6}	micro	µ	10^{-6}
giga	G	10^{9}	nano	n	10^{-9}
tera	T	10^{12}	pico	p	10^{-12}

Some small and big units

The size of eukaryotes is 10^{-4} to 10 mm, prokaryote 10^{-6} to 10-4 µm, molecule 10^{-9} nm, atom 10^{-10} nm, velocity of light 3×10^{8} m/s, mass of earth 6×10^{24} kg and mass of sun 2×10^{30} kg.

Question: How much seconds is in 1 nanosecond?

1.8 Importance of least count

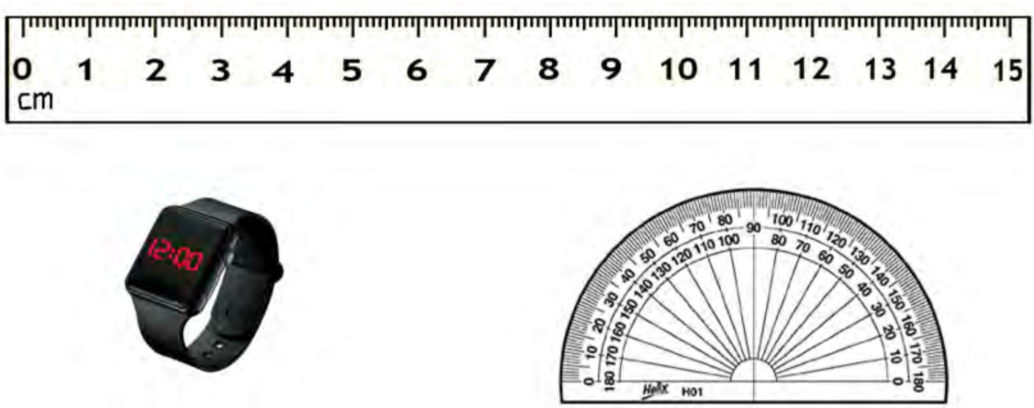


Fig. 1.18

The stopwatch, short scale and protector are shown in the diagram. What are the physical quantities that these instruments are used to measure? What is the value of unit of smallest quantity that can be measured from these instruments? Discuss and complete the given table.

S.N.	Name of instrument	Physical quantity	Smallest unit used in measurement
1	Scale	Length	0.1 cm = 1 mm
2	Stop watch		
3	Protector		

The stopwatch is used in different sport competition. For example, stopwatch is used to calculate the time taken by runners who secured the first, second and third position. From stopwatch, 0.01 second time can be measured so. it is easy to decide the first, second and third position of athletes. 0.01 second is the 1 part of 100 of 1 second or 1/100 second. 0.01 second is the lowest amount of digital stop watch. Similarly, if the thickness of notebook is 1.2 cm, the lowest unit of the instrument is 0.1 cm or 1 mm. The lowest amount that can be measured from any instrument is called the least count of that instrument. The least count may differ on the basis of instruments used in measurement.

1. Scale

In scale, two types of units of measurement are included, one is inch and another is cm. In scale, 1cm is divided into 10 small divisions. The minimum unit of scale is 1/10 cm = 0.1 cm. So, the least count of the scale is 1 mm.

2. In the protector, 10 small segments are there from 1 to 10 degree. 1 segment shows 1° or the acuteness of protector = 10/10 = 1°. So, the least count differs with the difference of instrument used. Example, the least count of handwatch is second and centi second in digital stopwatch. The least count has more value in scientific study. The accurate measurement is done with the help of least count. The conclusion was drawn after the data analysis of any measurement.

Activities 1.5

Observe the following instrument in your school lab and complete the table given.

<table>
<tr><th>S.N.</th><th>Instrument</th><th>Figure</th><th>Least count</th></tr>
<tr><td>1</td><td>Ammeter</td><td rowspan="3">


</td><td></td></tr>
<tr><td>2</td><td>Voltmeter</td><td></td></tr>
<tr><td>3</td><td>Measuring cylinder</td><td></td></tr>
</table>

1.9 Importance of taking average in measurement

Activities 1.6

Place a sheet of tin on the ground. Drop a marble or stone on the sheet of tin from 2 meter height. Record the time period of marble or stone to reach in the tin sheet. Fill your experimental data in the following table.

<table>
<tr><th>S.N.</th><th>Stone/Marble</th><th>Time to strike in tin sheet</th><th>Average time</th></tr>
<tr><td>1</td><td>When dropped first time</td><td>1.2 S</td><td rowspan="3">(1.2+...+...)/3</td></tr>
<tr><td>2</td><td>When dropped second time</td><td></td></tr>
<tr><td>3</td><td>When dropped third time</td><td></td></tr>
</table>

The time period taken by marble or stone to strike in a tin sheet from 2 meter height may differ all three times. In this process, the measurement of time is not accurate at once. Its average measurement is regarded as more accurate than a single one. This kind of problem may occur in measuring small quantities in scientific study. So, the average measurement of two or three readings gives a more accurate measurement. If the same result is obtained after repeated measurement again and again, it is regarded as a precise measurement.

Exercise

1. Tick (√) the correct answer.

(i) Which branch does the veterinary profession belong to?

(a) Physics (b) Biology

(c) Chemistry (d) Geology

(ii) Which field of science does Johann Gregor Mendel represent?

(a) Physics (b) Chemistry

(c) Biology (d) Astronomy

(iii) Which one is the least count when measured from scale?

(a) Centimeter (b) Millimeter

(c) Decimeter (d) Meter

(iv) How is 0.000024 expressed in scientific notation?

(a) 2×10^{-5} (b) 24×10^{-5}

(c) 0.24×10^{-6} (d) 2.4×10^{-5}

(v) What is the value of the Giga prefix?

(a) 10^{9} (b) 10^{10}

(c) 10^{11} (d) 10^{12}

2. Answer the following questions.

(a) How is scientific study done? Explain.

(b) Enlist the fields of science.

(c) Describe the interrelationship among the fields of science with examples.

(d) What is the value of experiment in scientific study? Explain with examples.

(e) Enlist the safety measures while conducting experimental work.

(f) Define the scientific notation.

(g) Why is matrix prefix important? Describe with examples.

(h) Explain in brief about least count in measurement.

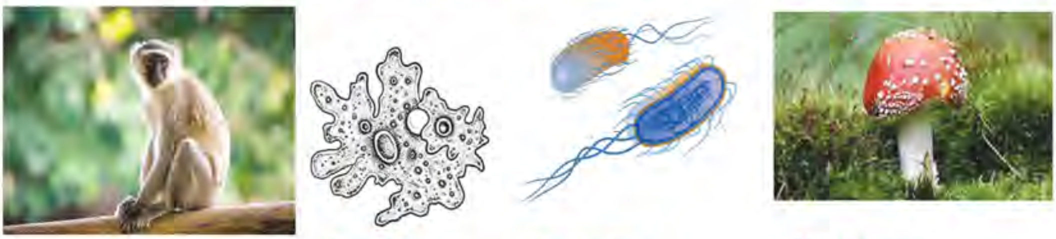
(i) Express the given numbers in scientific notation.

(i) 1230000 (ii) 0.00042

(iii) 0.00000001 (iv) 300000000

2 Classification of Living Beings

Discuss the organism given below



Monkey Amoeba Bacteria Mushroom

Fig.2.1 Organism

Questions for discussion

(a) Are there any differences in cells of these organisms?

(b) On the basis of nutrition, which organisms are similar and which are dissimilar?

(c) What are the differences between them in terms of reproduction?

(d) How are these organisms arranged from primitive to advanced order?

There are different types of organisms in our surroundings. On the basis of body structure, habitat and life process, some animals are same while some are different, like some organisms live in water whereas some live in land. The plants with chlorophyll are autotrophic and rest organisms are heterotrophic. The life processes of microorganisms like Amoeba, Paramecium are simple but advanced in Mammalia. The living beings are categorized into different groups on the basis of characteristics like body structure, feeding mode, reproduction, evolution and so on. The living beings with similar properties and nature are kept in same group. So, the process of dividing living beings into groups and subgroups according to their similar and dissimilar properties is called classification of living beings.

2.1 Importance of classification of living beings

Classification of living beings helps to identify the following facts.

(a) It helps to find the facts about the evolution of organisms.

(b) It helps to study the living beings in a short time.

(c) It makes it easy to give scientific name of living beings.

(d) It describes the natural interrelationship of living beings.

(d) It makes the study of living beings easier and scientific.

2.2 Binomial system of nomenclature

Discuss the organism given in the diagram which are matching to each other and fill it in the table.

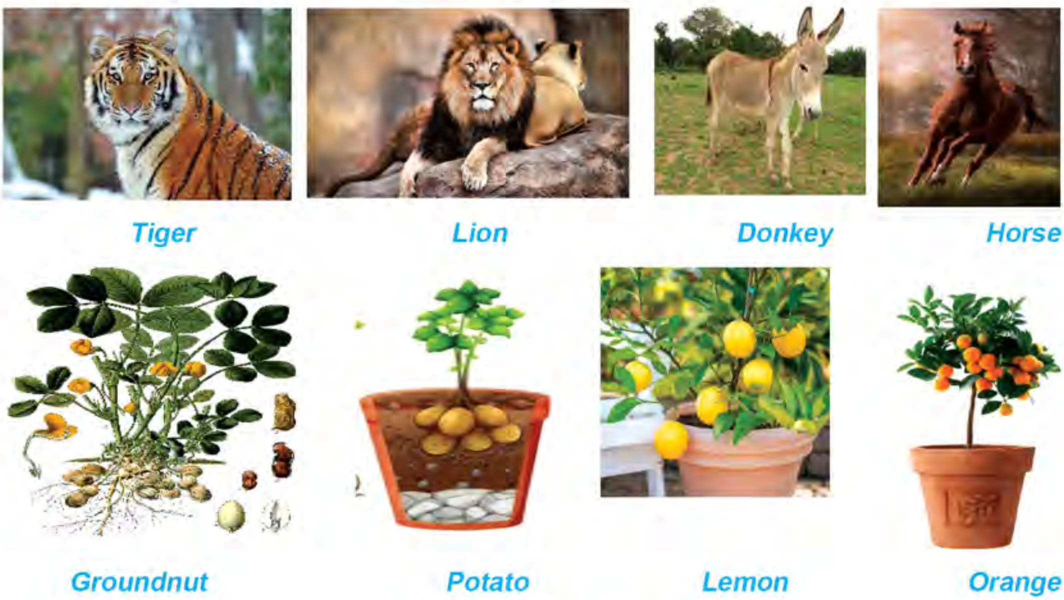


Fig.2.2 Plants and animals

S.N.	Name of organism	Nearest next organism
1	Tiger	
2	Potato	
3	Orange	
4	Horse	

Carolus Linnaeus has made a major contribution in the classification of organisms. He has divided the living beings into two kingdoms- plant kingdom and animal kingdom. Similarly, he prepared a framework for nomenclature (naming) of living beings. He was known as 'Father of Modern Taxonomy' since he was the first man to study classification and scientific nomenclature of living beings in detail.

Carolus Linnaeus used two words from Latin language to represent scientific nomenclature. Genus (Generic name) represents the first word and Species (Specific name) represents the second word of the scientific nomenclature. The way of giving generic names and specific names to an organism is called the binomial system of nomenclature. The first letter of genus is written in the capital alphabet and the small alphabet for the first letter of species.

Common Name	Generic Name	Specific Name
Mustard	Brassica	campestris
(Pea	*Pissum*	*sativum*
Maze	*Zea*	*mays*
(Paddy	*Oryza*	*sativa*
Potato	*Solanum*	*tuberosum*
Tiger	*Panthera*	*tigris*
Man	*Homo*	*sapiens*
Cat	*Felis*	*catus*
Dog	*Canis*	*lupus*
Cow	*Bos*	*taurus*
Lion	*Panthera*	*leo*

Genus:

The group of species having maximum similar characteristics is called genus. The hierarchical order of genus is just below the family and just above the species in the classification. For example, the genus Canis includes animals like Dog, Jackal, Wolf etc.

Species:

A group of similar organisms having ability of reproduction to each other is known as species. It is the smallest unit of taxonomy. Hierarchical level of taxonomy comprises Kingdom, Phylum, Class, Order, Family, Genus and Species respectively which are given in the chart.

Fig. 2.3 Hierarchy of classification

This chart demonstrates that the maximum number of living beings are included in the higher level and particular specific species are included in the lower level of classification hierarchy. For example, if we see the kingdom of human beings, all animals like Vertebrates, invertebrates, unicellular, multicellular etc. are placed in the same kingdom Animalia. But in its phylum Chordata only vertebrates are kept. In the same way, its class Mammalia bears only the animals with mammary glands. Further, its order Primates belongs to Monkey, Gorilla, Gibbons, Lemurs and Human beings. The family Hominidie of this order contains Chimpanzee, Gorilla, Human beings, Orangutan, etc. whereas the genus Homo bears only human beings. In this way, the upper taxon in classification hierarchy includes more organisms but lower taxons have only one species. Thus, this hierarchy of classification shows that there is a close relationship from lower taxon to upper taxon in hierarchy.

2.3 Five kingdom system of classification

Activities 2.1

In two kingdom system of classification, both achloroplyllous mushroom and chlorophyllous fern are placed in non-flowering plants. Discuss, whether this type of classification can include all of their features or not. Present the finding in the class.

Different scientists have recommended the various systems of classification of living beings. At present, the five kingdom system is more prevalent than the two kingdom system. The main shortcomings of two kingdom system are as follows;

(a) Prokaryotes and eukaryotes are not clearly distinct.

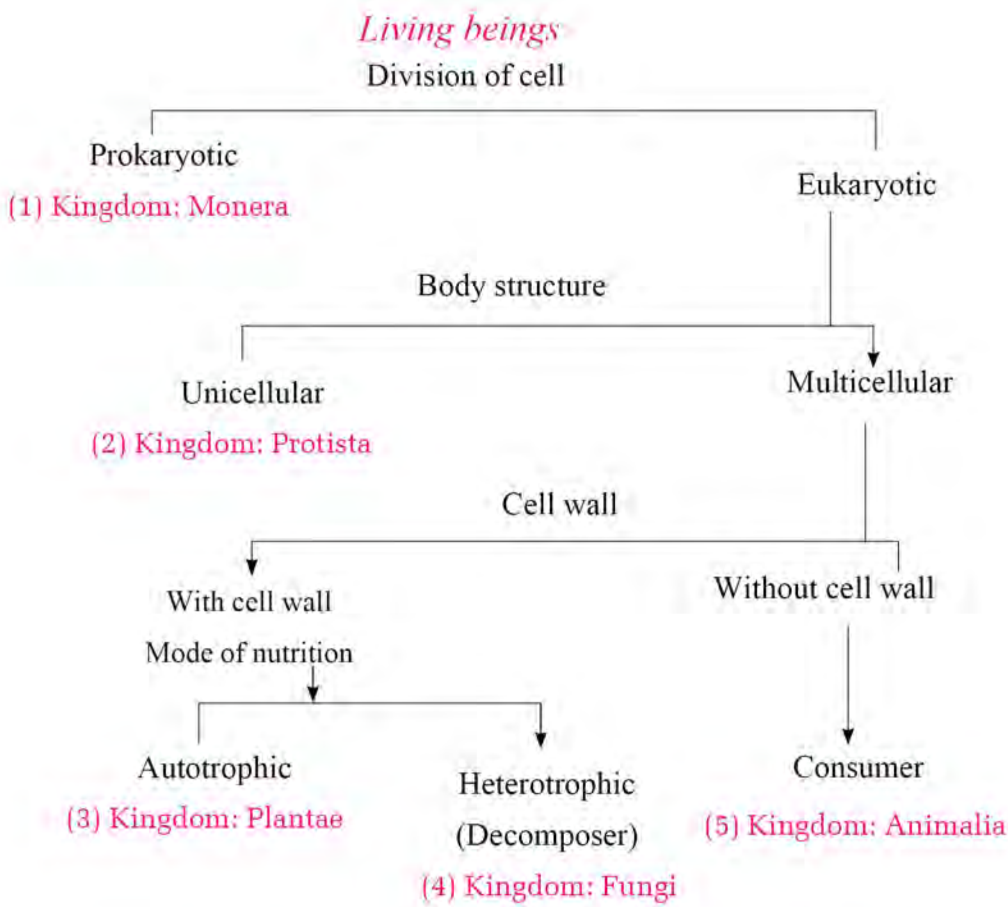
(b) Unicellular and multicellular organism are not separated

(c) Photosynthetic algae and non-photosynthetic fungi are not clearly separated.

(d) This system cannot include all living beings properly.

The five kingdom system is come over for making classification more relevant, scientific and avoiding the demerits of two kingdom systems. The concept of five kingdom system was coined by American taxonomist Robert Harding Whitaker in 1969.

2.4 Bases of Five kingdom method of classification



On the basis of cell, all living beings are divided into two groups. The animals with prokaryotic cells are kept in the kingdom Monera. The remaining organisms are classified on the basis of number of body cells (unicellular/multicellular) and unicellular organisms are placed in kingdom Protista. Multicellular organisms are classified on the basis of presence or absence of cell wall. The organisms with cell walls are further divided into two groups on the basis of mode of nutrition. The cell wall bearing autotrophs are placed in kingdom Plantae but heterotrophs with cell wall are in kingdom Fungi. Similarly, animals without cell wall and act as consumer in ecosystem are placed in kingdom Animalia.

Both of cell wall containing fungi and Animalia without cell wall are heterotrophs but they have different role in the ecosystem. The Fungi act as decomposer and Animalia as consumer but cell wall bearing autotrophs are in the role of producer. In this way, the living beings are classified in a five kingdom system.

Basis of classification	Kingdom
1. Types of cell - Prokyotic	Monera
2. Structure of the body - Unicellular	Protists
3 . Presence of cell ueall, Autothraphic, Producer	Plante
4. Presence of cell wall, Heterotrophic decomposer	Fungi
5. Absence of cell wall, Heterotrophic, consumer	Animelia

In this way, structure of cell, structure of body, presence of cell wall, mode of nutrition, and role in ecosystem are taken as main basis in five kingdom system of classification.

1. Kingdom : Monera

Kingdom monera includes prokaryotic microorganism. The following are the characteristics of them.

Fig.2.4 Bacteria

(a) Monera is prokaryotic microorganism.

(b) Its cell does not have well defined nucleus and Deoxyribonucleus Acid (DNA) act as genetic materials.

(c) They can survive in adverse conditions too.

(d) They are autotrophic, parasitic, saprophytic or symbiotic. Symbiotic organisms are mutually interrelated to each other and survive in common life.

There are three types of organism in Monera like Archaebacteria, Eubacteria and Cyanobacteria. Archaebacteria are very primitive bacteria .They are found in extreme habitats like very hot, salty and marshy places. They contain chlorophyll. They are autotrophic. Example: Hyperthermus, Pyrobus etc. Eubacteria are true bacteria.

The outer covering of these bacteria is made up of cell wall called peptidoglycan. They locomote through flagella. Example: Rhizobium, Clostridium etc. Cyanobacteria is also called Blue Green Algae (BGA). They contain chlorophyll too. They are autotrophic. Example: Nostoc, Anabaena, Spirullina, etc.

2. Kingdom: Protista

Unicellular organisms are placed in the kingdom Protista. The following are the characteristics of them.

(a) They are eukaryotes. Their cells bear nucleus.

(b) They are often unicellular. The cell organelles are covered by cell membrane.

(c) They have locomotor organs such as pseudopodia, cilia and flagella.

(d) Some unicellular eukaryotes are parasites. They absorb food from the host cell. Zooplanktons are heterotrophic.

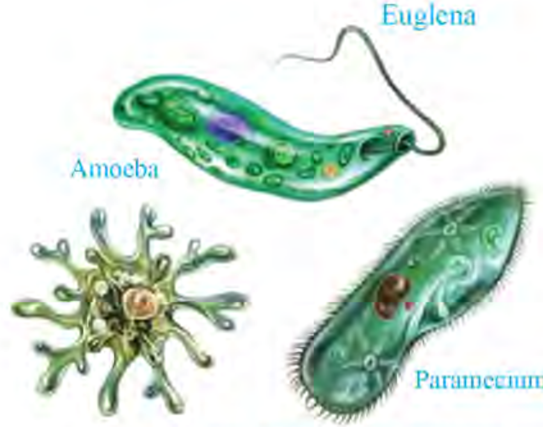


Fig. 2.5 Unicellular organism

(e) They are reproduced by both asexual and sexual mode.

(f) The examples of this kingdom are Amoeba, Euglena, Paramecium, etc.

The cell of some organism in Protista is similar to animal cell. These are called animal like Protista. Example: Amoeba, Paramecium etc. The cell of some organisms in Protista are similar to plant cell. These are called plant like Protista. Their cells contain chlorophyll and perform photosynthesis. Example: Euglena, Diatoms etc. The cells of some organisms are similar to Fungi. They are called fungi like Protista. Example: Slime mode, Water molds etc.

3. Kingdom: Fungi

It includes Mucor and Mushroom like organism. They are multicellular decomposer. The following are the characteristics of them.

(a) Fungi are achlorophyllous unicellular (Yeast) or multicellular (Mushroom, Mucor)


Fig.2.6 Mushroom

(b) They are often saprotrophic as they take food materials from dead/ decaying matter.

(c) Their bodies are thalloid, meaning that the root stem and leaf are not differentiated.

(d) Their body is made of mycelium.

(e) They are reproduced both by asexual and sexual mode.

(f) They store food in the form of glycogen.

(g) Yeast is used in the fermentation process (alcohol preparation) and bakery products.

(h) Examples of this kingdom are Mucor, Yeast, Mushroom etc.

On the basis of mode of nutrition, fungi are three types and they are as follows.

(1) Saprotrophic fungi: They obtain their nutrition from dead and decaying organic matter. Example: Mucor, Mushroom, Penicillium.etc

(2) Parasitic fungi: They obtain nutrition from other living beings. Example: Puccinia,Taphrina etc.

(3) Symbiotic fungi: This type of fungi survives through symbiotic relationship with other organism. In this relationship, both organisms are mutually benefitted. The symbiotic relationship between algae and fungi is known as Lichens. In Lichens, fungi provide habitat and water whereas algae prepare carbohydrate to the fungi.

Project Work

Study of mucor

(1) Take a small piece of bread or Roti.

(2) Keep the piece in a light deficient moist place.

(3) Observe the changes that take place in Roti.

(4) The White cotton-like structure in bread or Roti is called Mucor. Observe these Mucor through a microscope.

(5) Draw a neat diagram after observation. Present and discuss it in class.

Exercise

1. Circle the correct alternatives from given question;

a. Which kingdom does Blue green algae belong to?

(a) Monera (b) Protista

(c) fungi (d) Plantae

b. What characteristic makes the Euglena different from other animals?

(a) Presence of chlorophyll (b) Unicellular

(c)Find in water (d) Depend to other organism

c. Who is the founder of the binomial system of nomenclature?

(a) Carolus Linnaeus (b) R.H.Whitaker

(c) Chatton (d) Robert Koch

d. Which kingdom does the organism without a definite nucleus in their cell belong to?

(a) Monera (b) Protista

(c) Fungi (d) Plantae

e. Which one of the following is the example of prokaryotic microorganism?

(a) Azobacter (b) Euglena

(c) Yeast (d) Amoeba

2. Give reason.

(a) The five kingdom system is more appropriate and scientific than the two kingdom system for organisms.

(b) Fungi are also called saprophytes.

(c) Monera are considered as more advanced than Protista.

3. Write differences between;

(a) Prokaryotes and Eukaryotes

(b) Two kingdom system and five kingdom system

(c) Monera and Protista

(d) Protista and Fungi

(e) Yeast and Mushroom

(f) Genus and Species

(g) Kingdom and Phylum

(h) Mushroom and Bacteria

4. Answer the following questions.

(a) What is the binomial system of nomenclature?

(b) Write the scientific name of Human beings, Garden pea, Mustard and Leopard.

(c) What are Genus and species? Clarify.

(d) Draw the chart of the five kingdom system and give two examples of each kingdom.

(e) Present the characteristics of kingdom Monera with examples.

(f) Write the features of kingdom Protista with examples.

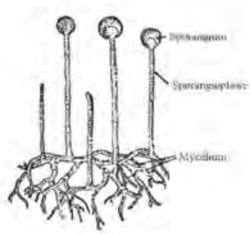
(g) Clarify the properties of Kingdom fungi with examples.

(h) Write the name of the kingdom of following organisms.

(i) Clarify the interrelationship among various taxa in hierarchy of classification of organisms with examples.

(j) Study the given diagram and identify the kingdom of organisms. Write any three properties of each organism.

Figure 1.26: *Rhizopus*



3 Mushroom

Observe and discuss the diagram given below

Fig.3.1 Different types of mushrooms

(a) Where does mushroom grow?
(b) Why is mushroom non-green?
(c) Are all mushroom edible?
(d) Why is Mushroom cultivated?

In the rainy season, the popping of mushroom in soil mound, dung, tree barks are easily seen. Mushroom is a type of fungus. Chlorophyll is absent in mushrooms. It is saprophytic. Some mushrooms are edible. Dalle mushroom, Parale mushroom, Kanye mushroom, Gobre mushroom, etc. are the examples of edible mushroom. Some wild mushrooms can be poisonous. In today's time, mushroom culture is one of the sources of income.

3.1 Structure of mushroom

The body of a mushroom is divided into two parts, mycelium and fruiting body. Its vegetative part is called mycelium. It is found under the soil. Mycelium is made up of fine thread like fiber which is called hyphae. Mycelium absorbs the water and organic food materials. The aerial part is called fruiting body. It is the reproductive part of a mushroom. Mushroom contains stalk and umbrella-like part too. The stalk of mushroom is called stipe. The umbrella-like upper part is called pileus. The lower part of pileus bears a lamellated part known as gills. Basidiospores lie in gills.

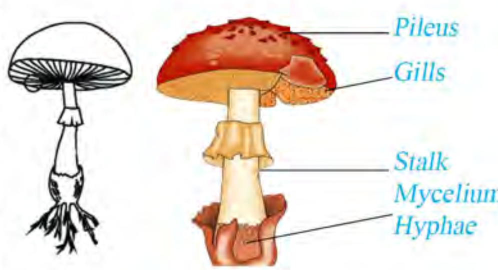


Fig. 3.2 Structure of mushroom

3.2 Life cycle of mushroom

In mushroom, the inner part of pileus contains lamillated gills .The gills of mature mushroom bears three layers, trama, sub-hymenium and hymenium. The outermost layer is hymenium. This layer contains two types of cells, basidium and paraphysis. Paraphysis is sterile. In basidium, there are two haploid nucleus, one male or plus(+) strain and other female or minus(-) strain.

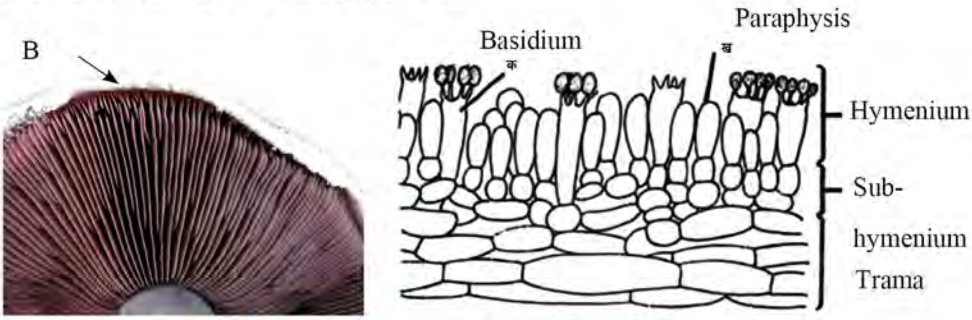


Fig.3.3 Gills and its parts in mushroom

One diploid nucleus is formed by the fusion of two haploid nuclei. This nucleus divides meiotically, forming four haploid nuclei. Of which, two are plus strain and rest two are minus strain. After that, four finger-like structures are developed at the tip of basidium. These are known as sterigmata. One haploid nucleus is migrated in each sterigma where one basidiospore is formed .

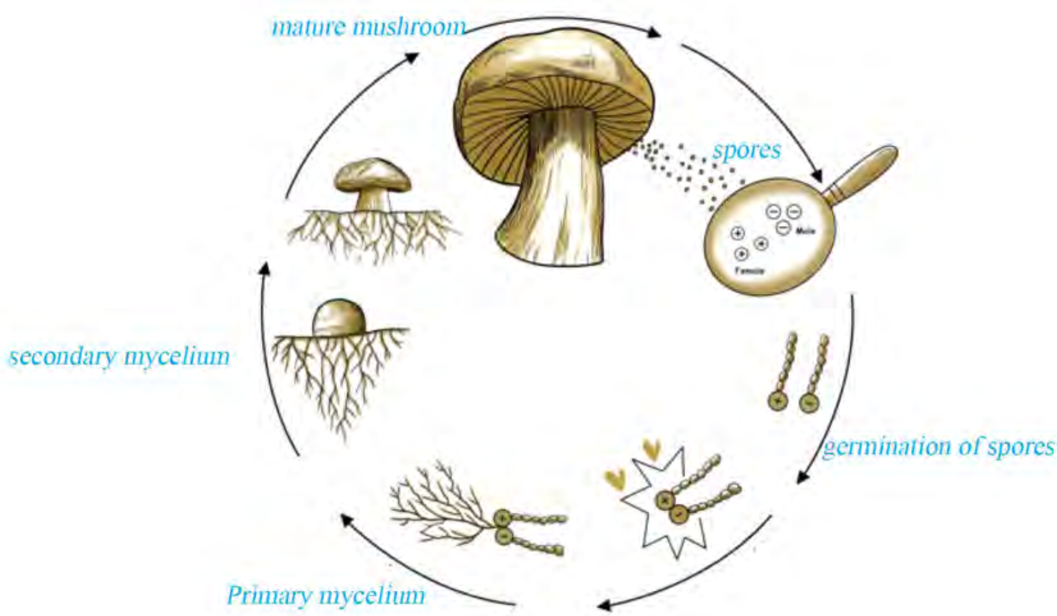


Fig.3.4 Life cycle of mushroom

Among basidiospores, two are plus strains and the rest two are minus strains. The basidiospores are detached from sterigmata when mature. Each spore germinates in favorable conditions forming primary mycelium. The primary mycelium bears one nucleus. The secondary mycelium is formed by fusion of two opposite strain primary mycelium having two nuclei coming from two opposite strains. So, it is called dikaryotic mycelium. The secondary mycelium germinates into mushroom at favorable temperature and humidity. At first, a small oval shaped mushroom is formed and with maturity, it opens up into an umbrella form. There are many basidiospores in hymenium situated at the base of pileus. The basidiospores disperse in air after maturity. At favorable conditions of air, water, temperature and organic matter, each basidiospore germinates forming mycelium. In this way, the life cycle of mushrooms is complete.

Activities 3.1

Draw a diagram of a mushroom in a chart paper and exhibit it in the classroom.

3.3 Use of mushroom

In ancient theology, mushrooms being used as food and medicine have been popular. Modern science proved that mushroom has excessive protein, vitamins, minerals with cholesterol free nutrition and it is a healthy nutritive food. World Health Organization (WHO) also recommends mushroom as a food item to be consumed. Mushroom is used as food and source of income. Some importance of mushroom are given as follows:

(A) Importance of mushroom for human health

Mushroom is extremely healthy and nutritious food. Mushroom contains vitamins, proteins, fibres and minerals. Mushroom is delicious and tasty. The importance of mushrooms are given below:.

(I) As a source of protein : On the basis of dry weight, mushrooms bears 19 to 35 % protein (7.5 % in rice, 12.5% in wheat, 38.1 5 in soybean and 18 to 20 % in chicken meat).The protein found in mushroom contains amino acid which is important for development of human body.

(II) As a source of vitamins: Mushroom is a good source of Riboflavin (B), Niacin, Pantothonic acid ,Thiamine(B), Biofin and Vitamin B 12 . Mushroom is an essential food for vegetarians.

(III) As a source of minerals: Mushroom contains excessive amount of minerals like potassium, sodium, phosphorus, calcium, copper, iron etc.

(IV) As medicine: Developed countries like China, Japan, and Korea have discovered the medicinal properties of mushrooms since long ago. In Nepal, especially the Ayurvedic doctors give emphasis to consume mushroom. The research said that the immune system is developed against diabetes, high blood pressure, cancer and other diseases by regular mushroom consumption. Similarly, the medicine like concord andsunchiha is produced from red mushroom (Pycnoporus cinnabarinus) which is effective in asthma, diabetes, cancer, piles and respiratory diseases.

(B) Economic importance of mushroom

Due to the presence of nutritive elements and medicinal values, mushroom is cultivated commercially. It is profitable business. Mushroom like Morchella, also called Guchi Chyau is found in Jumla and its surroundings which costs more than 500 dollar per Kg in the international market. In Nepal, mushroom sukuti and mushroom pickles are prepared with the help of biotechnology, which are good sources of income.

Kanne chyau (Pleurotus ostreatus) farming is the main mushroom farming in Nepal. In Kathmandu, it is cultured from March (Chaitra) to November (Kartik). Gobre Chyau (Agaricus bisporus) is cultured professionally in Mountain region.

3.4 Mushroom farming

Mushroom farming can be done in various ways. The method of farming differs according to mushroom varieties. Some mushrooms can be produced at home by applying simple technology while some need special technology. Here is a description of Kanya chyau farming in hay.

Fig.3.6 Mushroom farming

Method of *Kanya Chyau* farming

The following method is applied for Kanya Chyau farming:

(a) Collect the best quality hay and cut into pieces of 1 to 3 inches.

(b) Boil the small pieces of hay in water for up to 15-20 minutes so that germs in the hay will be destroyed and hay becomes soft. Mushrooms grow well in this type of hay.

(c) Dry the boiled hay well and is keep in a plastic bag for one day.

(d) Keep the piece of hay in plastic bag by making layers and mushroom seeds are sown in each layer.

(e) Generally, make 5-6 layers of hay pieces in a plastic bag and make each layer with 8-10 inches' height.

(f) Press the layers of hay pieces well by hand and make 10-12 holes in each plastic bag.

(g) Keep the plastic bag in a dark room for upto seven days so that small fibres like white materials cover the inner part of the plastic bag after seven days.

(h) Make three or four holes in a plastic bag and sprinkle water into it according to its need.

(i) The germinated mushroom can be observed after 10 days. At this time, isolate the mushroom by cutting the plastic. Around 17 days, mushroom can be germinated and coming outside from the holes.

(j) Around 25 days, mushroom is fully matured and can be picked.

Project work

Produce the mushroom in school/home by using mushroom farming methods. Prepare a report including effort and achievement of mushroom production and present it in class.

3.5 Storage and use of mushroom

Mushrooms have been used as medicine and food since ancient times due to their specific features. Lots of technologies are used to store mushroom long time for consumption. Sukuti, pickle, ketchup, soup etc. are prepared from it. Among them, a general method of preparation of Sukuti is given.

a. Wash the mushroom clearly.

b. Cut into small pieces.

c. Beat in boiling water.

d. Dry the mushroom in the sun or by fire or modern oven.

e. Pack it making air tight after drying well.

f. Store the packed mushroom in an appropriate place.

Fig. 3.6 Mushroom Sukuti

Fig. 3.7 Mushroom pickle

Method of mushroom drying

Generally, the following methods are applied to dry the mushroom.

(A) Drying by using chemicals: The qualitative sukuti is obtained by keeping mushrooms in solution of 1% Potassium bisulphite, 0.2% Citric acid, 6% Sugar and 3% common salt after 16 hours and by drying at 60-62 0C temperature in 8 hours. Mushroom Sukuti can be stored in the closed airtight pot by making powder.

(B) Drying by sun: Kanya Chyau is dry in sun at more than 250C temperature or 40-450C temperature maintained by machine. This type of dry mushroom can be stored for up to 120 days in a sealed polythene bag.

Project work

Visit the mushroom farming near your school or house. Prepare a report by collecting information about the method of mushroom farming, importance, economic income and use of mushroom in human health and present it in class.

3.6 Edible and poisonous mushroom

Have you heard of the death case from eating poisonous mushroom? The family death cases due to the consumption of poisonous mushroom come out in the communication media each year. It is difficult to identify the edible and poisonous mushroom in the forest. We shouldn't consume unknown wild mushrooms. We should eat only the self-identified and certified edible mushroom. There is no any separate technology to identify the poisonous mushroom. Edible and non-edible mushrooms have been consumed on the basis of elder's experience and identification. It is difficult to identify the poisonous mushroom, though the mushrooms of the following structures are guessed to be poisonous. But we should not consume mushroom just by guessing. Any mushrooms whether they are poisonous or not can be confirmed only after laboratory test.

Fig.3.8 Different types of mushroom

1. Light gray coloured mushroom
2. White gill's mushroom
3. Mushroom with volva at base of stipe
4. Mushroom of red stalk and pileus
5. Mushroom with smooth pileus without insect infection
6. Mushroom with yellow coloured secretion when press in pileus

Project work

Prepare a report about people's death by consuming poisonous mushroom in our country, searching information from knowledgeable people and the internet including causes, types of mushroom and remedial method. Present it in class.

Exercise

1. Tick(√) the correct answer.

a. Which one is the reason for mushroom called saprophytic?

(a) It does not prepare its food.

(b) It takes its food from dead and decaying matter.

(c) It depends to other for food.

(d) It absorb its food from organism.

b. What are the main components found in a mushroom?

(a) Minerals, vitamins, protein (b) Sodium, carbohydrate, protein

(c) Amino acid, vitamin, protein (d) Calcium, fats, minerals

c. Which mushroom is used to prepare the medicine of cancer?

(a) Red mushroom (b) Dalle mushroom

(c) Kanya mushroom (d) Gobre mushroom

d. What is the name of the sterile cell in hymenium?

(a) Basidium (b) Trama

(c) Paraphysis (d) Hypha

e. Where is basidiospore located?

(a) Hymenium (b) Sub-hymenium

(c) Trama (d) Paraphysis

2. Give reason

(a) Mushroom is called saprophytic.

(b) Mushroom is both beneficial and harmful to human beings.

(c) Patient of high blood pressure, diabetes, and heart disease are encouraged to consume mushroom.

(d) Precaution is followed to consume wild mushrooms.

3. Differentiate:

(a) Edible and poisonous mushroom

(b) Primary and secondary mycelium

(c) Paraphysis and basidium

4. Answer the following questions.

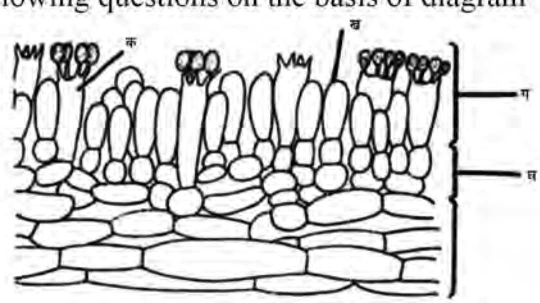
1. Write the name of the nutrients found in mushrooms.
2. Describe the medicinal value of mushrooms.
3. 'Mushroom is considered as significant for human health and income' write with facts.
4. How is mushroom farmed at home by simple technology? Describe in short.
5. Enlist the product of mushrooms.
6. Describe the method of preparation of mushroom Sukuti.
7. Write the properties of poisonous mushrooms.
8. Draw a diagram of a mushroom and label its various parts.
9. Describe the life cycle of mushroom with a diagram.
10. Observe the diagram and answer the following questions.

    A. Label the parts showing in diagram with one function each.

    B. Where are basidiospores?

    C. Isolate the parts into fruiting body and mycelium.

11. The section of gills is given in the diagram. Answer the following questions on the basis of diagram



    A. Write the name of parts in diagram

    B. What is the difference between A and B ?

    C. How is basidiospore formed? Describe.

4

Evolution

Fig.4.1

Discuss on the basis of questions given below.

1. Which living beings originated first on the earth?
2. Do living beings in our surroundings exist since the ancient times?
3. How does variation appear in living beings?
4. How do we know about living beings that existed millions of years ago?

According to modern concept, the advances organisms in today's earth are said to be evolved from simple microscopic organisms. The body of an organism is changed according to the changing environment. From various evidences of evolution, the organisms with complex body structure are originated from simple organism.

There are many types of living beings in our surroundings. It includes bacteria, Amoeba like simple organisms to complex multicellular mammals and flowering plants. Each organism differs from each other. It is considered that the characters are developed in organism from the reason of structure of earth, weather, adaptation and other various factors. As for example, both man and elephant are terrestrial back bone bearing mammals but their various features are different. The characteristics of humans like skin colour, height are also different depending on who lives in different part of earth so far. Similarly, thousands of flowering plants in the same group differ to each other.

4.1 Introduction to evolution

The information about ancient organism are obtained by the study of their fossils. On the basis of similar and dissimilar features of living beings, it is estimated in such a way that very simple organism originated first in the earth. Evolution is the way of changing the body structure of an organism from simple to complex form developing new species.

The model of evolution is seen in the diagram. The living beings were originated after millions years of origin of earth. At first, the environment was not favorable on earth to survive. Gradual change occurs on the earth's surface. The environment was going to change after rainfall. The organic molecule was formed by the reaction between different simple elements. The environmental change was going continuous. After the formation of organic molecule, very simple virus was evolved. The environment was going to favorable for living beings. During evolution, advanced eukaryotic cell was originated from the origin of prokaryotic bacteria. The unicellular animals and plants were developed. In the same way, multicellular animals and plants were evolved with changing environment.

Fig. 4.2 Evolution of organism

It is found that the body structure proceeds from simple to complex due continuous changes in living beings. In this order, the invertebrates like Hydra, tapeworm, earthworm, butterfly, snail, starfish were evolved. The aquatic simple vertebrates like sea horse, fish, etc. were developed from invertebrates. The vertebrates of complex animals like horse, elephant, and humans were evolved from aquatic amphibians via creeping reptiles.

Similarly, in plants multicellular algae were developed from unicellular algae and bryophytes, pteridophytes were evolved with the effect of changing environment. In this way, the flowering plants like gymnosperm and other complex flowering plants were evolved after non-flowering plants. These all processes in a single term is considered as evolution.

4.2 Evidences of organic evolution

The supporting evidence of development of organism on earth from simple to complex is also the evidence of the theory of organic evolution. The following are some main evidences of evolution

(A) Evidences from fossil

The trace, parts and sign of past animals and plants are found in sedimentary rock. It is known as fossil. Paleontology or paleobotany is the subject that studies the fossil. The information of living beings that existed millions of years ago is obtained by the study of fossils. The evidence from fossils is taken as strong proof of evolution.

How is fossil formed? Discuss from the diagram.

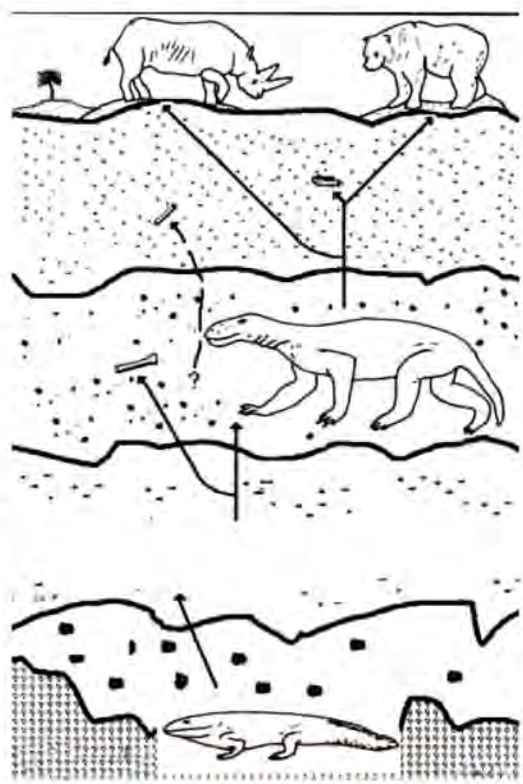


Fig.4.3 Process of fossilization

Fossil is only found in sedimentary rock. The dead bodies of living beings are carried away by rivers along with soil, sand and gravel. Finally, it is mixed in large lake or ocean and starts in deposition. This process happens continuously. The layers are formed at the bottom of lake or ocean which is converted into sedimentary rock. The formation of sedimentary rock takes millions of years. The soft part and muscles of living beings are decomposed while bone and cellulose remain in its original place. These parts are remnants in rock layer in the form of trace which is called fossil.

The fossil of simple structured algae is found in the lower layer of sedimentary rock and fossil of mammals in the upper layer. It proves the pattern of evolution of living beings from simple to complex structure. That's why the evidence from fossils is given more emphasis on evolution. Carbon dating and uranium dating is used to determine the age of rock and fossil. From this, the information of living beings that exist millions of years back is obtained.

(B) Evidences from comparative morphology and anatomy

The body structure of living beings in nature is of their own type but they have some common features. It implies that they are evolved from same ancestor. The evidence from comparative body structure is as follows.

1) Homologous organs

The body of vertebrates is made by the number of bone segments. The study refers that the body organs of vertebrates is made by similar pattern and arrangement of bone segment. It helps to know the interrelationship among organism. The organs of living beings with same embryonic origin but different function are called homologous organs. For example, the bones in human hand, fore leg of horse, wings of bat, paddle of whale are similar to each other. The bones- humerus, radius, ulna, carpels, meta carpels and phalanges- are found both in human hand and fore leg of horse.

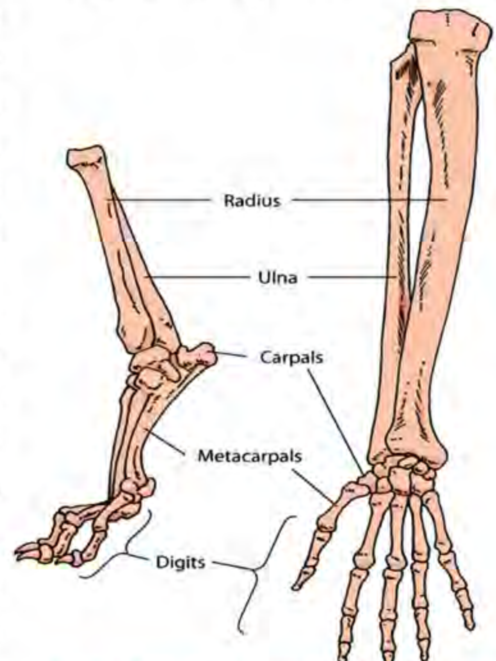


Fig.4.4 Fore leg of horse and human hand

From this evidence, it is proved that the above animals evolved from the same ancestral group. The organs of living beings of the same function but different embryonic origin are called analogous organs. For example, the wings of insect, bat and bird are used for flying but the inner structure of wing of insect is different than the wing of bat and bird. It proved that the ancestors of bird, bat and insect are in different groups. In this way, the similarity is also found in rest organs too. So, the evidence from the study of homologous and analogous organs helps to prove the evolution.

2) Evidence from vestigial organ)

There are many organs in our body. Some organs are inactive due to unused and in other animals it is advanced and functional. These types of model organs are called vestigial organs. The vestigial organs are found in different animals and plants. The canine teeth, tail vertebrae, muscle of pinna that helps to move ear, vermiform appendix in the digestive tract, nictitating membrane in eye are the vestigial organs in human beings that reflect the ancestor. On the basis of these vestigial organs, it is assumed that the ancestors of human beings are vegetarian, tail bearing with movable ears and consume fruit like walnuts broken by teeth. So, human evolution is considered to be from apes.

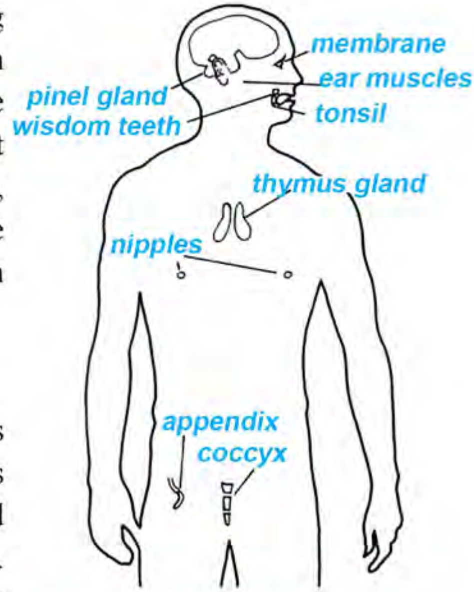


Fig.4.5 Vestigial organs in human beings

C) Evidences from bridge animals

The body structure of a duck billed Platypus shows the features between the animals of two groups. Its beak is like duck and body is covered by hairs like mammals. Similarly, it lays egg like bird and feeds breast to baby like mammals. It clearly


Fig. 4.6 Platypus


Fig. 4.7 Fossil of Archaeopteryx

proved that mammals are developed from the evolution of bird. Similarly, by the study of fossils of Archaeopteryx and Protopterus we can say that birds evolved from reptiles and amphibians which in turn are evolved from fishes. Here, the Platypus, Archaeopteryx and Protopterus are the example of bridge animals which connect the upper and lower class. They are known as connecting links. The fossilized bridge animals are called missing links. The relationship between two classes helps to prove the evolution of more advanced animal from less developed animals.

D) Embryonic evidences

There are many similarities in early stages of life of vertebrates when studied. For example, like in the diagram the structure of early embryo of fish, salamander, tortoise, chicken and humans are similar. In this way, the vertebrates are perhaps originated from same one ancestor. It helps to prove the theory of evolution.

Fig. 4.8 Embryonic evidences

Project work

Collect the various diagrams about evidence of evolution from the internet and other sources. Paste the collected diagram in chart paper and discuss it in class by exhibition.

4.3 Theory of evolution

Many scientists contributed in the postulation of theory of evolution. Jean Baptiste de Lamarck (France), Alfred Russel Wallace, Charles Darwin (England), Hugo de Vries (Holland) coined the various theory of evolution. Among them, the theory of Lamark, Charles Darwin and Hugo de Vries are discussed here.

Lamarckism Theory

Lamarck is a French naturalist who first postulated the theory of evolution. He described how the neck is elongated in Giraffe from short neck Giraffe in his theory. The theory of Lamarck was published in the book Philosophie Zoologique (1809). Lamarckism can be explained by three points given below.

1. Direct environmental effect
2. Use and disuse of organs
3. Inheritance of acquired characters

Along with the change in the environment, living beings need new modification in their body structure. The modification may occur in terms of development or change in existing organs or extinction of old organs. The modification of organs is based on the use or disuse of them. The existence and evolution of usable organs is frequent and least usable organ descendents continuously which finally become extinct. Acquired characters in living beings are inherited as such characters are usable for offspring. The new species originated from this type of changes in organs continuously in new generation.

This theory is connected to the process of development of long neck Giraffe. All the Giraffes were short necked initially. They grazed the grass on the field. The amount of grasses in the field is decreased due to environmental change and they started to take leaves of tree by their self-effort. In this way, the neck started for elongation due to its use and it transferred to next generation too. The modern long neck Giraffes are evolved from the continuous process of neck elongation. His theory does not seem true and there are many questions about the evolution which are not answered by this theory, like:

I. Can living beings be able to develop organs by their own will and requirement?

II. Can all acquired characters transfer in offspring?

Darwin's Theory

Charles Darwin is an English scientist. He published a book Origin of New Species in 1859. Darwin's theory is also called the theory of natural selection. In his book, he postulated the following concept about evolution of organisms.

1) Enormus fertility

Each organism has power of reproduction. If all the offspring survive, it will double in the next generation. The population of living beings is increasing in geometrical ratio but their population is approximately the same in nature. For example, an elephant can give the birth of 6 calves in his life and if all the calves survive, one couple of elephant can produce 1900000 progenies after 750 years.

2) Struggle for existence

If all living offspring can survive, the number of progeny increases excessively. This leads to scarcity of food and shelter taking place. Every animal has to compete and struggle for survival against food, shelter and reproduction in a changing environment. The struggle may take place between same group or in different groups. The successful organism in the struggle can survive and rest unsuccessful organism will extinct. This is known as the struggle for existence.

3) Variation and heredity

There are many differences in characters of individuals of same species in nature. There is also difference between one's own parents, brothers and children which is called variation. Variation takes place due to environmental change and genetic reasons. New characters are acquired in living beings due to variation which is transferred to the next generation. The variations may or may not suit with the environment. The organism which has adaptable variation to the environment can survive but the organism which has adverse variation will be distinct.

4) Natural selection

The living beings can only survive if they have characters adaptable to the environment. But they will decline if they have characters inadaptable to the environment. Nature itself determines the organism that how and why they survive. The favorable characters are developed from survival of the existence. These characters are transferred into offspring through which more favorable characters are developed once. After a long time, the offspring appear with absolute new characters. The presence of these characters makes the organism favorable to survive in an environment which is called natural selection.

5) Origin of new species

characters will be transferred to their offspring. If the process continues for a long time, new characters will appear in the offspring. If the new characters are completely different from their ancestor, a new species is assumed to have evolved. Two or more than two new species are evolved from same ancestor.

Criticism of Darwinism

1. This theory does not describe the fact clearly that the evolution of organisms occurs from the variation.
2. This theory cannot describe why favorable variation occurs only in some organisms and unfavorable variation occurs in others.
3. Natural selection is not only the cause of speciation because mutation also causes the variation in organisms.
4. If beneficial characters are only developed from natural selection, there are no chances of development of harmful characters but it is so.

Variation and mutation

The living beings in a group of certain species vary their characters in some respects. The accurate similarities are not reported in twins too. So, the existence of difference in every member of certain fixed species is called variation. The variation may appear in same type of species too.

The variation in organism takes place in two ways, somatogenic variation and blastogenic variation. Acquired muscular strength, intelligence, etc. are the examples of somatogenic variation. These characters neither come from parents nor heritable but finish after the death of organism.

The variation which is due to change in genetic characters of cell is called blastogenic variation. It is transferred to the next generation. For example, skin colour, hair colour, eye colour, etc. The variation is also due to the effect of environment. Living beings are able to develop characters to sustain in the environment.

An organism survives if all acquired variations are favorable but they become extinct if the acquired variations are unfavorable. Favorable variations inherit in the upcoming generation. In such cases, the new offspring will be evolved which is completely different from their parents in characters. The changes occur in organisms by the environment. The outer body appearances of two offspring of the same ancestor may differ from one another if they are existed in the different environment. These organisms will have same gene but different in external appearance due to the effect of environment. Thus, the variation that occurred due to the environmental effect is called environmental variation.

The development of new characters in offspring due to chromosomal change is called mutation. It is a sudden and discontinuous variation in an organism. These types of characters are recessive characters. For example, six fingers in one hand, split lip baby, two headed baby, hairless mice etc. The reason of mutation is the effect of chemicals and radiation in genes. The host organism with mutation is called mutant and the causative agent of mutation is called mutagene. Due to mutation, new characters are seen in the offspring which are not present in their parents.

Project work

1. Search and observe the six fingers man, man with physical variation, or five legs animals or sudden changed animals in and around your school, society and neighbors. Prepare a report including causes, merits and demerits of mutation and present it in the classroom.
2. Collect the characteristics of your five past ancestors from elders. Prepare a description of differences in characters between ancestors and todays offspring and present it in the classroom.
3. Collect the diagram showing examples of mutation from the internet and paste it in drawing paper. Present it in class from exhibition.

Hugo De Vries Mutation Theory

Hugo De Vries is a botanist from Nederland. He coined the theory of mutation in 1901. He conducted his experiment in evening prime rose (Oenothera lamarkina). He observed 15, 16, 20 and 22 chromosomes in different plants of that species. In fact, they should have 14 chromosomes. According to him, speciation is due to mutation rather than continuous variation. The theory of mutation as described by him is given below.

1. The new species is originated from mutation. So, mutation is one important base of evolution.
2. In mutation, new characters appear suddenly which are functional soon.
3. The mutation is transferred to the next generation.
4. The organism with favorable variation is selected for survival but other organisms with unfavorable variation disappear.
5. New species is originated from mass variation.

Critism of Hugo De Vries Mutation Theory

Though Hugo de Vries mutation theory has many good aspects, it is criticized. These criticisms are given below.

1. Oenothera lamarkiana is a hybrid of its old species, and new characters in this plant are due to dispersion and rearrangement of chromosomes not by mutation.
2. Mutation theory does not provide the fixed direction to the evolution.
3. If the mutation is sudden, the mutants are not favorable to the environment but this is not happening.
4. The role of nature is not explained in mutation.
5. Generally, the characters that appear from mutation are recessive.

Activities 4.1

Divide your friends in groups. Fill the following table by discussing variation in your ancestor and you in your group. Present it in the classroom.

Acquired change	Type of change	Effect of change
Variation		
Mutation		

Exercise

1. Tick (√) the correct answer.

(i) Who is the founder of the theory of natural selection?

(a) Charles Darwin (b) Lamarck

(c) Hugo De vries (d) Johann Gregor Mendel

(ii) Which one is the example of homologous organ?

(a) Our hand and fore leg of horse (b) Our hand and elephant ivory

(c) Our ear and rabbit ear (d) Canine teeth of human and dog

(iii) In which rock are fossils found?

(a) Sedimentary (b) Igneous

(c) Metamorphic (d) Volcanic

(iv) What is the process called for the appearance of new characters in offspring due to change in genetic structure?

(a) Evolution (b) Mutation

(c) Variation (d) Vestigial organ

2. Give reason.

a) The evidences from fossils are taken as a strong basis of evolution.

b) The number of birth of new offspring is excessive though population of organism is not increasing.

c) Variation is not only the cause of the origin of species.

d) Human, monkey, horse and birds are considered to have evolved from the same ancestor.

3. Write the difference:

A. Variation and mutation

B. Darwinism and Hugo De Vries theory

C. Homologous and analogous theory

D. Fossil and vestigial organs

4. Answer the following questions.

1. What is evolution?
2. What is called a fossil? How does it prove the evidences of evolution?
3. How is fossil formed? Explain.
4. What are the evidences of evolution? Describe with examples.
5. Describe the Darwin's theory of evolution.
6. What is natural selection? Describe.

7. According to Darwin, how is a new species originated? Explain.

8. Write the properties of mutation.

9. How does mutation help in evolution?

10. Mutation is not only the main factor but it is only one additional factor, clarify it.

11. Explain the Darwin's theory of struggle for survival and survival for fittest.

12. Discuss how Darwinism is criticized.

13. Prove that the organism in the modern era is developed from past primitive unicellular and multicellular organisms with the help of study of fossils.

14. Study the diagram and answer the given question.

    (a) What is shown in the diagram?

    (b) Which classes are evidence in diagram connected?

    (c) How can this diagram provide additional evidences of evolution?

15. Study the diagram and answer the following questions.

    A. What changes occur in the given diagram?

    B. Do these characters appear in all organisms?

    C. What are the reasons behind these characters?

    D. How does this character help in evolution?

    E. Write any three merits from this change?

16. Compare between Lamarckism and Darwinism.

5 Body Structure and Life Process

The life of every organism begins from a single cell. Unicellular organism performs their every activity from their own single cell. The tissue is made by the grouping of cells in multicellular organism. Organ is made from tissues which perform special function. The group of organs is called a system. There are various activities like nutrition, respiration, photosynthesis, circulation, excretion, reproduction etc. which gives the continuity of life cycle of an organism. These all activities are called life processes. In advanced animals, the system is developed to enhance the life process

5.1 Tissue

Observe the given picture and discuss.

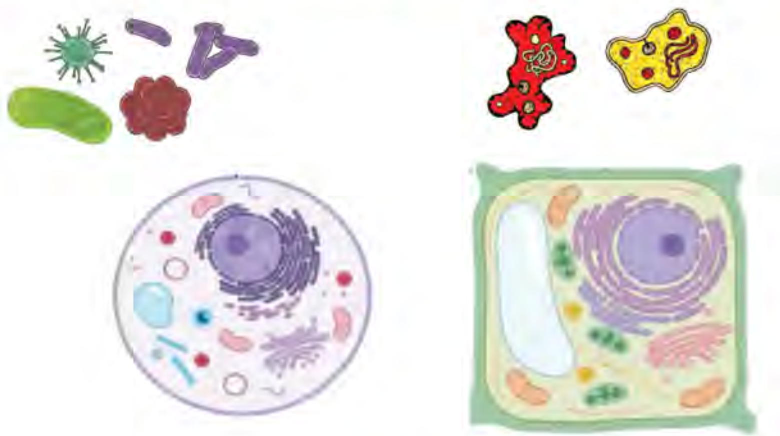


Fig. 5.1

(a) Where are these cells located?

(b) What are the differences among these cells?

(c) What is the role of these cells in the body of plants and animals?

(d) Do all plant cells and animal cells are similar?

(e) How are tissues made in plants and animals?

The body of each organism is made by simple and small units. These small units are called cells. The structure and function of unicellular or multicellular organism starts from cells. The body is made by cells where the life process is operated. So, the cell is known as the structural and functional unit of life. In unicellular organism, the life process like respiration, nutrition, excretion, locomotion and reproduction takes place within a single cell but it takes place from a different group of cells in advanced and multicellular organism. The similar or dissimilar cells are grouped together to conduct the life process in organism, which is called tissue. There are different types of tissues in plants and animals for different body functions. The branch of biology that studies about tissue is called histology. There are two groups of tissues like plant tissue and animal tissue.

Question to think: How is the whole body of an organism made from unicellular zygote?

Plant Tissue

Like the membrane of onion scale, each and every part of the plant is made by the same or different types of plant cells. These groups of cells are plant tissue. There are various types of plant tissues which conduct the body functions. Plant tissues are divided into meristematic tissue and permanent tissue on the basis of nature.

1. Meristematic tissue

Some of the different types of cells in the body of plants have the capacity of being divided. The process of formation of new cells from the division of mature cell is called cell division. Tissues made up of actively dividing cells are called meristematic tissues or meristem. These tissues have thin wall, large nucleus, and dense cytoplasm with no intercellular space. Meristematic tissue is found in growth area of plants. The main function of meristematic tissue is growth and development of plants. On the basis of location, it is divided into three types: apical meristem, lateral meristem and intercalary meristem.

Activity 5.1

Take two potted plants and break the young tip of one plant. Observe the growth and development of that plant after one week. Is the nature of growth of both plant same? Why does it happen? Discuss in class.

a) Apical meristem

The tip of plant is increased during growth. The meristematic tissue at the tip of plant is called apical meristem. It is located at the tip of stem and root. It increases the length of stem and root so that the height of plant increases. The height of plant does not increase if its tip is broken.

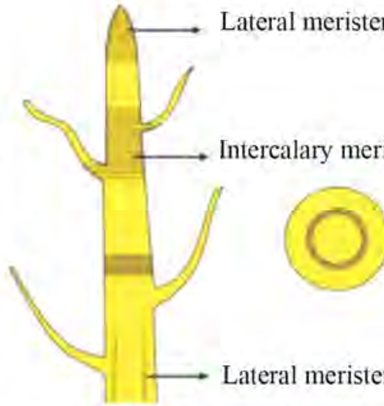


Fig.5.2 Meristematic tissue

b) Lateral meristem

The meristematic tissue is also found in the lateral side of root and stem which increases the girth or diameter. The meristematic tissue which is found inside the bark of stem and root at lateral side in parallel to the main axis is called lateral meristem.

c) Intercalary meristem

The meristematic tissue is also found in either side of nodes. It is known as intercalary meristem. It increases the length of internode.

2. Permanent Tissue

The meristematic tissue is changed into permanent tissue while losing its cell division capacity. Generally, cell division does not take place in permanent tissue. It has fixed shape and size. The cell wall is thick or thin. These tissues are made by living or non-living cells. There are three types of permanent tissues like simple permanent tissue, complex permanent tissue and special tissue.

Activities 5.2

Objective: Observation of plant tissue

Materials:

stem, blade, watch glass, safranin, glycerin, cover slip, and microscope

Procedure

a. Cut the small, fine and thin sections of the stem of plants.

b. Place the sections in watch glass with water.

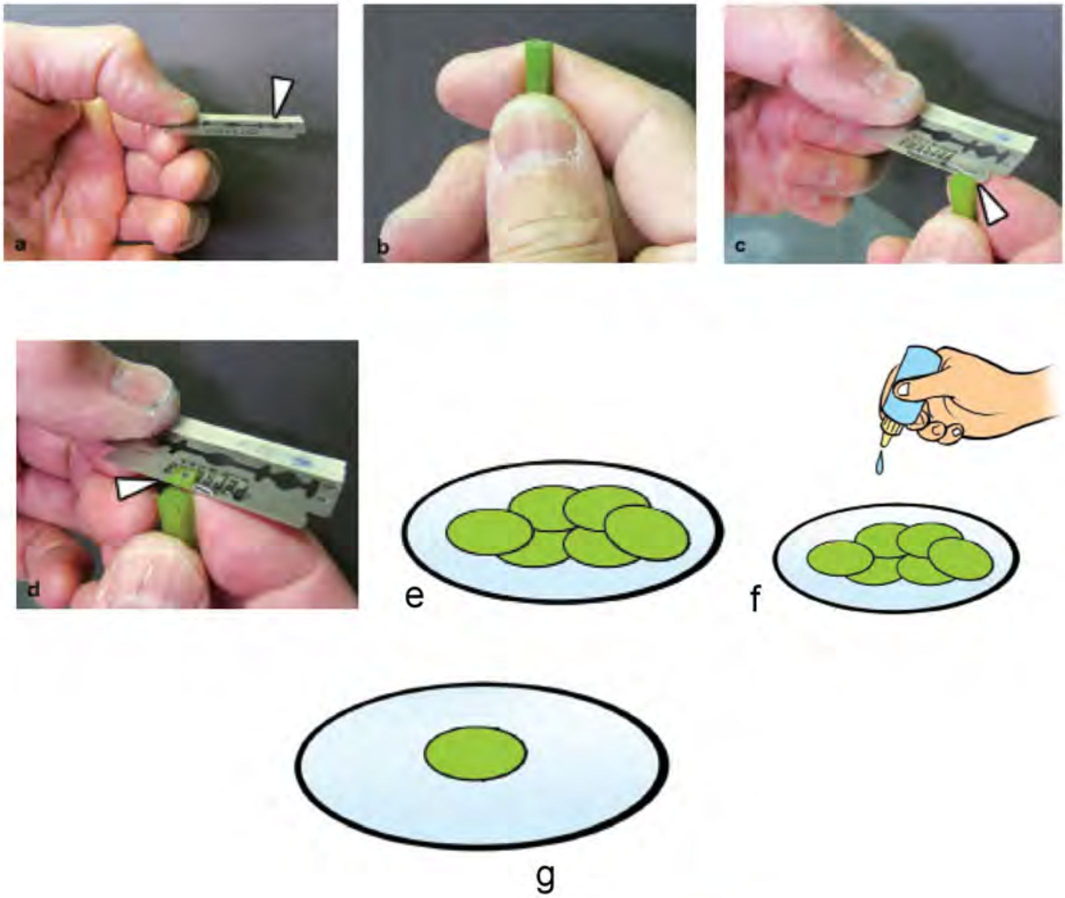


Figure 5.3

c. Pour one drop of safranin in the watch glass.

d. Put a drop of glycerin in the slide and place a thin section on it.

e. Cover it with the help of a cover slip by avoiding air bubbles.

f. The temporary slide of plant cell is ready.

Observation and discussion

Observe the prepared slide and draw the diagram of visible parts of plant tissue. Discuss the size, shape and features of tissues. Take the support from your teacher as per necessity.

(A) Simple permanent tissue

The simple permanent tissues are made by similar types of cells. Their structures are very simple. The functions of these tissues are protection, support and preparation of food materials and its storage. These tissues are of three types on the basis of structures. They are given below.

a. Parenchyma

Parenchyma tissue is made by thin walled living cells. The cells are oval and elongated. It has intercellular space. They are found in soft part of stem, root, leaf, flower and fruit. It is also found in pith, xylem and phloem. Chloroplast is present in parenchyma of leaf and green stem. It is called chlorenchyma. It prepares food materials by photosynthesis. So, it helps to prepare food and storage. The air is present in between cells of leaf of floating plant. The air bladder containing parenchyma is called aerenchyma. In hydrophytes, it helps to float in water.

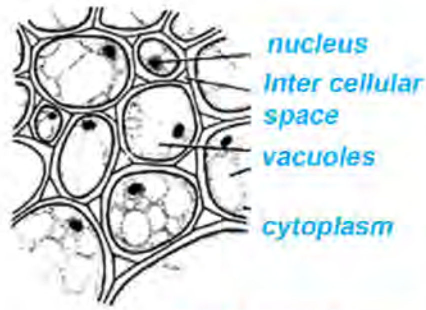


Fig. 5.4 Parenchyma

b. Collenchyma

This tissue is made by thick walled living cells. The carbohydrate like cellulose and pectin is deposited in corner of cell wall. Therefore, the cell wall is thick. These tissues are located in epidermis of stem and petiole of leaf. The main function of these tissues is to provide mechanical strength and flexibility to the plant. Some collenchyma bears chloroplast and helps in photosynthesis.

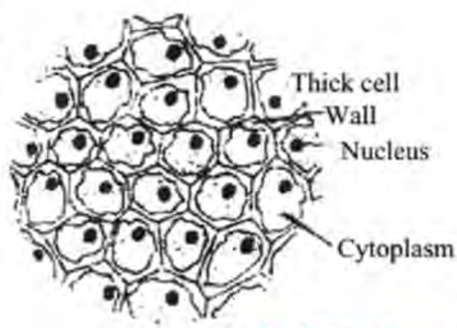


Fig. 5.5 Collenchyma

c. Sclerenchyma

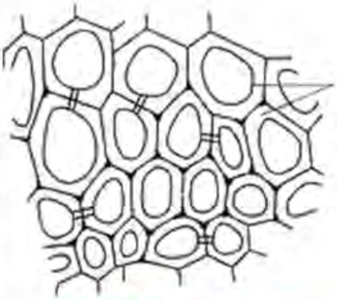


Fig. 5.6 sclerenchyma

This tissue is made by thick walled dead cells. These cells are elongated, narrow and spindle shaped. The cell wall is made by cellulose and lignin. Protoplasm is absent. It has narrow lumen which is found between cells. It is found in root, stem, veins of leaf, fruit and hard seed coat. On the basis of shape, it is of two types viz. sclerenchyma fibre and sclerids. Its main function is to make the plant strong and straight. It gives flexibility and mechanical strength to the plant.

(B) Complex tissue

Complex tissues are made by the group of different types of living and dead cells. These tissues are made by two or more than two simple tissues. So, their structure is complex. These tissues are called vascular tissue due to its conductive function. Complex permanent tissues are of two types which are given below:

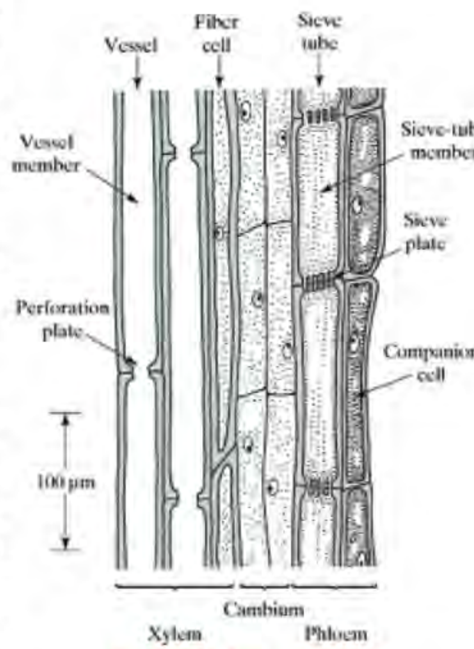


Fig.5.7 Xylem and phloem

a. Xylem

Xylems are made by dead cells. It has four components like vessels, tracheids, xylem fibre and xylem parenchyma. Xylem maintains the hardness to the plant so it is also known as wood. It is found in the inner part of root, stem, leaf and other parts. It conducts the water and minerals from root to different parts of plant.

b. Phloem

Phloem tissue is made by living cells. It also has four components like sieve tubes, companion cells, phloem fibres and phloem parenchyma. These tissues are found in all parts of plants like root, stem and leaf. It is also known as bast. It transports the prepared food materials made in leaf into different parts of plants. It also provides mechanical support to the plant.

(C) Special tissue

There are various types of specific tissues for specific functions in plants. These tissues are called special tissues. These tissues are formed by the modification of simple tissue. The functions of cells of these tissues are as excretion and secretion. These tissues are of two types: glandular tissue and lactiferous tissue.

a. Glandular tissue

Glandular tissue is made by a group of similar types of glandular cells. It secretes enzymes, hormones, digestive juice, oil, resin, gum etc. These tissues are found in Dhaturo, Ocimum (Basil or Tulasi) and Pine plants.

b. Lactiferous plant

Lactiferous tissues are made by specific cells. It secretes milk like liquid (latex). Gum is prepared from latex. It is found in plants like Ficus (Pipal), Poinsettia (Lalupate), Jackfruit (Katahar), Rubber(Rabar), Calotropis (Aank) etc.

Animal tissue

The tissue made by the group of animal cells is called animal tissue. Each animal tissue performs one fixed function. Generally, animal tissues are of four types:

A. Epithelial tissue

B. Muscular tissue

C. Connective tissue

D. Nervous tissue

(A) Epithelial tissue

The group of cells lies in the outermost covering of body of organism or its organs is called epithelial tissue. It is made by similar or dissimilar types of cells. The cells of these tissues are attached on basement membrane. The main functions of epithelial tissue are covering, protecting, secreting, excreting and absorbing.

Activity 5.3

Objective: Observe epithelial tissue.

Apparatus required: A piece of chicken skin, forceps, slide, cover slip, iodine, and microscope

Procedure

a. Peele the fine layer of chicken skin with the help of forceps.

b. Take the layer of skin in a slide by putting one drop of iodine and cover it by a cover slip.

c. Observe the slide from microscope.

Observation and discussion: Draw the diagram that is observed from microscope and discuss it in class.

The epithelial tissue can be divided into various types on the basis of nature of cells and thickness. Some important epithelial tissues are given below:

a. Pavement epithelium

b. Cubical epithelium

c. Columnar epithelium

d. Glandular epithelium

a. Pavement epithelium

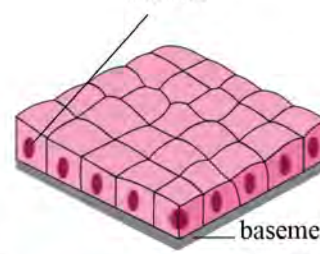


Fig 5.8 Pavement epithelium

In pavement tissue, the flat plate-like polygonal cells are compactly arranged. It has one layer of cells. It is also known as squamous epithelium. Covering, protecting, filtering are the functions of this tissue. This tissue forms the outer covering of heart, liver, kidney etc.

b. Cubical epithelium

Cubical epithelium is made by single layer cuboidal cells. The nephrons of kidney, thyroid gland, ducts of different excretory glands (salivary gland), inner layer of uterus and alveoli of lung is made by this tissue.


Fig. 5.9 Cubical epithelium

c. Columnar epithelium

This tissue is made by elongated cells at the basement membrane. Its surface is covered by fine, small hair like cilia which plays a role of clearing the liquid. This tissue is found in secretory organs like gall bladder, salivary gland. Its functions are secretion and absorption

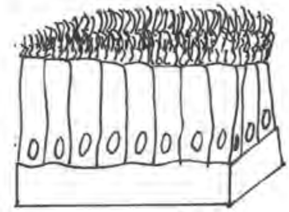


Fig. 5.10 Columnar epithelium

d. Glandular epithelium

The gland of body is covered by secretory epithelial cells. It is known as glandular epithelium. These cells are involved to produce hormones, enzymes, mucus, saliva, digestive juice

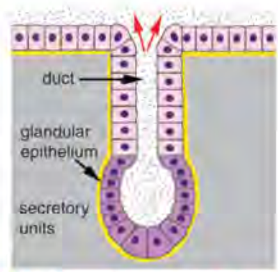


Fig.5.11 Glandular epithelium

(B) Muscular tissue

The type of tissue which produces the movement like contraction and relaxation of different organs in the body is known as muscular tissue. This tissue is made by a group of thread-like long muscle fibre cells. Its main function is to develop the movement in body. Muscular tissues are of three types:

a. Skeletal muscular tissue

This tissue is long in shape. It is attached to the bone. It produces the movement in the body by combining with connective tissue (bone). So, it is known as skeletal muscular tissue. The dark and light stripes are seen in this tissue. So, it is also called striped muscle. It is also known as voluntary muscle since it can run as desired.

Fig.5.12 Skeletal muscular tissue

b. Cardiac muscular tissue

This tissue is only found in wall of heart. It can contract and relax regularly. The heart beat is due to its contraction and relaxation and heart pump the blood. It has stripes too. This muscular tissue cannot be regulated voluntarily.

Fig. 5.13 Cardiac muscular tissue

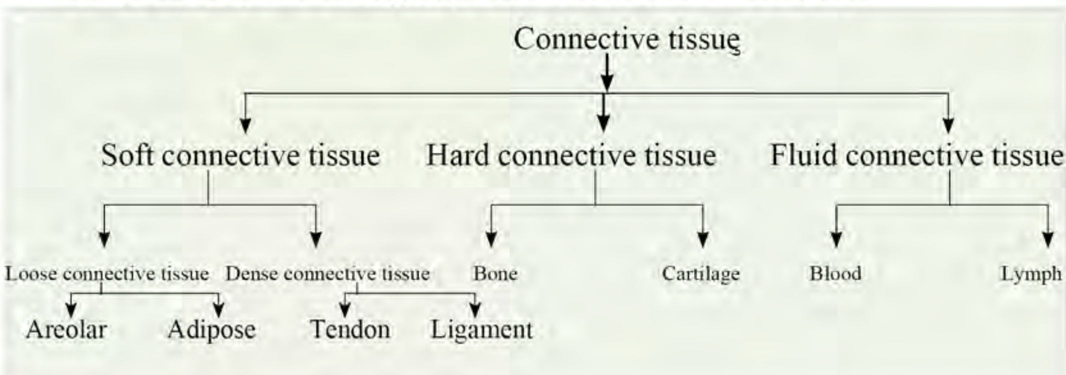
c. Smooth muscular tissue

It is made by the group of spindle shaped muscle fibres. The cells of this tissue do not have stripes. So, it is smooth. This type of tissue is located in the inner part of stomach and intestine. Similarly, it is also found in organs like ureter and blood vessels. It cannot be regulated autonomically. So, it is known as involuntary muscle.

Fig. 5.14 Smooth muscular tissue

(C) Connective tissue

The tissue that connects the different tissues and organs found in the body is called connective tissue. The cells of this tissue are isolated and distributed all places of the body. The functions of connective tissue are to give support and serve interrelationship between cells and tissue. This tissue has space in between cells which is called intercellular space. It is filled by solid or liquid which is called matrix. It contains water, fibre and minerals. Connective tissue can be divided into three groups on the basis of their structure:



a. Soft connective tissue

The cells of soft connective tissues are lightly arranged. It has excessive fibres and matrix in intercellular space. The cells of some tissues store a maximum amount of fats. These tissues are soft. Soft connective tissues are of two types; fibres and adipose.

i. Fibrous connective tissue

This tissue is made by loose or compactly arranged fibres. The loose connective tissues lie in dermis around blood vessels of muscles. The dense connective tissue is the

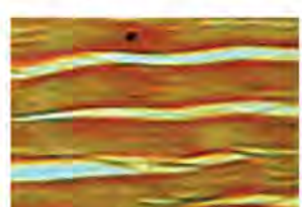


Fig. 5.15 Fibrous connective tissue

simplest connective tissue in the body. The dense fibrous connective tissue is elastic in nature. It binds the organs and gives shape. This type of tissues is found around kidney, liver, glands, muscles etc. This tissue also functions for maintenance. The fibrous connective tissue that connects the bone and muscle is called tendon. Similarly, the fibrous connective tissue that connects the muscles is ligament.

ii. Adipose connective tissue

The amount of fibres is less in loose connective tissue. Its matrix is made by fat or other soft matter. Areolar and adipose are the examples of this tissue. Areolar tissue lies in dermis which connects skin to muscle. Adipose is the fat (lipid) whose function is cushion in internal organs and regulate the temperature.

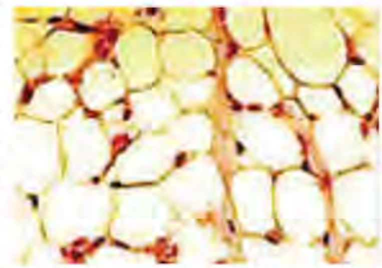


Fig. 5.16 Adipose connective tissue

b. Hard connective tissue

Bone and cartilage are included under hard connective tissue. The cell of this tissue is called osteocyte. The bone is covered by a thin membrane which is called periosteum. Calcium is deposited in bone. So, it is very hard. Cartilage is located in the nose, ear, neck, vertebrae and either side of the long bone. It decreases the friction in movable organs and prevents from shock. The cartilage which is formed in the embryonic stage is going on hard due to calcium salt. The bone in skull, limbs and vertebral column is made by strong bone. This connective tissue connects the various tissues in human body and provides support to the body.

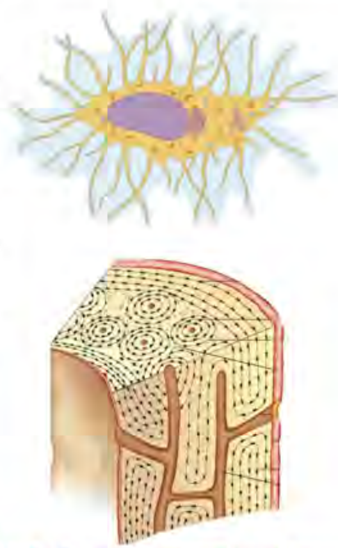


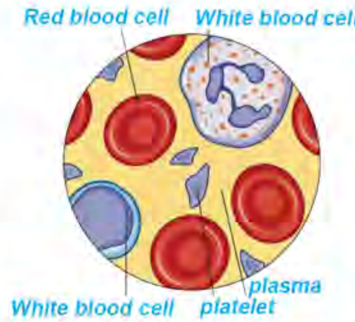
Fig. 5.17 Transverse section of bone

c. Fluid connective tissue

Some connective tissues are in the form of liquid. These connective tissues coordinate between different systems in body. These connective tissues help circulation in body. There are two types of liquid connective tissue in the body of an organism; blood and lymph.

i. Blood

Blood is red-coloured liquid connective tissue. It circulates the various materials from one part to another part of the body. Blood is made by 55% plasma and 45% blood cells. Plasma contains 90% water and 10 % solid matters. Nutrients, enzymes, hormones and other substances are circulated from one part to another through plasma. Blood has red blood cells, white blood cells and platelets.



Fi.5.18 Blood

Hemoglobin is made in red blood cells, which helps to take oxygen from the lungs and circulate it into various parts of the body. It collects the carbon dioxide from different parts of the body and sends it into lungs. White blood cells destroyed the harmful pathogen. Platelet helps to coagulate the blood in injured place and prevents from over bleeding.

ii. Lymph

Colourless liquid connective tissue found in the duct is called lymph. It has no hemoglobin. It has plasma and lymphocytes. The liquid filtrate from blood vessels derived from blood plasma in the intercellular space where blood is not exceeded is the lymph. Its functions are protection, nutrition and excretion of tissue.

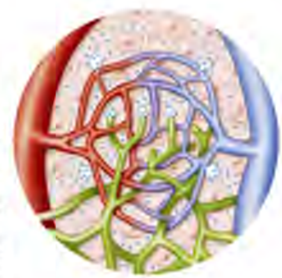


Fig. 5.19 Lymph

(D) Nervous tissue

The tissue that coordinates, communicates and directs the various organs of body of organism is called nervous tissue. The smallest unit of nervous tissue is called neuron. The nervous tissue is made by a combination of neurons. Nervous tissue is connected by a connective tissue named as neuroglia.

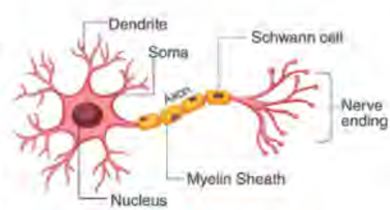


Fig.5.20 Neuron

Neuron or nerve cell

Neuron is the smallest unit of nervous tissue. The middle part of a neuron is called cell body which is ash in colour. Axon is the long single branch of cell body which is white in colour. Axon is covered by myolin sheath. The branched dendrites are raised from axon. Dendrites conduct the stimulus from other nerve cells to cell body and axon sends them into other neurons. For example, when our leg is injured, the pain reaches to brain, and we feel. It is possible due to the communication by neurons.

Exercise

1. Tick (√) the correct answer.

(i) Which one is the type of tissue with cell division capacity?

(a) Complex tissue (b) Connective tissue

(c) Permanent tissue (d) Meristematic tissue

(ii) Which tissue is located in inner surface of kidney and duct of salivary gland?

(a) Squamous epithelium (b) Glandular tissue

(c) Cuboidal epithelium (d) Columnar epithelium

(iii) Where does meristematic tissue lie in plants?

(a) Tip of root (b) Tip of stem and branch

(c) Around the stem (d) All parts of plant

(iv) In which organ is cardiac muscle found?

(a) Stomach (b) Kidney

(c) Heart (d) Pancreas

(v) What is the use of vascular tissue by plants?

(a) To make plant strong (b) To prepare the food

(c) Conduction of water and food (d) To increase the girth

2. Give reason.

(a) Blood is called liquid connective tissue.

(b) The height of plant does not grow while cutting.

(c) White matter is released when leaf of Lalupate (Poinsettia) is detached.

(d) Xylem is known as complex permanent tissue.

3. Write difference.

(i) Muscular tissue and connective tissue

(ii) Xylem and phloem

(iii) Meristematic tissue and permanent tissue

(iv) Sclerenchyma and collenchyma

4. Answer the following questions.

(a) What is life process? Describe with examples.

(b) Plot the concept map of classification of plant tissue and animal tissue with examples.

(c) Explain the meristematic tissue with a diagram.

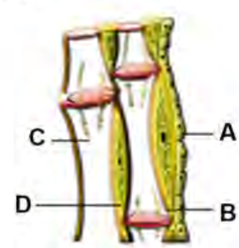
(d) What is permanent tissue? Describe in brief about its type with examples.

(e) Draw a neat and labeled diagram of sclerenchyma, collenchyma and parenchyma and prepare a list of their functions.

(f) Write the functions of epithelial tissue.

(g) Prepare a chart of animal tissue and write their location.

(h) Observe the figure and answer the following questions.



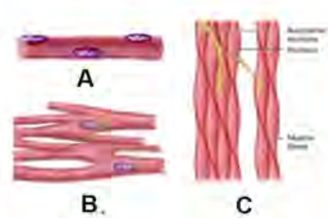
(i) Identify the figure.

(ii) Name the parts shown in figure.

(iii) Write the function of this tissue.

(iv) Write the importance of this tissue in plants

(i) Observe the figure and answer the following questions.

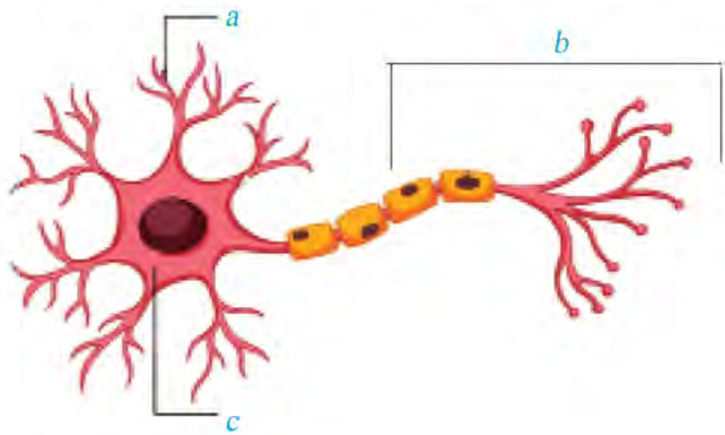


(i) Write the name of given muscular tissue.

(ii) Write the name of one organ each where these tissues are present.

(iii) Write one function of each tissue.

(j) Study the figure and answer the given questions.



(i) Identify the figure.

(ii) Write the name of a, b, c in figure.

(iii) Write the function of parts a, b and c.

5. Project work

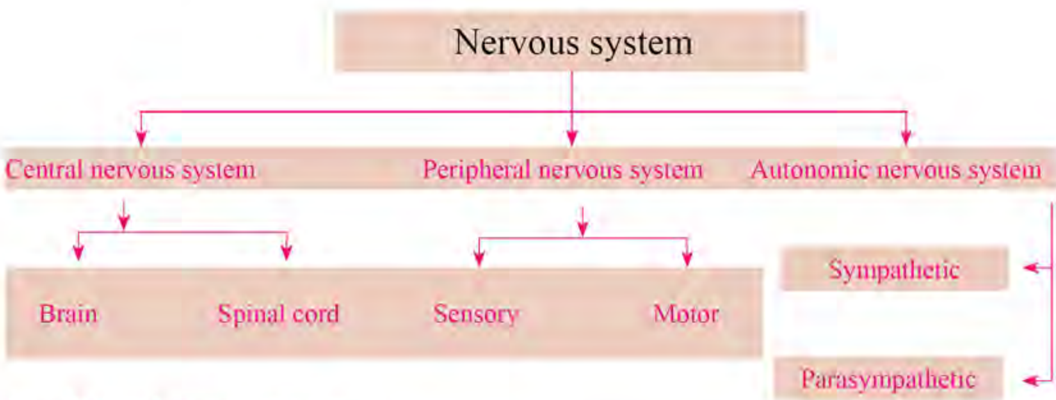
Draw a diagram of animal tissue by the use of available local materials and exhibit it in class.

5.2 Human Nervous system

How do we know about the effects and changes in the environment around us? Think about how our body organs communicate to each other.

There are various types of objects in our surroundings. We can take information from various objects in our surroundings with the help of our sense organs, nervous tissue and brain. Brain can control and conduct every organ of the body. Similarly, we react from stimulus to various changes in the environment. The system made by a group of specific organs for this work is the nervous system. Sense organs are the outer organs of this system. Similarly, nervous system is made by the combination of brain, spinal cord and nerve cells that coordinate the internal organs of body. On the basis of parts and function, the human nervous system is categorized into three parts.

1. Central nervous System
2. Peripheral nervous System
3. Autonomic nervous System



1. Central nervous system

The parts of nervous system which extend from middle of the human body head to the last vertebrae is known as central nervous system. It is made by brain and spinal cord. Central nervous system is made by the combination of neurons and ganglia. Neuron is the basic cell of nervous system. The followings are the two parts of central nervous system.

(a) Brain (b) Spinal cord

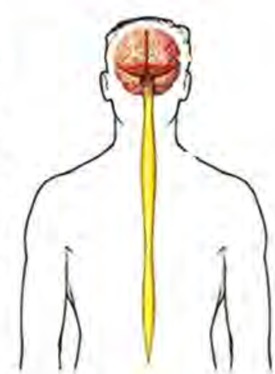


Fig. 5.21 Central nervous system

(a) Brain

Activities 5.5

Observe and identify the various parts of brain of a goat if possible or from model of brain. Take help from teacher if necessary. Discuss in groups in the class.

Brain is the largest and uppermost part of central nervous system and lies in inside of skull of head. It controls and coordinates all the parts of body. Brain is covered by a three layers of membrane known as meninges. Dura matter, pia matter and arachnoid are three layers of meninges. Dura matter is attached on the inner surface of the skull and pia matter on the surface of brain. There is a space in between arachnoid and pia matter. This space belongs to a viscous fluid known as cerebrospinal fluid or CSF. Its main function is protection and nutrition to the brain. It is the alkaline fluid made by water, minerals, glucose and protein. There are various parts of brain which are given below:

Fig. 5.22 Brain

(i) Cerebrum

Cerebrum is the largest part of brain. It covers 80% part of brain. It is divided into two left and right semispherical cerebral hemisphere. The two cerebral hemispheres are separated by deep longitudinal dorsal fissure. The outer surface of cerebral hemisphere is convoluted which increases the surface area. The outer surface of cerebrum has grey matter and white matter in its inner part. Cerebrum coordinates and controls the various activities of body. Similarly, the other functions of cerebrum are as follows.

Find out the sensation of odour.

Coordinate and control the speech, memory and hearing.

Create and control the consciousness, thought, stimulus.

Control the analysis, synthesis and prediction of various facts.

Control the other parts of brain

The loss of consciousness, decrease of imagination power, degradation of coordination capacity are the effects when brain is healed and suffer may be of in coma stage.

(ii) Cerebellum

Cerebellum is the second largest part of brain. It covers 10% part of brain. It is located backward of cerebrum and above of medulla oblongata in the form of two lemons like semispherical part. It is known as small brain. Its outer surface has also grey matter and white matter in its inner part. It performs the following functions.

Cerebellum controls the various functions of body.

Coordinate the timing of muscular movement.

Maintain equilibrium of human body during walking.

Control the voluntary movement.

Maintain the muscular tone and posture.

The body is unbalanced when cerebellum is healed and its effects on voluntary movement. It is the condition of disability. A person who drinks alcohol becomes loose postural stability of body while walking since alcohol affects the small brain.

(iii) Medulla oblongata

Medulla oblongata is situated on the lower part of brain. It is the one part among three parts of brainstem. Among these parts, pons varolii and mid brain act as a bridge between spinal cord and brain.

Medulla oblongata is located in between spinal cord and pons varolii. It is stem like tube shape. Its outer and inner surface has white matter. The medulla oblongata passes out through the opening of foramen magnum as it exists at the base of the cranial cavity of brain. It controls the involuntary action. If medulla oblongata gets injured, the person dies instantly. It has the following functions.

It regulates the respiration.

It controls the vomiting, coughing, sneezing and swallowing action.

It regulates the contraction and relaxation of blood vessels.

It helps the secretion of hormones, digestive juices and saliva.

(b) Spinal cord

Spinal cord is the long jelly-like structure that passes from canal of vertebral column. It extends from the base of medulla oblongata to second lumbar vertebrae of vertebral column. Its outer part is white and the inner surface is ash-coloured. It is also covered by meninges. It is about 45 cm long with 2 cm diameter. Spinal cord is able to communicate between different parts of body and brain. Similarly, it acts as a center for reflex action.

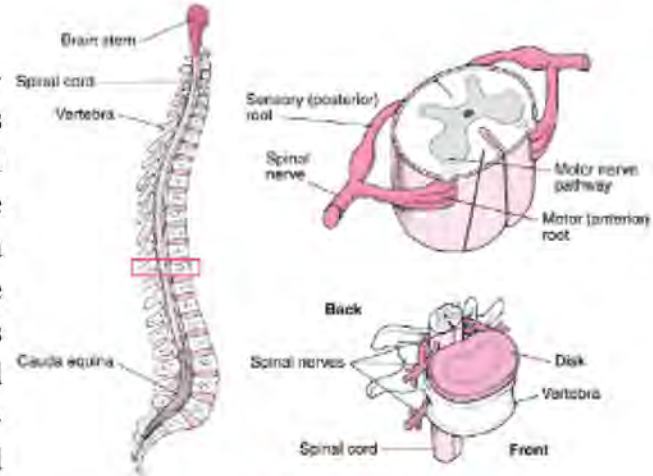


Fig. 5.23 Spinal cord

Nerve fibers

Nerve fibers are made by the combination of axons cells. Nerve fibers act as messenger to brain or spinal cord. On the basis of function, nerve fibers are of three types:

i. Afferent or sensory nerve:

It transmits the nerve impulse from receptor to brain or spinal cord.

ii. Efferent or motor nerve:

It sends the message or nerve impulse from brain or spinal cord to different parts of the body.

iii. Inter neuron:

It connects sensory nerves and motor nerves and transmits the impulse received from sensory nerves to motor nerves.

2. Peripheral nervous system

The nervous system that communicates between central nervous system and different parts of the body is known as peripheral nervous system or PNS. It is made by nerve fibers. On the basis of area of origin of nerve fibers, it is of two types:

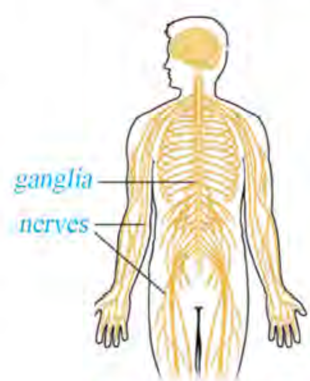


Fig. 5.24 Peripheral nervous system

A. Cranial nerves

The nerves that arise from brain are called cranial nerves. There are 12 pairs of cranial nerves. They communicate between different organs of head and brain like tongue, eyes, ears, nose etc.

B. Spinal nerves

The nerves originated from the spinal cord are called spinal nerves. There are 31 pairs of spinal nerves. They transmit and receive the impulse between the spinal cord and different parts of the body.

Reflex action

We immediately support ourselves with our hands when we suddenly slip on the road while walking. Similarly, we suddenly withdraw hands when we touch something hot. We do some activities without perceiving. We respond to these types of events in unconscious condition. In this way, a sudden and involuntary response to the stimulus shown by our body when touched to any object is called reflex action. Reflex action is controlled by spinal cord. Blinking of eyes when something enters in our eyes is also a reflex action. The impulse is conducted through a special way in the nervous system when reflex action takes place which is called reflex arc. For example, the impulse is conducted as follows with reference to reflex action of touching of a hot object.

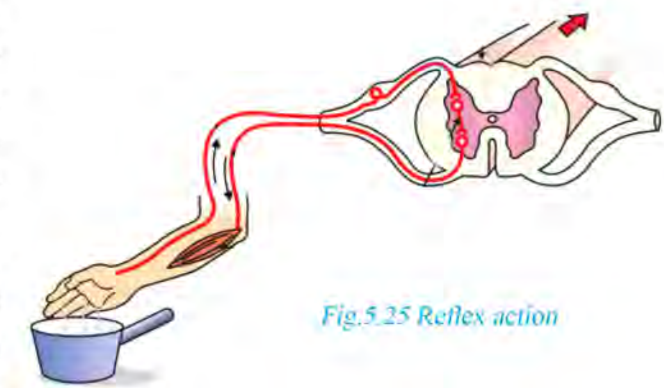


Fig.5.25 Reflex action

Receptor: Skin's nerve tip that receives the stimulus from environmental change.

Sensory nerve: The nerve that transmits the message from receptor to spinal cord.

Connecting nerve: Nerve that carries the impulse from top to bottom of spinal cord or nerve that coordinates between sensory nerve and motor nerve

Motor nerve: Nerve that transmits the impulse from spinal cord to muscles

Effector: Muscles that receive impulse showing effect

3. Autonomic nervous system

The part of nervous system that controls the involuntary action of organs like heart, kidney, lung is called autonomic nervous system or ANS. It controls the action of muscles and particular types of glands either in sleep or wake. It has two parts which are given below:

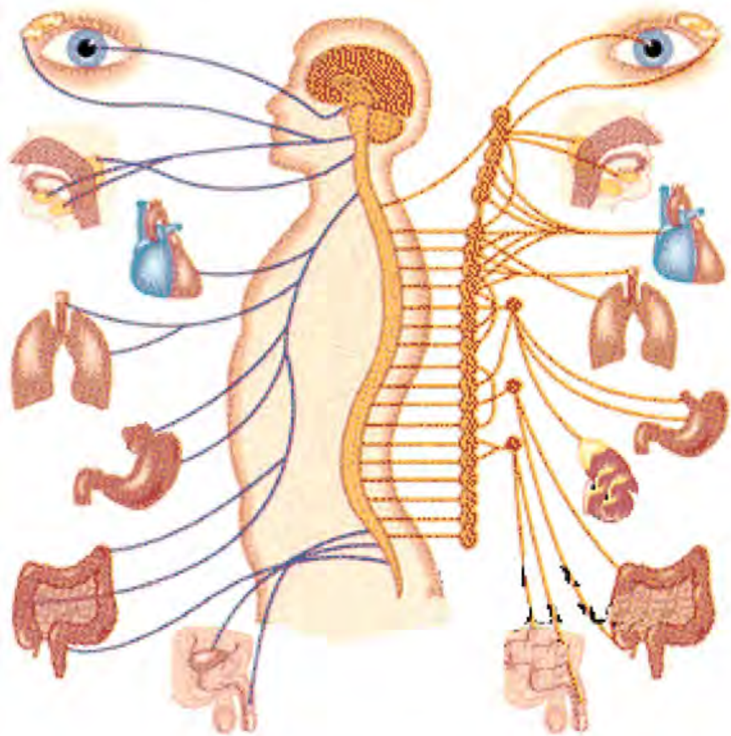


Fig. 5.26 Autonomic nervous system

A. Sympathetic nervous system

It prepares the body facing an emergency crisis. It increases the rate of heart and lung. It helps to produce more energy by increasing blood pressure and heart beat during emergence events. The organism protects themselves by using this energy.

B) Parasympathetic nervous system

It restores and prevents the effect of sympathetic nervous system. It minimizes the heart beat and blood pressure. It helps to bring general conditions of the rate of heart and respiration after the decline of emergency crisis.

Exercise

1. Tick (√) the correct answer.

(a) Which one is the right order in case of meninges (Outer to inner)?

(i) Pia matter, arachnoid and dura matter

(ii) Arachnoid, pia matter and dura matter

(iii) Arachnoid, dura matter and pia matter

(iv) Dara matter, arachnoid and pia matter

(b) Which part of nervous system is in ash colour?

(i) Nerve fibers (ii) Cyton

(iii) Axon (iv) Dendrites

(c) What is the part of brain when injured person can suffer in coma stage?

(i) Cranium (ii) Cerebellum

(iii) Cerebrum (iv) Medulla oblongata

(d) Which nerve transmits the message from different parts of body to brain?

(i) Motor nerve (ii) Sensory nerve

(iii) Ganglia (iv) Both motor and sensory nerve

(e) Which part of nervous system controls the reflex action?

(i) Cerebrum (ii) Cerebellum

(iii) Medulla oblongata (iv) Spinal cord

2. Give reason.

(a) A person suffers in a coma stage when the large brain is healed.

(b) The hand is withdrawn suddenly when a hot object is touched by finger.

(c) Spinal cord is known as the center of reflex action

3. Differentiate:

(a) Cranial and spinal nerves

(b) Sensory and motor nerves

(c) Cerebrum and cerebellum

(d) Sympathetic and parasympathetic nervous system

4. Answer the following questions.

(a) Sketch a neat diagram of brain and label its different parts.

(b) What is the function of medulla oblongata? Explain.

(c) What is the function of autonomic nervous system? Describe with a diagram.

(d) Discuss the way of reflex action that occurs when we touch hot object.

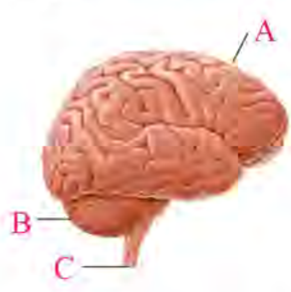
(e) What is nervous system? Describe its type in brief.

(f) Write the functions of the small brain, large brain and spinal cord.

(g) What is neuron? Draw a neat diagram and label its different parts and also write the functions of each part.

(h) Describe the reflex action with examples.

(i) Study the diagram and answer the following questions.



(i) Name the parts indicated in the diagram.

(ii) Write the function of A, B and C.

(iii) What happens when part C is healed?

5.3 Human glandular system

Human body contains various types of glands. These glands produce the essential secretions for body. Glands produce the hormones, enzymes and juice. These secretions help to make our body hygienic by maintaining different activities. The group of various glands in our body is called the glandular system. The secretion from the glandular system helps in digestion, reproduction, excretion etc. On the basis of nature of secretion, glands are two types: Exocrine and endocrine.

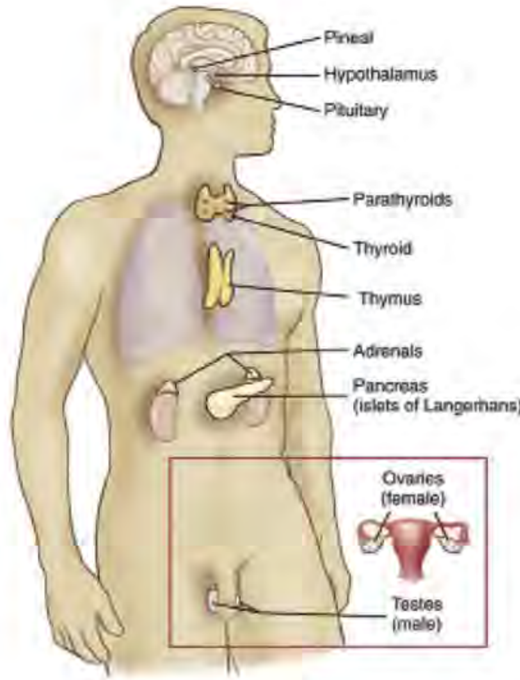


Fig. 5.27

A) Exocrine gland

The secretion of exocrine gland is transferred into the respective place through a separate duct. Examples of these glands are sweat gland, salivary gland, tear gland etc. The secretion of these glands plays an important role in life process; like digestion, excretion. It contains enzyme which acts as biological catalyst.

B) Endocrine gland

The secretion of endocrine gland is mixed in blood and circulated into different parts through blood vessels. It is known as hormone. Hormone stimulates and regulates the body cells and function of other glands. Hormone is produced from endocrine gland but it works in another part of body. So, hormones are called chemical messenger. Pituitary gland, thyroid gland, parathyroid gland, adrenal gland etc. are the endocrine glands. Many problems occur in our body due to irregular production of hormones. It effects on growth and development, loss of reproductive power and suffering from disease. The endocrine system is made by the grouping of endocrine glands. Hormone is the secretion of endocrine gland.

Some glands produce juice or secretion which is circulated directly from blood as well as through duct in their working place. Pancreas and gonads are the examples of these types of glands. They produce both hormones and enzymes. They are mixed glands.

Functions of hormone are as given below:

(a) Physical, mental and psychological growth occurs due to hormones.

(b) It stimulates and controls the various organs.

(c) It controls the production of sperms and ovum.

(d) It develops the sexual characteristics in human beings.

(e) It controls the reproductive power.

(f) It balances the calcium and phosphorus in body.

The endocrine and mixed glands are given in table on the basis of place and hormone production.

Endocrine gland	Occurrence in body	Hormone produce
1. 1. Pituitary gland	Base of brain	Growth hormone, stimulating hormones
2. Thyroid gland	Inside of neck	Thyroxine
3. Parathyroid gland	Above thyroid gland in neck	Parathermone
4.Adrenal gland	Upper part of kidney	Adrenaline
5. Pancreas	Back of stomach near duodenum	Insulin, glucagon
6. Gonads (a) Testes (b) Ovary	Lower part of abdomen	Testosterone Oestrogen and progesterone

Pituitary gland

Pituitary gland is like the pea shape. It is located inside of skull at the lower part of brain. It mainly produces stimulating hormones and growth hormones. The main function of hormones produced from these glands is physical and mental growth and stimulation of other glands. So, it coordinates and controls the function of other glands and is called master gland. The growth hormone maintains the physical and mental growth of human. If the production of growth hormone is reduced, then the person becomes obese, which is called dwarfism. If the body produces a lot of this hormone, then the person becomes very tall. This condition is called gigantism.

Thyroid gland

Pituitary gland is like the pea shape. It is located inside of skull at the lower part of brain. It mainly produces stimulating hormones and growth hormones. The main function of hormones produced from these glands is physical and mental growth and stimulation of other glands. So, it coordinates and controls the function of other glands and is called master gland. The growth hormone maintains the physical and mental growth of human. If the production of growth hormone is reduced, then the person becomes obese, which is called dwarfism. If the body produces a lot of this hormone, then the person becomes very tall. This condition is called gigantism.

Parathyroid gland

Parathyroid gland is located at the back of thyroid gland. Its number is four. It produces parathermone hormone. It exchanges the calcium between blood and bone and increase the calcium level in blood. There is a chance of having tumor and kidney stone in our body when this hormone is increased. The calcium level in blood is decreased by its hypo-secretion and muscle spasms which is called tetany.

Fig. 5.28

Adrenal gland

Adrenal gland is located in the upper part of kidney. It produces adrenaline and cortisone hormone. Adrenaline prepares our body in facing a sudden emergency or danger. Cortisone hormone also acts as sex hormone. Blood pressure is increased due to hyper-production of adrenaline. Weakness, decrease in blood pressure, decrease of sugar level and vomiting are its hypo-production effects.


Fig 5.29

Pancrease

Pancreas is one of the largest glands in human body. It is found at the back side of stomach in the loop of duodenum. It is about 12-15 cm long. It is known as mixed gland since it produces both pancreatic juice and hormone. The produced pancreatic juice contains different types of enzymes. This enzyme helps in digestion. The glucagon and insulin hormones produced by pancreas

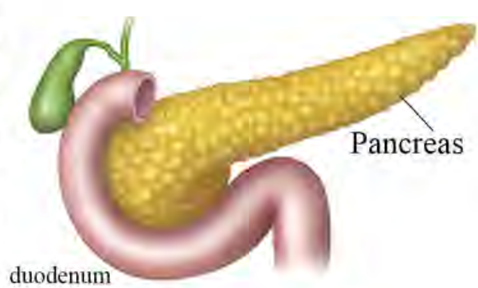


Fig. 5.30 Pancreas

perform opposite functions to each other. So, they are called antagonistic hormones. Insulin balances the sugar level in blood and glucagon increases sugar level. The amount of blood glucose increases when insulin is less secreted. This condition is called diabetes. In this condition, hunger, thirst and frequent urination happen. If insulin increases, the glucose decreases in blood, and that results anxiety, faint and brain hemorrhage.

Gonads

Fig.5.31 Gonads

The testes in male and ovary in female are called gonads.

A) Testis

The two ball-like glands in male scrotum are called testes. It produces the sperm and testosterone hormone. This hormone helps to produce sperms and expression of secondary sexual characters like facial hair, growth and development of penis and voice deepen.

B) Ovary

The two oval parts situated on female's lower abdomen near the fallopian tube are called ovary. It produces the ovum and sex hormones like oestrogen and progesterone. These hormones help to produce ovum and development of female sexual characters.

Project work

Observe the audiovisual aids of the endocrine gland. Prepare the description given in the table by observing the location of different types of endocrine glands in human body and present it in class.

S.N.	Name of gland	Location	Hormone	Function

5.4 Plant Hormone

Do you think plants produce hormone like animal to conduct life process?

Hormone is essential in plant for growth and development, initiation of fruit, ripening of fruit, and dispersion of seed from fruit. Plants also respond to environment like animals. Plants show the response to gravity, light and touch. As for example, the flower of sunflower plant grows towards the light. Plant reacts in response to environmental stimulus which is possible by hormones. Plants also contain glandular tissue like animals which produces the hormones and communicate from one cell to another cell. Plant hormones are not the nutrient. They are chemical messenger. Plants need special type of hormones in particular region in particular time.

The external (environmental) and internal factor affect the growth and development of plant. Hormone is the main internal factor which directly affects the growth and development of plants. The hormone which supports and regulates the growth and development of plants is called plant growth hormone. Auxin, gibberellin, cytokinin, ethylene and brassinosteroid are the example of plant growth hormone

Function of plant growth hormone

The main function of growth hormone is to regulate the growth and development of plant. Generally, growth hormones are produced in growth area of plant like tip of shoot and root. Auxin is produced in tip of shoot and helps to grow the tip toward the light which is called phototropism. It also helps in apical dominance. Cytokinin is found in tip of root, embryo and fruits in excessive amount. These hormones help in growth and development of plant.

Uses of plant growth hormone

1. Auxin and cytokinin is mixed artificially during tissue culture. It helps to initiate root and grow of shoot. So, auxin and cytokinin should be kept in proper balance which maintains rapid growth and development of plant.
2. Hormone plays an important role for the production of quality fruits, vegetable and unseasonable vegetable. But it creates serious health hazard if it is used in vegetable and fruits in higher amount.

Project work

Nowadays, professional farmers use excessive amount of synthetic hormones and increase productivity. It causes serious health problems if we consume the fruits and vegetables on which this type of synthetic hormones are excessively used synthetic hormones in vegetable and fruit production. Visit the garden and agriculture research center near from your locality. Prepare a report including name of plant hormone, its use and advantage by collecting data with the help of expert and present it in class.

Exercise

1. Use tick (√) sign in correct alternative from given question.

(a) Which hormone controls the blood sugar level?

(i) Thyroxine (ii) Insulin

(iii) Parathermone (iv) Oestrogen

(b) Which hormone is responsible for ripening of fruit?

(i) Ethylene (ii) Gibberellin

(iii) Cytokinin (iv) Auxin

(c) Which hormone causes apical dominance?

(i) Cytokinin (ii) Auxin

(iii) Ethylene (iv) Gibberellin

(d) Which gland is called master gland?

(i) Thyroid gland (ii) Pancreas

(iii) Pituitary gland (iv) Adrenal gland

(e) Which hormone controls and develops the male sexuality?

(i) Progesterone (ii) Thyroxine

(iii) Testosterone (iv) Oestrogen

(f) Which hormone is involved in ripening of fruit and abscission of leaf?

(i) Ethylene (ii) Cytokinin

(iii) Gibberellin (iv) Auxin

2. Give reason.

(a) Pancreas is called mixed gland.

(b) Pituitary gland is called master gland.

(c) Hormone is called chemical messenger.

(d) The function of glucagon and insulin is opposite to each other.

(e) Enzyme is known as biological catalyst.

3. Differentiates:

(a) Exocrine and endocrine gland

(b) Cytokinin and auxin

(c) Parathyroid and thyroid gland

4. Answer the following questions.

(a) What is gland? Prepare a chart of its type with examples.

(b) What are plants hormones? Write.

(c) Draw the diagram of endocrine glands in human body.

(d) Describe in short about pituitary gland.

(e) Enlist the plant hormones.

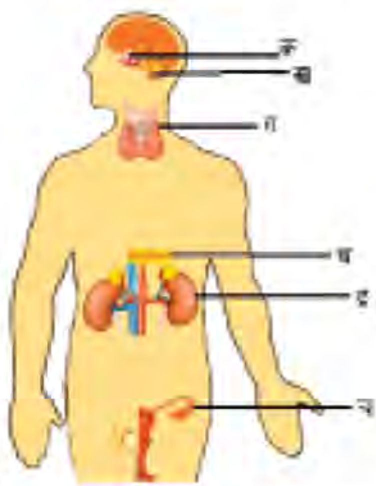
(f) Write the application of plant hormones.

(g) Explain the pancreas with diagram.

(h) What effect is seen in human body if excessive hormone is secreted? Describe with examples.

(i) Describe the interrelationship between glandular system and nervous system with examples.

(j) Observe the following diagram and answer the following questions.



a. Write the name of hormone in diagram.

b. Name the hormone produced by each gland with one function.

c. Which hormone is responsible for tetany?

6 Nature and Environment

There are many types of living and non-living beings found in our surroundings. Living beings include a microorganism, human, other animals, and plants. Similarly, the environment also includes non-living things such as; soil, air, water, light, etc. What is this total composition in our surroundings called? What is the relationship between them? Discuss

6.1 Ecosystem

Activities 6.1: Observe the diagram and discuss the questions given below.

Fig. 6.1 Aquatic and terrestrial ecosystem

1. What types of ecosystems are shown in the above picture?
2. What are the biotic components present in both ecosystems?
3. What are the abiotic components present in both ecosystems?
4. What are the differences in the ecosystem shown in the picture?
5. What type of relationship is in an abiotic and biotic component in the picture?

Green plants prepare food in chlorophyllous leaves by taking water and minerals from soil and carbon dioxide from the atmosphere in the presence of sunlight. Animals consume the food prepared by plants. The organism takes oxygen from the environment for respiration and releases carbon dioxide gas which is used by plants for photosynthesis. The water hyacinth (Eichhornia) and other aquatic plants in the pond absorb water and other soil components. The dead body of all organisms is decomposed by a decomposer and converted into a simple small molecule that is taken by plants. In this way, a cycle is operated in an environment in which animals, plants, and the environment are interrelated. Similarly, the interrelationship can be observed between living and non-living beings in the environment, and plants and animals are also interdependent. The group of living beings that are interdependent within the same environment is called community. The interrelations between all communities and the physical environment functions continuously.

The environment is formed by the combination of living beings and components of their surroundings like light, heat, water, soil, air, etc. There is a direct or indirect relation between environmental components and living beings. The continuous and permanent interrelationship between living beings and the physical environment is called the ecosystem. The branch of science that studies ecosystems is known as ecology. The concept of the ecosystem was first developed by English scientist A.G. Tansley in 1935 AD.

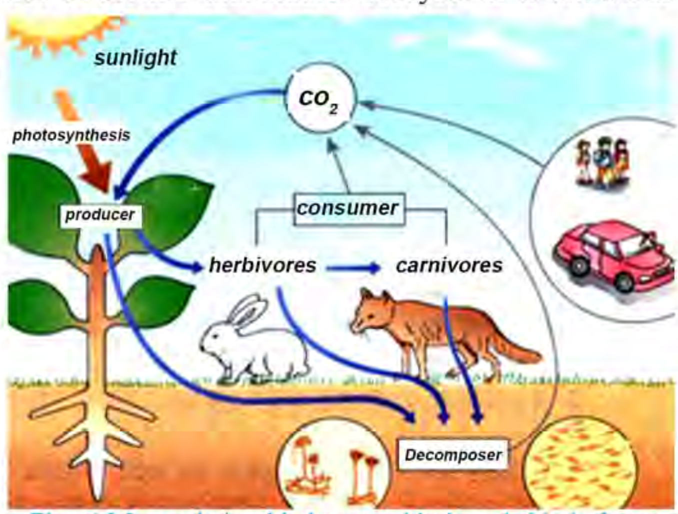


Fig . 6.2 Interrelationship between biotic and abiotic factors

Biotic and abiotic factors are the main parts of the ecosystem which is called the effecting component of living and non-living in the ecosystem. Biotic factors include; plants, human beings, animals, and bacteria which form a community. Abiotic factors include various types of non-living things and physical environments like soil, light, air, water, humidity, etc. In an ecosystem, the energy and other substances are transferred continuously between biotic and abiotic components. The ecosystem is balanced by this energy transfer mechanism and biotic interaction.

Components of ecosystem

Biotic and abiotic are two types of components in the ecosystem which are described below.

1. Abiotic components

The non-living thing that affects the ecosystem of any place is called the abiotic component. It includes air, solar energy, temperature, soil, water, humidity, etc. The biotic and abiotic components are interrelated to each other. Below are the details of abiotic components:

(a) Air

Air is an important abiotic component. The atmosphere contains different types of gas like nitrogen, oxygen, carbon dioxide, water vapor, etc. Green plants take carbon dioxide during photosynthesis and release oxygen which is taken by plants and other animals including human beings. Similarly, during respiration carbon dioxide is released by all living things. In this way, the relationship is maintained between plants and animals. Nitrogen is essential for chlorophyll synthesis in plants and plants prepare food by photosynthesis. The atmospheric nitrogen is converted into soluble nitrate which is absorbed by the root of the plant. Water vapour plays an important role in the water cycle. The atmospheric humidity is increased by water vapour. So, water is an important factor in the ecosystem.

(b) Solar energy

Solar energy plays an important role in the life process of plants, animals, and other organisms in the environment. The heat and light energy of the sun play an important role in the life of living beings. The plant prepares its food in the presence of solar energy. Solar energy is not obtained uniformly due to geographical conditions. So, the climate, rainfall, and food production differs in place to place. So, the plants and animals are also different in various places. The solar heat helps to balance the atmospheric temperature. It makes the life process of an organism easy. The different types of plants are found in different places based on temperature. Solar heat plays an important role to maintain the water cycle.

What is the reason behind the occurrence of fewer animals and plants in the cave and deep sea?

(c) Water

Water is an important factor for plants and animals. Water is important in photosynthesis. Similarly, water is essential for bodybuilding. Man, animals, etc. use water from ponds, lakes, wells, waterfalls, rivers, and sea in their life. Water is essential in living beings for the life process. Water is present in a certain percentage in the body of plants and animals. This amount of water is supplied from food and absorbed by an organism. Water is essential for the conduction of biochemical processes in the body like for organism requires it in physiological metabolism. It is difficult to live life for plants and animal in a water deficit place.

(d) Soil

Soil is also an important component of the abiotic factor. Soil contains minerals, organic matter, animals, and chemicals like nitrogen, phosphorus, and potassium which are essential for plants. Plants take water and minerals from the soil. These components help the plant for growth and development. Humans and other animals consume plant products like grain, vegetables, fruits, and herbs. The habitat or settlement of man and animals is in soil.

2. Biotic Components

The biotic component includes the biotic community. The plants, animals, fungi, bacteria, and microbes are called biotic components. These organisms have an interrelationship with each other. The relationship of communities among organisms affects the environment and being affects themselves directly or indirectly. The relationship is maintained for food, habitat, and movement. The biotic community includes producers, consumers, and decomposers. The biotic community is categorized as following based on energy transfer in the ecosystem.

(A) Producer

The chlorophyllous unicellular, multicellular organisms and plants that prepare their food materials themselves are called producers. Cyanobacteria, diatoms, etc. are an example of phytoplankton. The chlorophyll-bearing microorganism of plant stock is called phytoplanktons. They prepare food by photosynthesis. Producers can convert inorganic matter into organic matter during photosynthesis by the use of solar energy or chemical energy. This is used by the higher-level organism.

(B) Consumer

The biotic community that depends on producers for food is called consumer. The consumer is divided into three groups on the basis of food.

(i) Primary consumer

The living beings that depend only on the plant for food are called primary consumers. They are herbivorous. It includes zooplankton, insects, grasshopper, rabbit, cow, buffalo, dear, etc.

(ii) Secondary consumer

The living beings that depend on the primary consumer for food are called secondary consumers. Small fish, jackals, frogs, etc. are an example of the secondary consumer.

(iii) Tertiary consumer

The living beings that survive by consuming secondary consumers in the ecosystem are called tertiary consumers. They are upper-grade carnivores. Tiger, lion, large fish (Whale). Crocodiles etc. are an example of a tertiary consumer.

(C) Decomposer

The bacteria, fungi, and microbes in the soil are decomposers. These microorganisms decayed and decomposed the dead body of the organism and mixed it in soil by converting it into a simple molecule. Bacteria and fungi break the dead body of plants and animals into simple molecules and mix them in soil and clean the environment. So, they are called natural scavengers. The plant absorbs the decomposed nutrient from the soil.The ecosystem, basically divided into two types as follows:

Types of ecosystem

Ecosystem

- Terrestrial ecosystem
  - Grassland ecosystem
  - Forest ecosystem
  - Desert ecosystem
- Aquatic ecosystem
  - Pond ecosystem
  - Lake ecosystem
  - Ocean ecosystem

1. Terrestrial ecosystem

One-third of part of the earth is covered by land. The terrestrial ecosystem is affected by different types of climate and topography. The existence of the various types of ecosystems is due to the irregular distribution of climate and topography. The ecosystem in the land which is made by the interrelationship between abiotic and biotic factors is called the terrestrial ecosystem. It includes grassland ecosystem, forest ecosystem, and desert ecosystem. The grassland ecosystem is described below

Grassland ecosystem

A grassland ecosystem is an ecosystem made by the interrelationship between biotic and abiotic factors in open land and grassland. The biotic and abiotic factors of this ecosystem are described below.

a. Abiotic factor

Fig.6.3 Grassland ecosystem

The abiotic factors in the grassland ecosystem include air, soil, minerals, solar energy, humidity, and water. Water is the most important factor for plants among all factors. Plant prepares food from water and carbon dioxide in the presence of solar energy. All living beings in this ecosystem take oxygen from the air in respiration and release carbon dioxide. Similarly, the soil is the haven for all living beings in the grassland ecosystem. The minerals and water in the soil are absorbed by the plant. In this way, the grassland ecosystem is balanced by maintaining the interrelationship between abiotic and biotic factors.

B. Biotic factors

Plants and animals are the biotic factors in grassland. It is divided into three groups viz. producer, consumer, and decomposer which are discussed below.

i) Producer

The green plants are the producer of grassland. Producers prepare their food with the help of water, carbon dioxide, and solar energy. All the autotrophs including grasses in the grassland ecosystem are producers.

ii) Consumer

The consumers in the grassland ecosystem are as follows:

Primary consumer

The insects, grasshoppers, earthworms, rabbits, deer, etc are the primary consumers of the grassland and these animals depend on the grasses for their food. These all herbivores are primary consumers.

Secondary consumer

The living beings that depend on a primary consumer for food are called secondary consumers. Frogs, birds, jackals, and the wolf in the grassland ecosystem are the secondary consumers. These organisms depend on the primary consumer for their food. Some organisms in this group are omnivorous.

Tertiary consumer

The organism that depends on the secondary consumer for their food is called the tertiary consumer. These organisms are physically strong and carnivores. Snake, tiger, leopard and lion are some examples of a tertiary consumer.

iii) Decomposer

The dead body of the producer, primary, secondary and tertiary consumers are decayed by the bacteria and fungi in the grassland ecosystem and converted into a simple molecule in soil. The root of the plant absorbs the simple molecule in the soil. Bacteria and fungi are examples of decomposers.

Activities : 6.2

Visit the grassland in your surroundings. Study and observe the biotic and abiotic components in this environment and fill the table given below. Draw the diagram of the grassland ecosystem based on observation and study and present it in class.

S.N.	Producer	Primary consumer	Secondary consumer	Tertiary consumer

2= Aquatic ecosystem

The ecosystem in water is made by the interrelationship between biotic and abiotic factors called an aquatic ecosystem. The structure and condition of the sources of water are different. Diverse types of plants and animals are found in different types of water sources due to its structure and formation. The aquatic ecosystem includes the ecosystem of ponds, rivers, oceans, lakes, wetlands, etc. Here is a description of the pond ecosystem which has the following biotic and abiotic components.

Pond ecosystem

The interrelationship between abiotic and biotic factors in the pond is called pond ecosystem. The abiotic and biotic factors in the pond ecosystem are described below:

Fig. 6.4 Pond ecosystem

a. Abiotic components

Minerals, water, soil, light, heat, oxygen, carbon dioxide, nitrogen, etc. are the abiotic factors in the pond ecosystem. Fish respire by taking soluble oxygen in the water. Light rays reach up to the bottom of the pond from where plants prepare food material by the use of soluble carbon dioxide and water in the pond. Besides this, the plant absorbs the nitrate salt of the pond. The biotic community in the pond depends on the abiotic component for food and shelter and is interdependent to each other.

b. Biotic components

The green plants are the producer in the pond ecosystem. The producer feeder insects, grasshoppers, small fish, frog, large fish, snake, etc. in the pond ecosystem are consumers whereas bacteria is a decomposers which are described below.

i) Producer)

The algae including Volvox ,Chlamydomonas, Clostridium in the pond are the producers. The microorganism in the pond is called phytoplankton. The green plants like phytoplankton, Pistia and Hydrilla prepare the food from solar energy.

ii) Consumer

The living beings that have to feed on producers to survive are called consumers. These living beings are heterotrophic and depend on the producer for food. The following are the consumers in the pond.

Primary consumer

Herbivores living beings in the pond that feed on plants to survive are called a primary consumer. They survive by taking microorganisms from the pond which are known as zooplankton. Some examples of zooplankton are Cyclops, Daphnia, beetles, molluscs. Small fish, tadpoles, and earthworms are the primary consumers in the pond ecosystem.

Secondary consumer

The organism that survives from the feeding of the primary consumer is called the secondary consumer. Frog, crab, and large fish, which depend on small fish in the pond, are the secondary consumer. If the snake is present in the pond, it is considered as a tertiary consumer since it consumes the frog.

c. Decomposer

The dead organism is decomposed by microbes like bacteria and fungi when the producer and consumer in the pond die. Then, the decomposers convert them into simple molecules which are easily mixed in soil and absorbed by the plant. In this way, this process is operated continuously.

Activities : 6.3

Visit the pond in your surroundings. Study and observe the biotic and abiotic components in this environment and fill the given table below. Draw the diagram of the grassland ecosystem based on observation and study and present it in class.

S.N.	Producer	Primary consumer	Secondary consumer	Tertiary consumer

Food chain

Energy is required for the life process which is obtained from food. Green plants prepare food by photosynthesis. The animals do not prepare their food due to the absence of chlorophyll. They take food from the producers. For example, insects consume phytoplankton and grass. Birds and frogs survive by consuming insects. Fish eat the small organism in the pond and fish by snake and heron. The organism takes its food from different sources according to the situation. In this way, the interrelationship is maintained between autotrophs and heterotrophs. Thus, the energy is transferred when one organism is eaten by another and a food chain is formed.

The plants and animals in the ecosystem depend on each other for nutrition. The energy is transferred from an organism that is being eaten and a trophic level is formed. This level is transferred from producer to consumer. Solar energy is permanent energy for the plant. In this way, plants are the primary source for all organisms which is called the first trophic level. The primary consumer is called the second trophic level since the energy in the producer is transferred to the primary consumer when it is eaten. In this way, the energy is transferred in the upper feeding level continuously.

The given diagram of the terrestrial ecosystem shows the interrelationship among three, four, and five-level producers and consumers where maize, carrot, and grass are a producer.

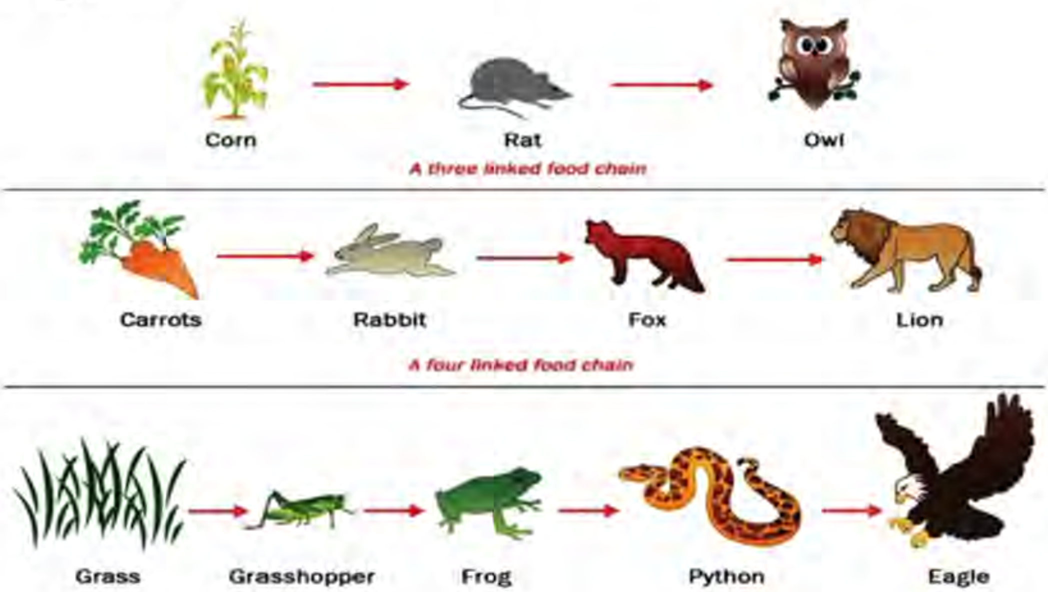


Fig. 6.5 food chain

Producers are placed in the first feeding level. Mouse, rabbits, and insects which are survived by taking producers are primary consumers. It forms the second feeding level. Owl, fox, and frogs which survive by taking food from the primary consumer are secondary consumers which form the third feeding level. In this way, the level of feeding level increases. At last, the decomposer decomposes the producer and consumer when dies and is mixed in the soil. The plant absorbs them and converts them again into energy. So, the linear transfer of energy from the producer to the top level of the consumer who is eating and who is being eaten is called the food chain.

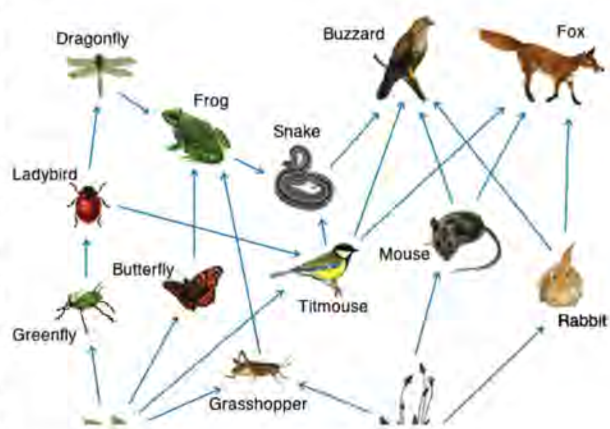
Activities 6.4 Demonstration of food chain

Prepare a flash card of producer, primary consumer, secondary consumer, tertiary consumer and decomposer. Prepare it in groups of your friends. Select 11 friends as producer, 8 as primary consumer, 6 as secondary consumer and 4 as tertiary consumer. Who is eating whom? Whose food is who? Arrange in the order and demonstrate the food chain. Discuss and conclude about energy transfer from producer to top level consumer after demonstration.

Food web

How many food chains are connected in the given diagram? Discuss it.

In an ecosystem, there are three to five feeding levels which constitute the food chain. A complex network is formed by the interconnection of various food chains which is known as food web. The food web is permanent in nature where consumer has opportunity of various food sources. For example, the upper level of consumer takes food from many consumers of lower level. The food chain has a mutual relationship between food and energy.



The given diagram shows that the grass, bird, and hawk constitute three levels of the food chain and similarly, five-levels of the food chain in nutrition are formed between grass, grasshopper, frog, snake, and hawk. In this way, the food web is formed by the combination of many food chains where insects survive by taking food from grass which is once taken by birds and frogs. So, many organisms depend on a single organism for food which is repeated and becomes complicated.

So, the multidirectional flow of energy from the producer to the upper level of the consumer by eating and being eaten in an ecosystem is called the food web.

Activities 6.5

Observe the food chain in the above figure of 6.6 and discuss how the food web is formed.

6.2 Interaction between living beings

The organism in our surroundings is directly or indirectly interdependent to each other. Would it be possible for human beings to survive without other living beings?

Activity 6.6

Draw a table like the given below and and complete it as given.

S.N.	Name of plant or animal	Host organism	Nature	Biotic interrelationship
1.	Tapeworm	Cow, human body	Endoparasite	
2.	Mosquito	Animal body	Exoparasite	
3.	Orchid			
4.	Aijeru			
5.	Lichens in bark of tree or in stone			

You may have seen birds in the body of cattle grazing in the field, Lichens in a large tree, tapeworms, and Ascaris that suck the blood for survival. Similarly, you may have seen nodules in the leguminous plant, pea, and bean. These are some of the examples of interrelation and interaction among organisms. Birds eat the insect from the ear on seating to the body of animals. The Lichens in tree bark where an alga takes water and shelter from fungi and fungi takes food from algae. So, different types of interrelationships and interactions are found among the living beings. Organisms conduct interaction through various ways of their life process. Among them some major interaction of living beings are given below.

i) Symbiosis/Mutualism

The diagram shows a bird sucking nectar from the flower. In this relation, the bird takes juice from flowers and helps in pollination where bird and plant both are mutually benefitted. In this way, the longtime relationship where both organisms are mutually benefited is called symbiosis. In this relationship, the organisms depend on each other. Some more examples of mutualism are given below.

Fig. 6.7 Mutualism

(a) The bacteria in the human digestive tract also has interrelationship. The bacteria in the digestive tract helps to digest food in another way. It takes food from the food consumed by human.

(b) The interrelationship is also in clownfish and sea anemones where clownfish is situated in the tentacle of sea anemone safely where clownfish attract other organisms which are eaten by sea anemone.

ii) Commensalism

In the given diagram, a cow is grazing and a heron tries to eat insects. The insects get stirred up while grazing and the heron eats those insects. This process shows the biotic interaction in such a way where the heron is benefited and as a host the cow is neither benefited nor harmed. It is known as commensalism. Other examples of commensalism are given here.

Fig. 6.8 commensalism

(a) When one spider makes a net in a tree, in this case the spider is not harmful to that tree.

(b) The spiky burrs is attached on the body of animals and burr falls by walking of animals which helps to disperses the seed.

(c) Barnacles is attached on the body of whale which covers the distance with the movement of whale but don't harm to whale.

iii) Parasitism

It is the biotic interaction in which parasites suck their food from the host organism. In this type of interaction, one organism is benefited but another is being harmed. Some examples of parasitism are given below.


Fig. 6.9 Parasite

(a) Flea, mosquito and bed bug suck the blood from animals. They are called external parasites.

(b) The tapeworm in the animal intestine takes food from the body of animals. As they live inside the body of the animal, it is called internal parasite.

(c) The louse in human hair sucks the human blood. In this condition, lice are benefitted but harmful to human.

iv) Competition

In an ecosystem, the living beings compete with each other for the same source like food and shelter. It is necessity to balance all the biotic factors in an ecosystem. The ecosystem is disturbed if the number of biotic factors is imbalanced. The competition between organisms in the ecosystem is given here.

(i) Sea sponges and corals are in competition for obtaining food from the source of ocean.

(ii) Wolf and bear both compete for hunting organisms.

v) Predation

The carnivores take their food by killing other weak animals. The way of taking food by killing another animal is called predation. This type of interaction is found in carnivores. Some examples are given below.


Fig. 6.10 Predation

(i) Leopard kills the dear for food.

(ii) Owl hunts the mouse.

(iii) Tiger hunts the other animals.

Exercise

1. Tick (√) the correct answers.

(a) Which of the given organism is decomposer?

(i) Algae (ii) Insect

(iii) Mushroom (iv) Lichens

(b) What is the relationship made between producer and consumer on the basis of nutrition supply?

(i) Food web (ii) Food chain

(iii) Ecosystem (iv) Community

(c) Which type of interaction is found in Lichens of tree bark?

(i) Mutualism (ii) Commensalism

(iii) Parasitism (iv) Competition

(d) In biotic interaction, prey sucks the food from host. What happens in this interaction?

(i) Only one organism is benefited

(ii) Both organisms are benefited

(iii) Both organisms are harm

(iv) Both organisms neither benefit nor harm

(e) Which one is the first nutrition level?

(i) Green plants (ii) insects

(iii) Frog (iv) Snake

2. Give reasons.

(a) The ecosystem is disturbed if decomposer is absent.

(b) The grassland ecosystem is imbalanced if the number of primary consumer- insects is increased excessively.

(c) In the food chain, generally the number of producers is more than consumers.

(d) In mutualism, both organisms are benefited.

(e) The environment is fresh where ecosystem is balance'

3. Write differences.

(a) Producer and consumer

(b) Grassland ecosystem and pond ecosystem

(c) Food chain and food web

(d) Biotic and abiotic component

(e) Mutualism and commensalism

(f) Parasitism and mutualism

4. Answer these questions.

(a) List out the abiotic factors in ecosystem and describe each in brief.

(b) Describe the role of decomposer in ecosystem.

(c) Describe the grassland ecosystem in brief with a diagram.

(d) What effect are seen when the number of frogs is increased in pond ecosystem? Explain.

(e) The farmer works on the land and kills all of the mice that ate rice but rice production is very less after killing the mice in his field. Why does the production of rice decrease? Describe with your illustration.

(f) Describe the food chain in a pond with a figure.

(g) In an ecosystem, the balance cycle is operated among producer, consumer, decomposer and environment. The ecosystem is disturbed if any one of component is imbalance. Prove this statement with reason.

(h) State the types of ecological interaction. Explain each with examples.

(i) Isolate the type of ecological interaction from given examples.

i. Bee and bumble bee takes flowers nectar

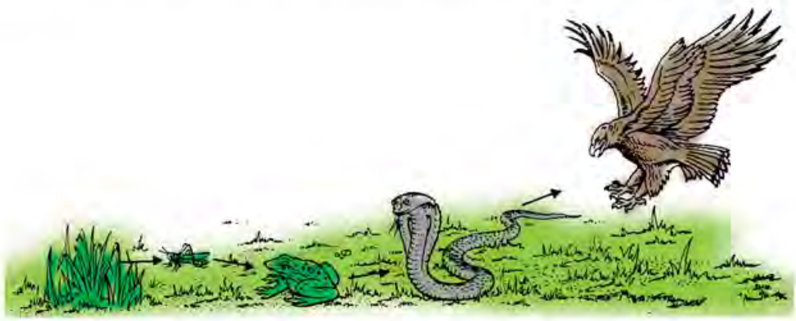
ii. Spider makes the net in tree

iii. Barn Swallow makes the nest in home

iv. Bed bug, flea and mosquito that survive by sucking blood from animals

v. Tapeworm and roundworm lives inside of body of animals

(j) Study the ecosystem given in the picture and answer the following questions.



i. Identify the producer and consumer from the diagram.

ii. How do producers prepare food?

iii. The number of producer is more in this system, why?

iv. Explain the role of decomposer in this system.

v. Write the benefits of balanced ecosystem.

Project work

A. Prepare a diagram in a chart paper showing producer, primary consumer, secondary consumer, decomposer and abiotic factors in the pond and grassland ecosystem, and present it in the class.

B. Prepare a list of types of biotic interaction you have observed or seen in different times in your surroundings. How are these interactions interrelated? Search about it and prepare a report to present in your class.

7

Force and Motion

The bus journey of Batuli

Batuli reached point B from A by bus through the way shown on the adjacent map. The bus was at rest while she boarded it at A. When the driver started the engine, the bus moved slowly due to the force applied by the engine. The bus accelerated after a while. When the brakes were applied in different places, her body jerked forward.

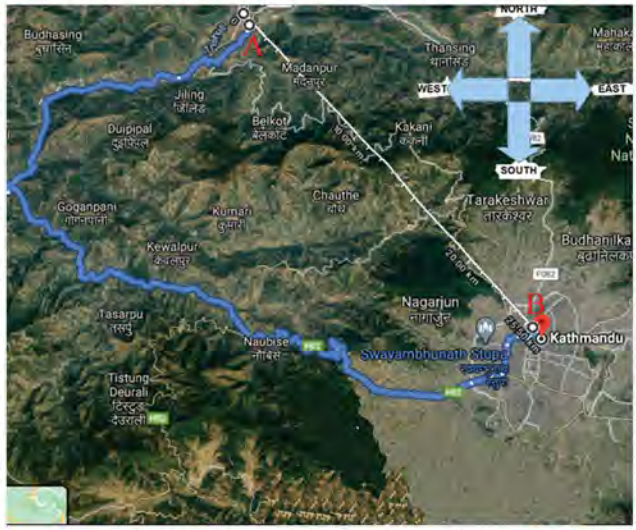


Fig 7.1: Google map showing road joining A and B

The bus moved in different directions on the way. Batuli was observing how the driver was rotating the steering wheel to change the direction of the moving bus. Can you imagine what will happen when the steering wheel is damaged?


Fig 7.2: Bus on the bending road

Batuli noticed the distances covered by the bus mentioned in the milestones placed by the roadside.

Time (in minutes)	10	25	30	40	50	......
Distances (in km)	5	10	Bus was stopped	15	20	....

Batuli noticed the reading of the speedometer was 50 km/hr while the bus was moving with a uniform motion on a straight road. She calculated the time to cover the distance of a similar situation by observing the speedometer from time to time. When she reached the destination, she found that the distance between A and B was 74 km. She also calculated the average speed by dividing the total distance by total time. She also searched the displacement from A to B by using Google Map. It was 25.5 km towards the south.

Fig 7.3: Speedometer in front of the driver

Questions:

(a) How can a map like the one shown in fig. 7.1 be obtained with the help of the internet? Discuss in your classroom.

(b) Find the distance and displacement between any two places as shown in fig. 7.1 by using the available technology.

Speed and velocity

Fig 7.4 shows the change in the direction of motion of the bus during Batuli's journey. Using a 50 m long measuring tape or a rope, fix a track in your school ground. Ask your friend to walk along the track at a random speed. With the help of a stopwatch, note the time taken to cover the track. Also, note the directions of the motion in each segment. Calculate the displacement, average speed and average velocity in a particular segment.

$$\text{Average Speed (AS)} = \frac{\text{Distance covered (d)}}{\text{time (t)}} = \text{... m/s}$$

The average distance covered by an object in 1 second in a particular direction,

$$\text{Average Velocity (AV)} = \frac{\text{Displacement (s)}}{\text{time (t)}} = \text{m/s direction}$$

In fig 7.4, the total distance covered by the bus from place A to place F is ABCDEF m and displacement is AF m North West. The total length covered by an object is the distance. It is a scalar quantity because only the magnitude is expressed and no direction is specified. Displacement is the shortest distance covered by an object from the initial point to the final point in a particular direction. Displacement is a linear distance between two points. Displacement is expressed by both magnitude and direction. Hence, it is a vector quantity.

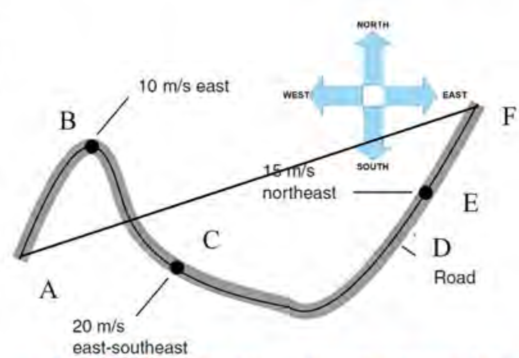


Fig 7.4: Distance covered by the bus and its displacement

When the distance ABCDEF is divided by the time required to cover the distance, speed is obtained. The velocity of a segment is obtained by dividing the distance covered in a particular direction by the time taken in the different segments of the road. In place B shown in fig 7.4, the bus was moving towards the East, covering a 10 m distance per second. In place C, velocity changed to 20 m/s towards North East. In the DF segment, the velocity of the bus was 15 m/s towards North East. Thus, the distance covered by a body in a unit of time is called the speed and the distance covered by a body in a particular direction per unit of time is called the velocity. In variable motion, the moving object moves slow and fast and covers different distances in equal intervals of time. When the total distance covered in a particular direction in a variable motion is divided by the total time taken to cover the distance, it is called average velocity. Speed is a scalar quantity and velocity is a vector quantity. Even when the magnitude remains constant, the velocity changes because of the change in its direction. But, speed remains constant. When an object moving in a particular direction starts moving in the opposite direction from the reference point, as shown in fig 7.5, the velocity becomes negative. But, the speed is always positive.

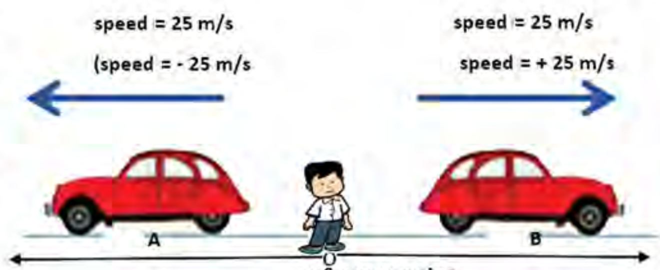


Fig 7.5: positive velocity and negative velocity from the reference point

Acceleration

Activity 7.2

Objective: To observe the change in velocity of an object

Required materials: A smooth wooden plank of 3 m length, some books, marbles or small balls, a stopwatch, chalk or pencil

Methods:

1. Support the wooden planks on a pile of books.
2. Roll the ball/marble from the upper part.
3. When the ball/marble is rolling, ask your friend to notify at the interval of 1 second with the help of a stopwatch. Mark the distance covered by the ball/marble on the plank's surface after each second.
4. Observe the motion of the ball/marble.

The objects in motion may not have uniform velocity. The velocity of a moving bus sometimes increases, sometimes decreases. The velocity of an object rolling in a uniform downhill slope under the effect of gravity increases every second. Acceleration is the change in velocity per unit time. Its SI unit is m/s^2.

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

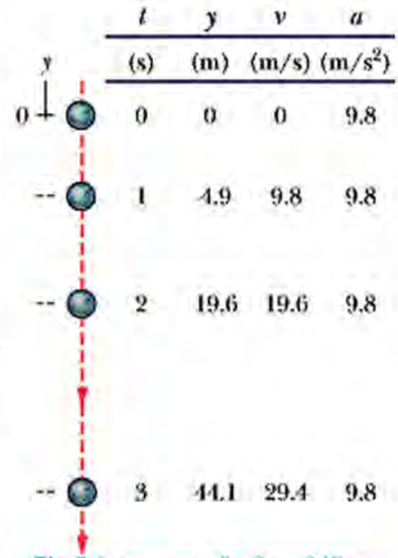


Fig 7.6: motion of a free-falling object up to 3 s

The acceleration produced due to the force of gravity in an object falling freely is the acceleration due to gravity. It is denoted by 'g'. Its average value on the earth's surface is 9.8 m/s^2.

We can experience a decrease in the velocity of a moving bus when brakes are applied. Retardation is the rate of decrease in velocity per unit time. It is also known as negative acceleration.

Questions for discussion:

Data obtained from the observation of a free-falling object in fig 7.6 is given below. Draw a suitable conclusion from the calculation based on the given data.

Average Velocity (AV)= $\frac{\text{(Displacement (s)}}{\text{time (t)}}$ $= \frac{44.1}{3}$ = 14.7m/s towards the centre of the earth	Average Velocity (AV)= $\frac{\text{initial velocity (u)+final velocity (v)}}{(2)}$ $= \frac{(0+29.4)}{2}$ = 14.7 m/s towards the centre of the earth

The direction of the free-falling object remains the same throughout the motion but the distance covered per second keeps changing. So, it is a variable velocity. The acceleration of the free-falling object per second is uniform. The mean of the initial and final velocity of an object with uniform acceleration in a straight line gives the average velocity. Hence, for an object with uniform acceleration in a straight line,

$$\text{Average Velocity}(V_{av}) = \frac{\text{initial velocity (u)+final velocity (v)}}{2}$$

Equations of linear motion

Let us consider that an object in motion reaches the final velocity (v) from its initial velocity (u) by covering a distance (s) with a uniform acceleration (a) in time (t).

1. **For motion in a straight line, the equation related to initial velocity (u), final velocity (v), acceleration (a) and time (t):**

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

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

$$at = v - u$$

$$v = u+at \text{ .... (i)}$$

Example 7.1:

A plane, starting from rest, ran towards the north on the runway of Tribhuvan International Airport and took off in 40 s. The acceleration of the plane for the duration was 0.75 m/s2. Calculate the final velocity before taking off.

According to the description given for the plane in example,

Initial velocity (u) = 0 m/s (∵plane starts from rest)

Time taken (t) = 40 s

Acceleration (a) =0.75 m/s2

Final velocity (v) =?

By using equation of motion,

Fig 7.7

$v = u+at$

or, $v = 0 + 0.75\times 40$

or, v = 30 m/s North

The final velocity of the plane before taking off was 30 m/s in the northerly direction.

2. For motion in a straight line, the equation related to initial velocity (u), final velocity (v), acceleration (a) and distance (s):

For a body moving with uniform acceleration,

Displacement = Average velocity × Time

Substituting the value of t in equation (ii), we get,

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

$s = \left(\frac{u+v}{2}\right) \times \left(\frac{v-u}{a}\right)$ $\quad \left[\because a = \frac{v-u}{t}, \ t = \frac{v-u}{a}\right]$

$$s = \left(\frac{v+u}{2}\right) \times \left(\frac{v-u}{a}\right)$$

$$s = \frac{v^2 - u^2}{2a}$$

$$2as = v^2 - u^2$$

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

3. For motion in a straight line, equation related to initial velocity (u), time (t), acceleration (a) and displacement (s):

From equation (ii),

$$\frac{s}{t} = \frac{u+v}{2}$$ Substituting the value of t in the above equation,

$\frac{s}{t} = \frac{u+u+at}{2}$ $\quad [\because v = u + at]$

$$\frac{s}{t} = \frac{2u+at}{2}$$

$$\frac{s}{t} = u + \frac{1}{2}at$$

$$\therefore s = ut + \frac{1}{2}at^2 \quad \text{(iv)}$$

Example 7.2

The acceleration of a motorcycle, starting from rest and running eastward on the East-West highway, is 0.5 m/s2. After covering 400 m, the driver applied brakes. Retardation of 6 m/s2 was produced for 4 s. Calculate the total displacement of the car from the starting point.

According to the description given for motorcycle in example,

For first segment	For second segment
Initial velocity (u) = 0 Acceleration (a) = 0.5 m/s^2 Displacement (s) = 400 m पूर्व Final velocity (v) = ? By using equation of motion, $v^2 = u^2 + 2as$ $v^2 = 0 + 2 \times 0.5 \times 400$ $v^2 = 400$ $\therefore$ v=20 m/s towards East	Initial velocity (u)= 20 m/s towards east Time taken (t) = 4 s Acceleration (a) = - 6 m/s^2 Displacement (s) = ? By using equation of motion, $s = ut + \frac{1}{2}at^2$ $s = 20 \times 4 - \frac{1}{2} \times 6 \times 4^2$ s= 80-48 $\therefore$ s= 32 m towards East
The total displacement from the starting point = displacement of first segment + displacement of second segment = 400+32 = 432 m towards East.	

Graph of linear motion

$v = u + at$ — (i)

$v = \frac{u + v}{2} \times t$ — (ii)

$v^2 = u^2 + 2as$ — (iii)

$s = ut + \frac{1}{2} at^2$ — (iv)

When an object is falling freely towards the earth's surface, neglecting the air resistance,

a=g and s=h

displacement- time graph

Suraj saw Rohan ahead of Binaya in a race organized by his school. After sometimes Binaya leads Rohan. Fig. 7.8 shows their respective motion. Fig 7.9 shows the displacement - time graph where displacement (s) is plotted on the y-axis against the time (t) on the x-axis.

Questions

Fig 7.8: Students running on a race track

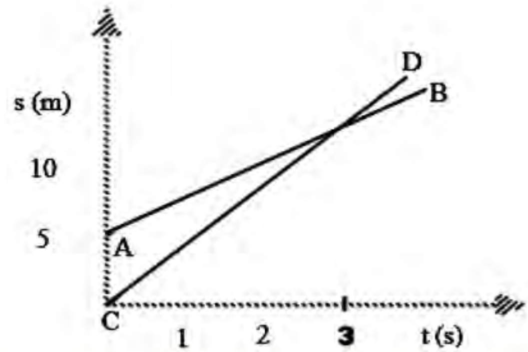


Fig 7.9: Displacement- time graph of the race

1. Identify the lines in the above displacement - time graph that represents the motion of Rohan and Binaya respectively.
2. By how much distance was Rohan leading Binaya at the beginning?
3. After how many seconds did Binaya overtake Rohan?
4. Which line between AB and CD has a greater slope? What is the relation between the slope of the line and the velocity of the respective person?

The motion of an object can be explained by using a graph. Displacement- time graph (s-t graph) is the graph plotted to show the relation between the displacement of any object and the time taken for the displacement. In the displacement- time graph, displacement (s) is plotted on the y-axis against the time (t) on the x-axis. The slope of the line in the graph represents the velocity of the object. Comparing the slopes of two lines of an s-t graph, we can distinguish between slow and fast-moving objects. A greater slope indicates faster motion, and a smaller slope indicates slower motion. At the point of intersection of the lines, displacements covered by both objects are equal.

Activity 7.3

Objective: To observe the change in velocity of an object

Required materials: A 3 m long smooth wooden plank, some books, marbles or small balls, a stopwatch, ruler or tape, chalk or pencil

Methods:

1. Repeat activity 7.2.
2. Measure the displacement covered by marble or ball in each second and fill in the table given below.

Time	First second	Second second	Third second	Forth second
Displacement				
Velocity				

3. Calculate the velocity of marble or ball in each second.
4. Illustrate the above data in a graph as shown in fig 7.10.
5. Calculate the slope of the line drawn in the graph as shown below.

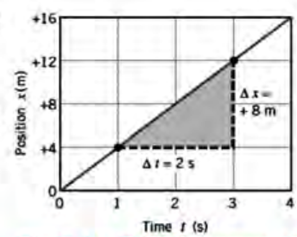


Fig 7.10: Displacement- time graph of moving the body with uniform

$$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{\text{change in displacement } (\Delta s)}{\text{change in time } (\Delta t)} = \ldots$$

For example, in the figure,

$$\text{Slope} = \frac{8 \text{ m/s}}{2\text{s}} = 4\text{m/s}$$

Discussion and conclusion: The slope of the line plotted in an s-t graph shows the velocity of the object.

Example 7.3:

In the graph given below, the motion of a motorcycle is shown in three segments. Find the average velocity of the motorcycle in each segment and mention the states of motion.

According to the graph, in the AB segment,

Average velocity (V_{AB}) = slope of the line of the s-t graph

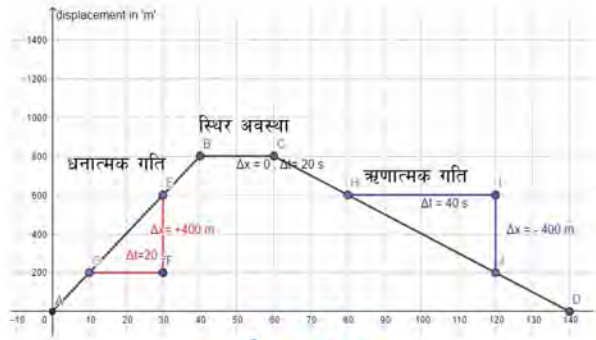
$$= \frac{\Delta s}{\Delta t} = \frac{s_2 - s_1}{t_2 - t_1} = \frac{600 - 200}{30 - 10} = \frac{400}{20}$$

$$V_{AB} = 20 \text{ m/s}$$

The motorcycle is moving forward with uniform velocity in a straight line. In BC segment,

Average velocity (VBC) = 0 m/s

The motorcycle is in rest.



चित्र न. 7.11

In the CD segment,

Average velocity (VCD) = slope of the line of s-t graph

= slope of the line between H(80, 600) and J(120, 200)

$$= \frac{\Delta s}{\Delta t} = \frac{s_2 - s_1}{t_2 - t_1} = \frac{200 - 600}{120 - 80} = \frac{-400}{40}$$

$$V_{CD} = -10 \text{ m/s}$$

The negative sign shows the opposite direction of motion. The motorcycle is returning with uniform velocity in a straight line.

Activity 7.4

A man was walking in a straight line with uniform motion. He was then chased by a dog. The adjoining graph shows the motion of the man for 10 s. Describe the motion of the man. Demonstrate the motion with your friends in a group.

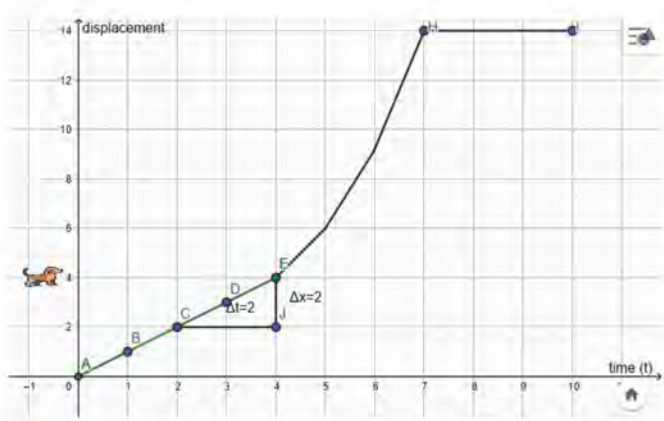


Fig 7.12:

Segment AE	Segment EH	Segment HI
The slope of the line of the s-t graph between any two points is constant.	The slope of the line of the s-t graph between two different points is different.	......

The line parallel to the x-axis in the displacement time graph shows that the distance covered by the object does not increase with time. It indicates the rest state of the object. The straight line with slope indicates the uniform velocity of the moving object. If the line in the displacement time graph is curved, then the velocity of the moving object is variable.

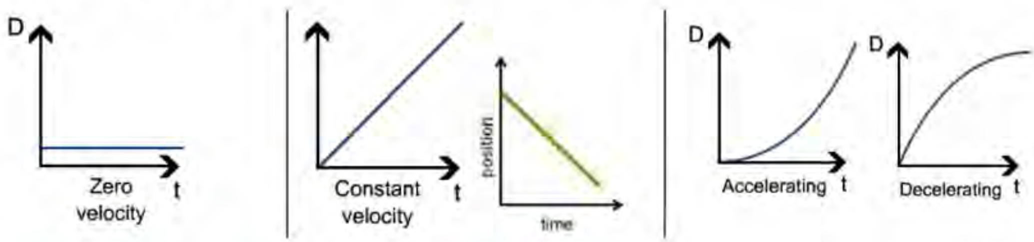


Fig 7.13

velocity- time graph

Activity 7.5:

Draw the graph each from the given data, plotting time on X-axis and velocity on Y-axis respectively.

For motorcycle moving in a straight line — *Table*

Time (s)	0	1	2	3	4	5
Velocity (m/s)	5	5	5	5	5	5

For a free-falling object from a fixed height — *Table*

Time (s)	0	1	2	3	4	5
Velocity (m/s)	0	9.8	19.6	29.4	39.2	49

For a plane about to take off — *Table*

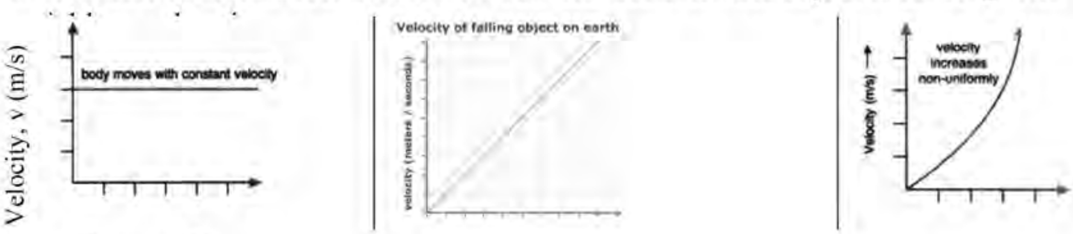
Time (s)	0	1	2	3	4	5
Velocity (m/s)	0	2	6	12	20	30

Analyze the velocity-time graph (v-t graph) plotted from the above data

Graph	Shape of the line in v-t graph	Slope of the line in v-t graph	Analysis
First	....	....	Velocity of object (uniform/ changing uniformly/...)
Second	....	....	Slope between any two points (uniform/variable).............. Relation between slope and acceleration........
Third	....	....	Difference between the slope of the lines when velocity changes uniformly and variably ....

When the velocity (v) of a moving object is plotted against time (t), the graph is known as the velocity-time graph. In this graph, time and velocity are plotted on the x-axis and y-axis respectively. From the observation of the velocity-time graph, information about the motion of a body at rest, moving with uniform velocity, or braking is obtained. The slope of the line in the velocity-time graph is its acceleration. Comparing the slopes of two lines of the velocity-time graph, differences between the rates of changing velocity can be learned.

Velocity-time line parallel to the x-axis indicates that the velocity of the object has not changed with time, that is, the object is moving at the same velocity without any acceleration. A straight line with a constant slope indicates that the object is moving with uniform acceleration. But the curved line indicates the object is moving with



Time, t (S)
Uniform velocity

Time, t (S)
Free falling object

Time, t (S)
Variable velocity

Fig 7.14:

Activity 7.6

Observe the graph and complete the table given below.

Among the segments with equal acceleration, in which segment the velocity of the object has changed rapidly

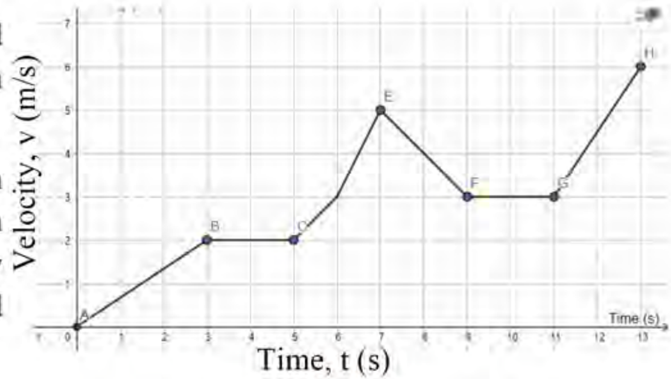


Fig 7.15

The segment of uniform velocity	The segment of uniform acceleration	The segment of variable acceleration	Segment of retardation
BC and	.... and	............and	.........and ....

Between two segments AB and GH, the slope of the velocity-time line in GH is more than that in AB. Therefore, the velocity of the object can be found to have changed rapidly in the GH segment.

Inertia

Discuss in your class to find out the facts and reasons related to the following incidents.

1. While swinging in a swing, it takes some time for the swing to move and to come to a steady-state from the motion.
2. The electric fan does not rotate perfectly as soon as it is switched on. Similarly, it does not stop as soon as it is switched off.

   When the forces applied to an object are balanced, there is no change in the state (velocity and direction of motion) of an object. To change the position of the object or to move the object, an unbalanced force must be applied to the object. The object resists any attempt to change its state of rest or uniform motion. The object in a rest position tries to remain at rest. The moving object tries to move in the same direction with the same velocity. The inability of the body to change by itself its state of rest or of uniform motion in a straight line is called inertia.

Activity 7.7

Place a boiled egg and a raw egg on a table and rotate them. Bring the rotating egg to stop by touching it with your finger. Remove the finger as soon as it stops rotating. See what happens then. Observe and tabulate as given below. Justify the result.

Observation	Result	Explanation
....	....	....

Relation between mass and inertia

Activity 7.8

Objective: To demonstrate the relationship between mass and inertia

Required materials: Two bottles of similar size, shape and mass, rope, water

Methods:

1. Fill one bottle with water and keep the other empty.
2. Hang them both on the rope of equal length in a stand so that they can move back and forth.
3. Now displace the hanging bottles for equal distances and observe their motion.

Discussion and conclusion: Which bottle comes in the rest position the first? Why?

Observation	**Result**	**Explanation**
Time to stop the bottle with less mass = ... Time to stop the bottle with more mass = ...	...... takes less time to stop than	

Both objects having less and more masses try to remain in their own position. All objects have inertia. The inertia of an object depends upon its mass. Inertia increases as the mass increases and it decreases as mass decreases.

Types of inertia

1. Inertia of rest

Activity 7.9

Fig 7.16:

Objective: To demonstrate inertia of rest

Required materials: Coin, a glass mug, cardboard

Methods:

1. Place cardboard above the mug and a coin on the card as shown in the adjacent figure.
2. Pull the card rapidly and observe what happens.

Discussion and conclusion:

When we suddenly try to move the coin that is at rest, it resists the change. Since the card moves away from the coin before the coin even starts to move, the coin drops into the mug.

The inertia of rest is the tendency of an object at rest to remain at rest. Some examples of the inertia of rest are listed below.

i. Dust in a carped can be removed by hanging it and beating with a stick.

ii. If the branches of a mango tree are shaken, the mangoes will fall.

iii. When a pile of carrom coins is struck with a striker, only the lowest coin moves away. The remaining pile remains intact.

iv. When the stationary bus starts to move suddenly, the lower part of the passenger's body that is in direct contact with the bus comes into motion while the upper part tends to maintain at rest. Hence, the passenger tends to fall back.

Activity 7.10

From the conclusion of the classroom discussion, explain the inertia of the given examples as shown in the table given below.

Example	Object or it's part that comes in motion	Object or it's part that tends to remain in rest	Explanation in terms of inertia

Newton's first law of motion

Activity 7.12

Mention the requirement of external resultant force to change the state of an object in our daily activities as given in the examples.

The first segment (from rest to motion)	The second segment (change in direction)	Third segment (from motion to rest)
1. When a player passes the football on a ground		
A football moves in the direction of the resultant force applied by the first player's foot	The football moves in a straight line toward the direction of the force applied by the first player. Its direction is changed by the resultant force applied by another player.	In the absence of frictional force between the football and the ground, the ball moves continuously. But, this is impossible. Football comes to rest because of the external force such as friction or the force applied by another player.
2. Driving a bus on a winding road		
Effect of resultant force applied by the engine	*Effect of resultant force applied by the steering wheel*	*Effect of resultant force applied by brakes and friction with the ground*
....	....	....

Before Newton's laws of motion, the scientist Galileo Galilei had already established the law of inertia. Newton also defined inertia, establishing the first law of motion. According to Newton's first law of motion, an object at rest remains at rest, and an object that is moving will continue to move straight and with constant velocity unless any resultant force acts on it. According to this law, if the resultant force is zero, then the object continues in the same state. To bring a body from rest to motion, and uniform motion to rest, an unbalanced force is required. Thus, force is a cause of change in the state of an object. Newton's first law describes the property of matter that tends to remain at rest or in uniform motion unless an unbalanced force acts on it. So, it is also known as the law of inertia.

Newton's second law of motion

Questions for discussion: A cyclist cycles quickly from rest to motion with a changing velocity. How will the acceleration differ when there is one person on the bicycle versus two people? On a leveled and uniform road, how will the acceleration differ when less force is applied on the pedal versus more force?


Fig 7.17: acceleration when only the cyclist is on the cycle


Fig 7.18: acceleration when there are two people on the ycle

If the force applied by the cyclist is constant, acceleration decreases when mass increases. If the mass is fixed, the acceleration increases when the cyclist applies more force on the pedals

Discuss additional examples, as asked in the questions above, which are applicable in our daily lives.

Change in acceleration according to the change in mass of the object	Change in acceleration according to the change in the size of force applied to the object
We can walk faster if we lessen the load we are carrying. When a loaded truck on a steep uphill road is unloaded, its acceleration increases. It is easier to push an empty wheelbarrow than a loaded one	We can run faster when more force is applied to our muscles. When we increase the engine's force on a vehicle more acceleration is produced. Retardation is produced when brakes are applied. We should apply more force to move the ball fast on the ground.

Changes in acceleration due to the change in mass and applied force are shown in the above examples. Do the activity given below to investigate the relationship between acceleration, force and mass.

Activity 7.13

Objective: To demonstrate Newton's second law of motion

Materials required: a dynamic trolley or toy car, 1 pulley with clamp, thread, anchor to suspend weight, 10 slotted masses of 50 g each, stopwatch

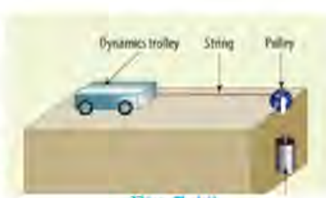


Fig 7.19:

Methods:

1. Connect the materials as shown in the figure.
2. Mark the 1 m distance from the pulley on the table.
3. Putting the 50 g slotted weight on the anchor, place the trolley on the mark.
4. Let the trolley move to the other end of the table and measure the time taken. Fill in the table below.
5. Add another 50 g weight on the anchor and repeat step 4.
6. Add the other weights respectively and repeat step 5.

The force required to pull the trolley or weight on anchor (W) in N	Displacement (s) in m	Time (t) in s	Acceleration (a = 2s/t2)
....	1	....	....
....	1	....	....
Data analysis and result: Discuss the relationship between the force applied on the trolley and acceleration.			

Data analysis and result: Discuss the relationship between the mass of the trolley and acceleration.

Discussion and conclusion: Keeping the mass of the trolley constant, the acceleration of the trolley increases when the pulling force.

According to Newton's second law of motion, the acceleration produced on an object by applying a force is directly proportional to the force applied and inversely proportional to the mass of an object.

The acceleration produced on a body increases when the force applied to it increases.

i.e. $a \propto F$...............(i) (if mass remains constant)

The acceleration produced in a body increases when the mass of the body decreases.

i.e. $a \propto 1/m$ ....(ii) (if force remains constant)

Combining equations (i) and (ii);

$a \propto F/m$ $\quad\quad$ $F \propto ma$

$F = k\,ma$................(iii) $\quad$ Where K is proportionality constant.

1 N force is defined as the amount of force required to produce an acceleration of 1m/s2 in a body of mass 1 kg. Thus, when F=1N and m=1 kg, a=1 m/s2, k=1

Thus, F = ma

Example 7.5

A car of mass of 1500 kg was moving at a speed of 36 km/hr in a straight line. When the driver pressed the accelerator, it travels 64 m distance in 4 s. Calculate the resultant force acting on the car and acceleration produced on it.

Solution:

Mass of the car (m) = 1500 kg

Initial velocity (u) = 36 km/h = $\frac{\cancel{36 \times 1000m}}{60 \times 60s}$ = 10 m/s

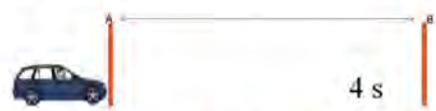


Fig 7.20:

Displacement (s) = 64 m

Time taken (t) = 4 s

By using the equation of motion,

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

$$\text{or, } 64 = 10 \times 4 + \frac{1}{2} \times a \times 4^2$$

$$\text{or, } 64 - 40 = \frac{1}{2} \times a \times 16$$

$$\text{or, } 8a = 24$$

$$\therefore a = 3 \text{ m/s}^2$$

According to newton's second law of motion,

F = m a

F =1500 × 3 = 4500 N

Hence, the resultant force applied to the car is 4500 N.

Newton's third law of motion

Question: Can we walk forward without pushing the ground with our feet? Try it once.

Activity 7.14

Take 2 similar spring balances. Fix one end of spring balance B as shown in the figure, and join the hook of spring balance B with the hook of spring balance A. Pull the other end of spring balance A outward you by applying a certain force. Observe the value and direction of force shown by spring balances A and B.

In figure	Observation	Result
 *Fig 7.21: one spring balance is pulling the other*	Force exerted by spring balance A on B= Force exerted by spring balance B on A=	

Action and reaction both never act on the same object. According to Newton's third law of motion, if an object A exerts a force on B, equal force is exerted on A by B in the opposite direction.

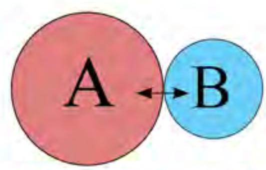


Fig 7.22: forces exerted by one on another on the collision of 2 balls


Fig 7.23

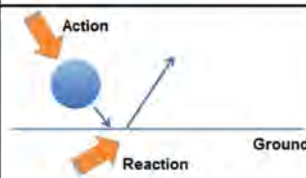
Fig 7.24

Although these pairs of forces are equal in magnitude and opposite in direction, they do not cancel each other because they act on different objects. Forces cancel each other only when they both act on the same object. Action and reaction act on two different objects.

Activity 7.15

When an object exerts a force on a second object, the second object also exerts a force that is equal in magnitude but opposite in direction to that of the first object. In this pair of forces, one is called action and the other reaction. According to newton's third law of motion, every action has an equal but opposite reaction.

Separate action and reaction on the activities done to move objects in our surroundings.

Example	Figure	Action	Reaction
Rowing a boat		The boatman pushes the water backward with the oars.	The water applies an equal and opposite push on the boat and makes it move forward.
Swimming in water		The swimmer pushes the water in the backward direction with their hands.	The water exerts an equal and opposite force on the swimmer, propelling him or her forward.
Bouncing the ball		....	....
Launching a rocket		....	....
Flying of bird		....	....
Firing a bullet		....	....

Activity 7.16

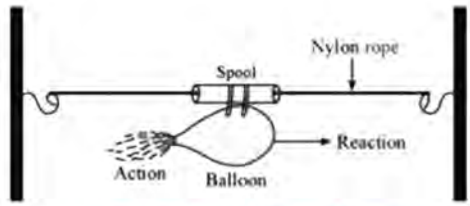


Fig 7.25: rocket of a balloon

Objective: To demonstrate Newton's third law of motion

Materials required: balloon, straw, thread, cello tape, and scissors

Methods:

1. Attach a piece of straw to the balloon's surface with a piece of tape. Pass the thread through the straw.
2. Fix both ends of the thread as shown in the figure.
3. Fill the balloon with air and grip the neck of the balloon firmly.
4. Remove the grip suddenly and observe the motion of the balloon.

Discussion and conclusion: Explain the motion of the balloon according to Newton's third law of motion.

Elasticity and plasticity

Which objects do you think of when you read the word 'elastic'? Similarly, which objects do you think of when you read the word 'plastic'? Prepare a list.

Activity 7.17

Activity	Figure	Effect of force	
		Change in shape and size	Does it regain the original shape after removing the force?
Stretching, bending, twisting, pressing an eraser by holding the both ends			
Stretching a rubber band	....	....	regain
Squeezing the toothpaste tube with fingers	....	Change in shape	....
Stretching a piece of plastic by pulling both ends	....	....	....

Pressing an air-filled balloon with both hands	....	....	....
Pulling and pushing a steel spring held vertically	....		

When we pull a rubber band slowly, its length increases. After removing the exerted force, the rubber band returns to its original length. Similarly, when we press a rubber ball or an air-filled balloon, their shape changes, and they regain their original shape when the force is removed.

When we apply a force on a body from different directions, the effect of a single resultant force is seen. Resultant force changes the shape and size of an object. The amount of change depends on the composition of the object, quantity of applied forces and their directions. The resultant force which can change the shape and size of an object is known as a deforming force.

Question:

Does the steel spring regain its original shape if stretched as much as possible?

When deforming force is removed from the object deformed to a certain extent, it regains its original shape and size. Elasticity is a property of a matter by which it regains its original shape and size when the deforming force is removed.

Fig 7.26: Karnali bridge supported by steel rods

The elasticity of objects differs depending on their composition. It is hard to change the shape and size of the body with higher elasticity. Steel has very high elasticity, so it is used for the construction of houses, bridges, etc. When the deforming force exceeds a certain limit, the object cannot regain its original shape, i.e. it is deformed permanently. The property of a matter by which the matter retains its extended or deformed shape even when the deforming force is removed is known as plasticity. Plasticity is the opposite of elasticity. We can shape mud into brick easily due to its plasticity. If force is continuously applied to a deformed object, it tends to break.

Fig 7.27: mud

Discussion:

1. Are only the visibly stretchable objects elastic?
2. Which is more elastic, rubber or steel?

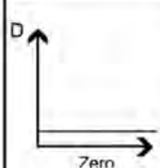
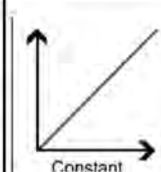
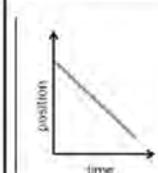
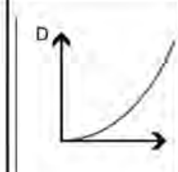
Project work

a. Using materials available in your surroundings, prepare a toy car run by a balloon. Using balloons of different elasticities and different weights on the car, demonstrate Newton's second law.

b. Using available materials in your surroundings and the elasticity of a rubber band, prepare a toy helicopter.

Reflection:

1. Comparative study of displacement time graph and velocity-time graph

Graph	Slope	Parallel to X-axis	The straight line shows a slope in an up-ward direction as shown in the graph	The straight line shows a slope in a downward direction as shown in the graph	Curved line
					
displacement time graph	Velocity	Slope zero, the object is at rest	Uniform slope, uniform velocity in the forward direction	Uniform slope, uniform velocity in the backward direction	Slopes are different in any 2 points, variable velocity
velocity-time graph	Acceleration	Slope zero, uniform velocity	Uniform slope, uniform acceleration	Uniform slope, uniform retardation	Slopes are different in any 2 points, variable acceleration

2. Selection of appropriate equations to solve numerical problems related to linear equations

Given variables	Equations for horizontal motion	Equations for vertical motion
Any three among initial velocity (u), final velocity (v), acceleration (a), time (t)	$v = u + at$	$v = u + gt$
Any three among initial velocity (u), final velocity (v), displacement (s), acceleration (a)	$v^2 = u^2 + 2as$	$v^2 = u^2 + 2gh$
Any three among initial velocity (u), displacement (s), acceleration (a), time (t)	$s = ut + \frac{1}{2}at^2$	$h = ut + \frac{1}{2}gt^2$

3. Newton's laws of motion

First law	Second law	Third law
An object at rest remains at rest, and an object that is moving will continue to move straight and with constant velocity unless any resultant force acts on it.	The acceleration produced on an object by applying force is directly proportional to the force applied and inversely proportional to the mass of an object.	Every action has an equal but opposite reaction.

4. Elasticity and plasticity

Property	Removing the deforming force	Type of change in shape and size	Restoring force
Elasticity	regains its original shape	temporary	develops
Plasticity	retains its deformed shape	permanent	doesn't develop

Exercise

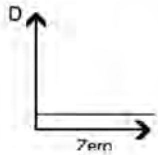
1. Select the correct answers from the given alternatives.

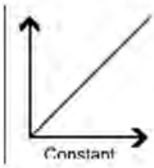
a. In a velocity-time graph, which value is given by the slope of the line?

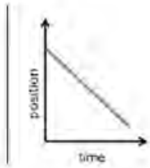
i) speed ii) velocity

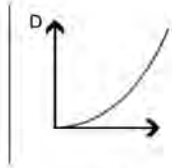
iii) acceleration iv) displacement

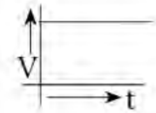
b) Which of the following is a displacement time graph?











i) ii) iii) iv)

c) Stepping down from a running bus is dangerous. On which of the following basis, the statement can be justified?

i). Inertia of rest ii) Inertia of motion

iii) Second law of motion iv) Third law of motion

d) Which statement about action and reaction is true?

i. One cancels another ii. Both act on the same body

iii. Both are equal and act in the same direction

iv. Act on different objects

e) Which of the following is the application of elasticity?

i. Shaping the mud into the flowering pot

ii. Beating iron into sheets

iii. Shaping the dough into flatbread

iv. Hitting the shuttle cock with a badminton racket

f) A loaded truck and a car are moving with the same velocity on a road. If brakes are applied on both vehicles with equal forces, then which of the following statement will be true?

i. Distance covered by the truck is less than the distance covered by the car.

ii. Distance covered by the car is less than the distance covered by the truck.

iii. Distance covered by the truck is equal to the distance covered by the car.

iv. Distance covered by the truck is not related to the distance covered by the car.

2. State the differences between:

i. Displacement time graph and velocity-time graph

ii. The inertia of rest and inertia of motion.

iii. Elasticity and plasticity

3. Give reason:

i. It takes different times to bring a motorcycle, car, bus, train, etc. moving with uniform velocity into the rest position.

ii. On shaking the branches of a tree, the leaves and fruits fall.

iii. The bag placed on the isle on a bus moves forward during the bus ride.

iv. Strong support should be provided while firing a bullet from a gun.

v. When two rubber balls of the same size were dropped on the floor, one is seen to bounce more than the other.

vi. A rubber band should not be stretched beyond a certain limit.

4. Answer the following questions.

i. Define average velocity and acceleration.

ii. Prove the following equations related to the linear motion:

a) $v = u + at$

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

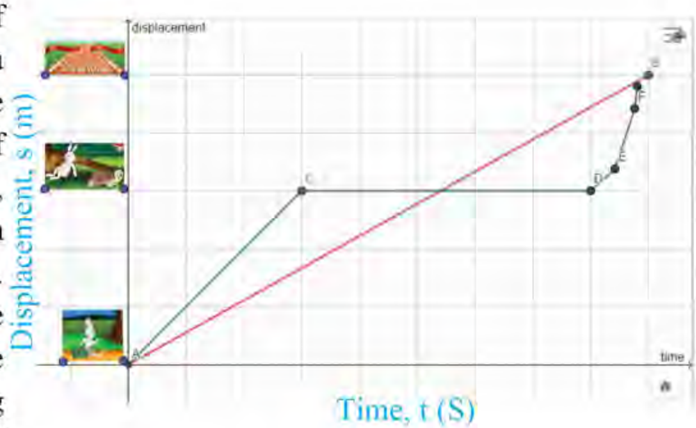
c) $s = ut + \frac{1}{2}at^2$

iii. Draw a displacement time graph and a velocity-time graph to show the linear motion of a moving object with uniform velocity.

iv. Draw a displacement time graph based on the given data. Study the slope of the line on the graph and mention the nature of the motion. Calculate the average velocity of the first 4s of the object using the slope of the line.

Time (s)	0	2	4	6	8	10	12	14
Displacement (m)	0	4	8	8	12	8	4	0

v. The motion of a hare and a tortoise, from the famous story of hare and tortoise, is demonstrated in the given graph. By studying the graph, rewrite the story including every step of moving from the initial position to the final.



vi. Define inertia. Give two examples each of inertia of rest and inertia of motion.

vii. Mention the relation between mass and inertia.

viii. State Newton's first law of motion.

ix. Give two examples that show the resultant force changing the state of motion of objects.

x. Explain, based on high velocity and the first law of motion, why bus accidents are more probable on winding roads in mountainous areas.

xi. State the second law of motion and prove that F = ma.

xii. State the third law of motion.

xiii. Give two examples of daily life activities based on each of the three laws of motion.

xiv. Find any two uses each of the first, the second, and the third law of motion and explain them.

Activities	Newton's law related to the activity	Explanation
....	....	....

xv. Separate actions and reactions in the following activities.

xvi. Define elasticity and plasticity with examples.

Numerical problems

a) A plane, starting from rest and then running south on a runway, took off in 30 s. The acceleration of the duration was 1.5 m/s^2. Calculate the displacement of the plane on the runway and the final velocity before taking off.
(675 m, 45 m/s south)

b) Rohan dropped a stone from a bridge on to water surface of the river, Suraj noticed that the stone took 2 s to reach the surface of the water. Assuming the acceleration of the falling stone is 9.8 m/s^2, calculate the height of the bridge from the water surface. (19.6 m)

c) The mass of Suraj and his bicycle are 50 kg and 12 kg respectively. When he was cycling on a downhill road, an acceleration of 2 m/s2 was produced. Calculate the resultant force acting on the bicycle in that situation. (124 N)

d) A car of mass of 1500 kg was moving at a speed of 72 km/hr. When the driver applied the brake, the speed was reduced to 10 km/hr after covering 50 m. Calculate the resultant force acting on the car. (5850 N)

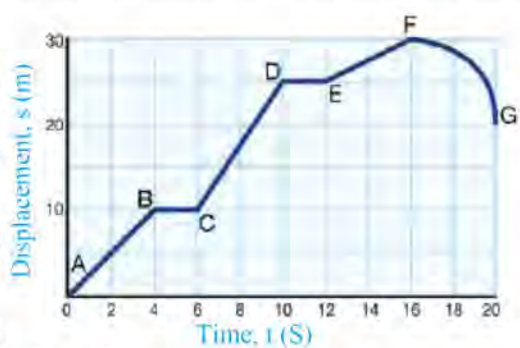
e) The velocity-time graph of the motion of a bus is given in the figure. Observe the graph and answer the following questions.

   i) Separate the segments of uniform velocity, uniform acceleration, variable acceleration and retardation.

   ii) Among the segments of uniform acceleration, in which segment does the velocity of the bus change rapidly?

   iii) Find the acceleration of the segment between C and D.

   iv) Calculate the displacement covered by the bus from C to D. (70 m due East)



8

Simple Machine

Activity 8.1

Observe the figures given below and complete the table.

Simple machine					
Work done					
Types of simple machine					

Fig. 8.1

Many types of equipment are used in our daily life to do different work easily. Screw, pulley, wheel and axle, snuffers, motor jacks, sickles and axes are some examples of domestic equipment. To use them, electricity, diesel, petrol or any other fuel is not required. Only human forces are sufficient. Simple tools which help us work faster, with greater comfort, and with less effort are called simple machines. There are four types of simple machines based on structure. They are the lever, pulley, wheel and axle, and inclined plane. Wedge and screw are the specific forms of the inclined plane.

Fig 8.2 use of lever

A simple machine is used to magnify a force. In fig. 8.2, a lever lifts a 600 N load by using 400 N force. The load lifted is 1.5 times the applied force. When a simple machine is used to work, the ratio of load lifted to the effort applied is its mechanical advantage. i.e.

$$\text{Mechanical Advantage (MA)} = \frac{\text{Load}}{\text{Effort}}$$

Mechanical advantage is the ratio of two forces, so, it has no unit.

The velocity ratio of a simple machine is defined as the ratio of the velocity of effort to the velocity of load.

Mathematically,

$$\text{Velocity Ratio (VR)} = \frac{\text{Velocity of effort}}{\text{Velocity of load}}$$

In a well-functioned simple machine, both load and effort take the same time to cover the distance. Then,

$$\text{Velocityratio(VR)} = \frac{\text{Distance moved by effort (ED) / Time (t)}}{\text{Distance moved by effort (ED) / Time (t)}}$$

$$\frac{\text{Distance moved by effort (ED)}}{\text{Distancemovedbyload (LD)}}$$

In fig. 8.2, effort covers 2 times the distance covered by the load. So, the velocity ratio of the lever is 2.

Velocity ratio is the ratio of two velocities, so it has no unit.

The same formulae mentioned above are used to calculate the mechanical advantage and velocity ratio of all other simple machines.

1. Pulley

To raise a flag without a pulley on a flagpole, a force acts in an upward direction. The Pulley of the flagpole redirects the force in a downward direction. The pulley makes our work easier by changing the direction of the force applied. Pulley is a type of simple machine. A pulley consists of a wheel that is free to rotate about its axis. The wheel is made from plastic, wood or metal. The wheel has a groove around it. A rope can be passed through the groove. At one end of the rope, the effort is applied and the load is attached to the other end. Pulleys can be used in different places, for example, to uplift water buckets from a well, raise a flag on a pole, lift construction materials in tall buildings, etc.

Activity 8.2

Fix a single movable pulley, a single fixed pulley and a combined pulley system as shown in the given figure. Weigh each load given in each pulley system by using a spring balance. Measure the effort distance needed to lift the load up to 20 cm by using a ruler. Collect the required data and complete the table given below.

Fixed pulley *Movable pulley* *Combined pulley*

Fig. 8.3

Note: Effort distance denotes the distance covered by the string from its initial position. Load distance denotes the height covered by the load from its initial position.

Types of pulley	Load distance	Effort distance	ED / LD	Load	Effort	Load / Effort	Input work= Effort× ED	Output work= Load × LD

Discussion and Conclusion:

Fill up the table by calculating obtained data and answer the following questions.

i. Differentiate between the first pulley system and the second pulley system.

ii. What is the relation between the ratio of effort distance to load distance and the number of the pulley?

iii. In which pulley system, the ratio of load to the effort is maximum, and in which is it minimum?

iv. Where can we see these pulley systems being used? Mention their uses.

There are three types of pulley systems: fixed, movable and combined. A fixed pulley is placed at a rigid place. It does not move but rotates freely. It is used to change the direction of the force. In a movable pulley, the pulley changes its position along with the load. It cannot change the direction of the force. The combined pulley consists of both fixed and movable pulleys. It contains at least one fixed and one movable pulley. Increasing the number of pulleys in the combined pulley system reduces the effort needed to do the work. So, the mechanical advantage increases with the increase in the number of pullies.

Velocity ratio

In a single movable pulley, the distance covered by the effort is two times the distance moved by the load. So, the velocity ratio of the single movable pulley is 2. Load is supported by two segments of the rope in it.

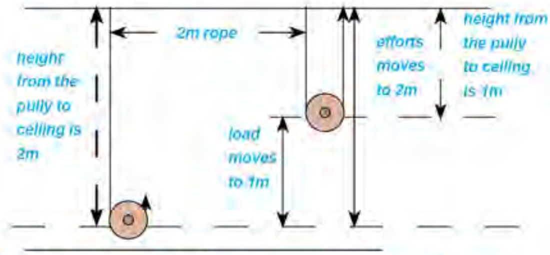


Fig 8.4 Load distance and effort distance in a movable pulley

According to the conclusion of activity 8.2, the distance covered by the effort is equal to the distance covered by the load in the single fixed pulley. So, the velocity ratio of the single fixed pulley is 1. Also, the load is supported by a single segment of the rope in it. Hence, the velocity ratio in the pulley system is;

Velocity ratio (VR) = Number of the segment of rope used to support the load

Mechanical Advantage

The ratio of load to effort gives the value of the mechanical advantage. According to the conclusion of activity 8.2, the mechanical advantage becomes more with the increasing number of pulleys. In a pulley system;

$$\text{Mechanical advantage (MA)} = \frac{\textbf{Load}}{\textbf{Effort}}$$

For example, in a pulley system, 50 N effort is required to lift the load of 200 N.

$$\text{Then, } \textbf{Mechanical Advantage (MA)} = \frac{\textbf{200N}}{\textbf{50 N}} = \textbf{4}$$

By using this pulley system, 50 N effort is sufficient to lift the load which is four times the effort.

If frictional force is negligible in a fixed pulley, then applied effort will be equal to the uplifted load. Due to frictional force, the effort may be more than the load and MA may be less than 1. Although MA is one or less than one in the pulley system, it changes the direction of the force. It is convenient to use effort along the direction of gravity to lift the load by using a pulley rather than using effort directly in an upward direction.

2. Inclined plane

Activity 8.3

Collect the wooden planks of different lengths 200 cm, 300 cm, and 400 cm respectively. Fix them as the inclined plane of a height of 60 cm as shown in the figure. Take a small wooden block with a smooth surface that creates negligible friction with the plank. Weigh the block by using a spring balance. Pull the block on these planes from the lower ends to the upper ends by using the spring balance turn by turn and measure the respective efforts. Collect the required data and complete the table given below.

Fig. 8.5 Inclined plane

S.N.	Length of inclined plane (l/cm)	Height of inclined plane (h/cm)	Velocity ratio	Load	Effort	Mechanical advantage	Efficiency
1.	200	60					
2.	300	60					
3.	400	60					

Questions for discussion:

i. **Why is an inclined plank used to load and unload the materials from trucks?**

ii. **Which staircase is easier to climb, one with a small slope or a large slope?**

iii. **What are the advantages of winding roads on sloppy mountains?**

Fig. 8.6 Inclined plane

An inclined plank is used to load and unload heavy materials from a truck. The slanted slope which is used to lift the heavy load up to a height easily is known as an inclined plane.

In the adjoining figure of an inclined plane, slanted length (AB=l) represents the distance covered by effort and the height of the inclined plane (BC=h) represents the distance covered by the load. Hence, for an inclined plane:

$$\text{Velocity ratio (VR)} = \frac{\text{Effort distance (ED)}}{\text{Effort distance (ED)}}$$

$$= \frac{\text{Length of inclined plane (l)}}{\text{height of inclined plane (h)}}$$

$$VR = l / h$$

For a constant height, the angle formed by the plane with a horizontal surface decreases when we increase the length of the inclined plane. Thus, less effort is needed to push or pull an object up the slope. On increasing the length of an inclined plane, the effort distance also increases. Hence, for the same height, the VR decreases upon increasing the length of the inclined plane. The roads on the sloppy mountains have more bends to increase the length of the road, and because of this, the engine of vehicles can pull heavy loads easily.

Fig. 8.7: Inclined planes with the same height but different slopes

Fig. 8.8: a winding road

2 (a) Wedge

We chop fruits with a knife, cut vegetables with a kitchen knife (chulesi) and split wood with an axe in our daily lives. Simple machines used in the above activities are some examples of a wedge. Their sharp edge is made up of two inclined planes. The instrument having a flat and broad surface on one end and a sharp edge formed by the meeting of the two inclined planes at the other end is called a wedge. It is based on the principle of an inclined plane. So, it is a specific form of an inclined plane. In fig 8.10, when a wedge penetrates completely, friction develops across the width of the broader surface. So, the width of the wedge becomes the load distance. When a wedge is penetrating the object, the depth of penetration is effort distance. When the wedge penetrates the object completely, width of the wedge = load distance, length of the wedge (depth) = effort distance.

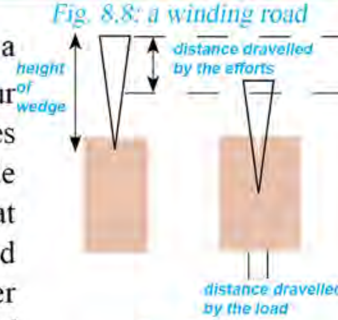


Fig. 8.9: wedge

Velocity ratio of wedge

A wedge has a flat and broad surface on one end and a sharp edge formed by meeting two inclined planes on the other end. The sharp end makes it easier to work against frictional force (load).

When wedge penetrates the object completely,

Effort distance = length of wedge (depth) = H

Load distance = thickness of the broad edge of the wedge = L

$$\text{Velocity ratio (VR)} = \frac{\text{Effort distance}}{\text{Load distance}} = \frac{H}{L}$$

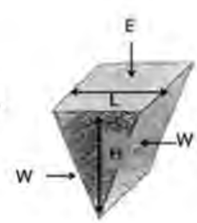


Fig. 8.10: wedge

Example:

A Force of 200 N is used to chop wood by using an ax in the adjoining figure. When the wedge penetrates the wood, 600 N frictional force is observed on its surface. The depth of the wedge is 10 cm and its width is 2.5 cm. Then, calculate its MA and VR.

Given,

Effort (E) = 200N

Frictional load (L) =600N

Depth of wedge (H) = 10 cm

Width (L) = 2.5 cm

Fig 8.11

Now,

Mechanical advantage (MA)

$$\mathbf{MA = \frac{W}{E}}$$

$$= \frac{\mathbf{600\ N}}{\mathbf{200\ N}} = 3$$

$$\text{Velocity ratio (VR)} = \frac{\text{Effort distance}}{\text{Load distance}}$$

$$= \frac{H}{L} = \frac{10}{2.5} = 4 \quad \frac{\mathbf{H}}{\mathbf{L}}$$

In the given figure, MA and VR of the wedge are 3 and 4 respectively.

2 (b) Screw

In our daily lives, we join blocks of wood by a screw nail, lift loads using a jackscrew, and tighten sheets of metal by using nuts and bolts. As shown in fig 8.12, the screw has a sharp thread-like structure formed by joining two inclined planes coiled spirally. So, the screw is also known as a spiral inclined plane. A screw is formed by wrapping an inclined plane in a cylindrical object like a nail. It is a specific form of an inclined plane.

fig 8.12

The segment between two threads, as shown in fig 8.12, is known as pitch. On rotating the screw once, it penetrates the object by the distance equal to its pitch. Hence, in rotating a screw having a radius of the head (R) through one complete turn, Effort distance = circumference of the head = $2\pi R$

Load distance = distance of penetration = pitch (P)

Velocity ratio (VR) = $\frac{2\pi R}{P}$

In a screw, the velocity ratio depends on its pitch. On decreasing the length of the pitch, working becomes easier.

3. Wheel and Axle

Activity 8.4:

Take a model of a wheel and axle. Wrap a thick thread around its circumference. Hang loads on the axle and apply the effort on the wheel. Use spring balance to measure the effort. Repeat it for different loads and collect the required data to fill the given table.

S.N.	Load	Effort	MA	Radius of the wheel (R)	Radius of the axle (r)	R/r	efficiency
1							
2							
3							
4							

A lattai is used to fly kites. Similarly, handles on doorknobs and pedals on bicycles are used. These are examples of wheel and axle. A wheel and axle consists of two cylinders fitted on the common axis. The bigger cylinder is called a wheel and the smaller cylinder is called an axle. When the load hanging on the axle is lifted up by applying the effort on the wheel, force is magnified.

Fig 8.13: wheel and axle

When the wheel and axle rotates once along their axis, the rope is unwrapped on the wheel and wrapped on the axle while lifting a load. The length of the rope is equal to their respective circumferences. In a wheel and axle, effort covers the distance equal to the circumference of the wheel and load covers the distance equal to the circumference of the axle. Thus,

VR = effort distance/load distance

= circumference of wheel/circumference of axle

If the radius of the wheel is R and the radius of the axle is r, then

$$\mathbf{VR} = \frac{\mathbf{2\pi R}}{\mathbf{2\pi r}} = \mathbf{R/r}$$

Hence, the ratio of the radius of the wheel to the radius of the axle gives the velocity ratio of a wheel and axle.

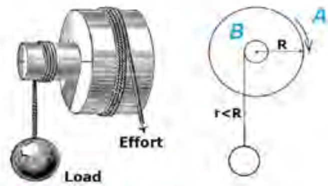


Fig 8.14: continuous lever

Wheel and axle is also called continuous lever because load and efforts are in the two ends of the axis as in a lever. The Center of the axis can be taken as the fulcrum. It works continuously rotating 360^0 on its axis. Effort point (A) on the wheel touching the rope to apply effort and load point (B) on the axle touching the rope to lift the load are changing continuously as shown in figure 8.14.

distance covered by the load is more than the distance covered by the effort during the same period, then a simple machine increases the speed of doing work. For example: while flying a kite, the distance covered by the load is more than the effort. So, the thread is wrapped quickly. On the contrary, if the distance covered by the effort is more than the load during the same period, then the simple machine magnifies the force. For example, the force applied by the driver on the steering wheel is multiplied to change the direction of the wheels of heavy vehicles. On increasing the diameter of the steering wheel, effort distance is also increased and force is magnified more. That's why the steering wheels of trucks are larger than that of cars.

Complex machine as a combination of simple machines

Activity 8.5

Observe a water pump, motor engine, sewing machine and pictures or audiovisual materials related to industrial machinery. Discuss the following questions and draw an appropriate conclusion.

a. Why is the motor engine of a vehicle considered a complex machine?

b. Are all complex machines made from simple machines?

It is not possible to do complex work with simple machines. For example, complex machines of industries need to do complicated work, large trucks transport heavy loads, bulldozers are used for excavation, and so on. So, to do complicated work, complex machines are formed from the combination of different types of simple machines. These machines help to do work with less effort, in less time and with ease.

Activity 8.6

As given in the example, from which simple machines are the complex machines of our surroundings made up? Find out and fill the table given below.

S.N.	Complex machine	Simple machine
1.	Crane	Lever and pulley

Efficiency

The ratio of output work of the pulley to the input work on it, in the activity 8.2, shows the amount of energy converted to complete the real work. It informs the percentage of energy converted into other forms. For example: if the value of the ratio is 75%, then 75% of the total applied energy is utilized to lift the load and the remaining 25% is wasted due to friction converting it into heat, sound, and other less useful forms.

The output work is the work done by the load on the machine. Mathematically,

Output work = work done by load = load × load distance

Similarly, the input work is the work done by effort on the machine. Mathematically,

Input work = work done by effort = effort × effort distance

In a simple machine, the ratio of output work to input work is known as efficiency. It is expressed as a percentage. Mathematically,

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

उत्पादित कार्य र लागत कार्यका सूत्रलाई कार्यक्षमताको सूत्रमा प्रतिस्थापन गर्दा,

$$\text{efficiency}\ (\eta) = \frac{\dfrac{\text{load}}{\text{effort}}}{\dfrac{\text{Distance moved by effort}}{\text{distance moved by load}}} \times 100\ \%$$

$$\text{efficiency}\ (\eta) = \frac{\text{MA}}{\text{VR}} \times 100\ \%$$

In a simple machine, output work is always less than input work. To be 100% efficient, total input work must be utilized to produce output work. Due to friction in a simple machine, total input work cannot be utilized to produce output work. So, the efficiency of a simple machine is always less than 100%. By using oil and grease to reduce friction, we can increase the efficiency of a simple machine to some extent.

Perfect machine

When input work and output work are equal, then efficiency will be 100%. This type of imaginary machine, with 100% efficiency, is called a perfect machine. In a perfect machine, MA and VR are equal. Practically, a machine without friction is impossible, and thus, a perfect machine is also impossible.

Example:

The efficiency of a pulley system is 80%. For MA to be 4, how many pulleys must be there? How much effort is required to uplift the 1000 N load on the system?

Solution:

Efficiency $(\eta) = 80\%$

Mechanical advantage (MA) = 4

Load (L) = 1000N

Number of pulleys = ?

Effort (E) = ?

According to the formula,

$$\text{Efficiency -}(\eta) = \frac{MA}{VR} \times 100\,\%$$

$$\text{or } 80\% = \frac{4}{VR} \times 100\,\%$$

$$\text{or } VR = \frac{400}{80} = 5$$

Thus, number of pulleys = 5

$$\text{Again, } MA = \frac{L}{E} \text{ or } 4 = \frac{1000}{E} \text{ or } E = \frac{1000}{4}$$

Thus effort = 250 N

Exercise

1. Tick (√) the best answers.

a) Why is a single fixed pulley used even when it does not have a mechanical advantage?

i) To magnify force ii) To increase the velocity of an object

iii) To increase efficiency iv) To change the direction of force

b) Which of the following is the velocity ratio of a three pulley system?

i) one ii) two iii) three iv) four

c) A 6-meter-long wooden plank is used to lift the load up to a 2-meter height in a truck. What is the velocity ratio of the inclined plane?

i) one ii) two iii) three iv) four

d) What is the efficiency of a perfect machine?

i) 100% ii) <100% iii) >100% iv) 0%

e) From which of the following simple machines, a wheelbarrow with a single wheel is formed?

i) Wheel and axle, and lever ii) Pulley and wedge

iii) Inclined plane and screw iv) Lever and wedge

2. Give differences:

a. Pulley and wheel and axle
b. VR and MA
c. Jackscrew and ax
d. Input work and output work

3. Give reason:

a. Winding roads are made in the hilly region.
b. Crane is a complex machine.
c. No machine has 100% efficiency.
d. Mechanical advantage is always less than the velocity ratio in a real machine.
e. The wheel and axle is a continuous lever.

4. Answer the following questions

a) What is a simple machine? Mention its advantages.

b) What is a complex machine? Describe with an example.

c) Define an inclined plane with its examples.

d) What is a wedge? Write its importance with examples.

e) What is a screw? Give examples of its use in daily life.

f) Define the types of pulley with labeled diagrams.

g) Describe the methods to calculate MA and VR in screw and wedge with respective figures.

h) How do we increase MA and VR in an inclined plane? Give examples.

i) The efficiency of a machine is 75%. What does it mean?

j) A perfect machine is almost impossible in our life. Describe with reason.

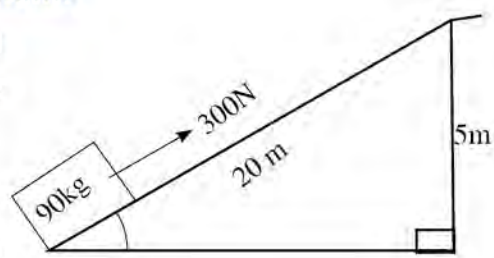
k) Explain, with a figure, the method to calculate the velocity ratio in wheel and axle.

l) Identify the simple machines from which each of the given complex machines is made.

i)	Sewing machine	ii)	Stapler machine
iii)	Bicycle	iv)	Domestic flour mill

5. Solve the given numerical problem:

a) Calculate the MA, VR and efficiency of the inclined plane shown in the figure.



[Ans : MA = 3, VR = 4, η = 75%]

b) Four pulley system is shown in the given figure. If the efficiency of the pulley system is 80%, then solve the questions given below.

i. How much force is required to uplift 1000 N load?

ii. Calculate mechanical advantage.

iii. Calculate input work and output work to lift the load up to 6 m height.

[Ans: Effort = 312.5 N, MA = 3.2, Input work = 7500 J and output work = 6000 J]

c) The radius of the wheel is 20 cm and that of the axle is 5 cm in a wheel and axle. An effort of 250 N is required to lift a load of 500 N by using this machine. What are its MA, VR and efficiency?

[Ans: MA = 2, VR = 4, Efficiency = 50%]

d) In the adjoining figure, a wooden block is split by using a wedge. Width is given as 6 cm and vertical height as 12 cm. When we apply 300 N force, it produces the resistance (load) of 500 N. Calculate its MA, VR and efficiency.

[Ans: MA = 1.67, VR = 2, η = 83.33 %]

9

Energy

Fig 9.1 heat converting water into water vapour

Fig 9.2-electric scooter

Fig 9.3 using LPG gas to cook food

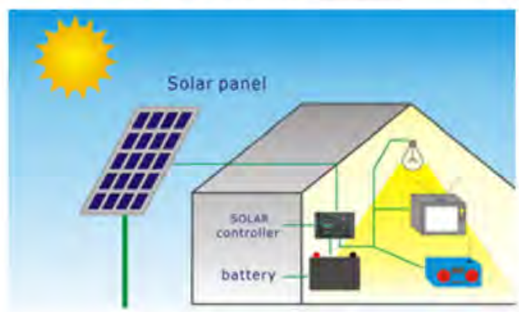


Fig 9.4 conversion of energy

a. In fig 9.1, which form of energy is used to dry clothes?

b. Which energy does an electric scooter use to operate?

c. Which sources of energy can be used to cook food?

d. To which forms of energy can we convert solar energy?

The sun is the main source of energy. Life is not possible without the sun. Solar energy is used directly in the water cycle, photosynthesis, drying woods, etc. Petroleum products, natural gases, hydroelectricity, etc. are the indirect and converted form of solar energy. Thus, almost all types of energy are directly or indirectly derived from the sun.

Source of energy

Activity 9.1

In the pictures below, various sources of energy commonly used in our country are shown. Study the pictures and answer the following:

Dung cake

wood

LPG gas

Biogas

petroleum oil

briquette

Fig. 9.5

a. Which energy sources are shown in the pictures above?

b. How are these sources obtained?

c. Among them, which sources of energy are continuously available in nature?

d. Which sources of energy are not available continuously and exhausted after a certain time?

We utilize various sources of energy, depending on our needs. Any object that can give a useful form of energy is a source of energy. Coal, diesel, kerosene, natural gas, hydroelectricity, etc. are the sources of energy. Energy is obtained from various sources like petrol, kerosene, wood, dung cake, solar energy, etc. in different areas of Nepal. The sources of energy can be categorized into two main types:

Non renewable source of energy

Some sources of energy in nature are formed after hundreds of thousands of years. If they are finished, they cannot be produced and replenished within a short period. Hence, they cannot be used forever. The sources of energy that are exhausted after continuous use and cannot be reproduced when needed are called the non-renewable source of energy. For example coal, mineral oil, natural gas, etc.

Renewable source of energy

Some sources of energy can be replenished in a short period. They are not finished even after continuous use as they can be reproduced when needed. The sources of energy that are continuously produced in nature and can be quickly replaced are called the renewable source of energy. For example, solar energy, wind energy, hydroelectricity, wood, dung cake, biogas, etc.

Solar energy

The heat and light that the earth receives from the sun directly are called solar energy. Solar energy can also be used indirectly with the help of various technologies. For example: converting the sun's heat and light into electricity. The sun is the main source of energy for the earth. Life is possible on the earth due to solar energy. The earth receives a huge amount of energy every day from the sun. The nuclear fusion of hydrogen atoms in the sun releases this massive amount of energy.।

Some facts regarding the Sun

Mass of the sun = $2x10^{30}$kg, Distance between the sun and the earth = $1.5x10^{8}$ km

Temperature of the core of the sun = 15,000,000 K, Temperature of the surface of the sun= 5778 K, Energy released by the sun = $3.8x10^{26}$ J/s

The solar radiation energy received by every square meter area of the earth = 1.4 kW

Nuclear reaction in the sun

For your information

Some elements have atoms with different masses. The atoms having the same atomic number but different atomic mass are called isotopes. For example, protium, deuterium and tritium are the isotopes of hydrogen.

The sun is a medium-sized star containing a huge amount of hydrogen. The core of the sun measures almost 15 million 0C in temperature. At this high temperature, the electrons of the hydrogen atom separate to form H+ ions. Although there is high repulsion between the H+ ions (protons), the high pressure at the core brings them together. The process of joining hydrogen atoms to form helium atoms in presence of high pressure and temperature is called thermonuclear fusion. This process releases a huge amount of energy in the form of radiation. In the Sun, the process of nuclear fusion takes place in three different steps as given below.

1. Two protons (H1) fuse to form a nucleus of deuterium (H2) and a positron.

   $${}_{1}H^{1} + {}_{1}H^{1} \longrightarrow {}_{1}H^{2} + {}_{1}e^{0} + \text{energy}$$

2. A third proton (H1) collides with the deuterium nucleus (H2). This collision results in the formation of a light helium isotope (2He3).

   $${}_{1}H^{2} + {}_{1}H^{1} \longrightarrow {}_{2}He^{3} + \gamma\text{- radiation}$$

3. Two helium isotopes collide, creating a helium nucleus plus two extra protons that escape as two hydrogen atoms.

$$_{2}He^{3} + {_{2}He^{3}} \longrightarrow {_{2}He^{4}} + {_{1}H^{1}} + {_{1}H^{1}} + \text{energy}$$

Overall, the thermonuclear fusion in the sun can be written as:

$$4\,{_{1}H^{1}} \longrightarrow {_{2}He^{4}} + 2\,{_{1}e^{0}} + \text{energy}$$

In this way, four hydrogen atoms in the sun fuse to form 1 helium atom. This process produces a large amount of energy.

Necessary conditions for thermonuclear fusion in the Sun

An enormous amount of hydrogen: The Sun has a massive amount of hydrogen gas, which continues the fusion.

High temperature: High temperature of the sun creates free protons.

High pressure: The high pressure in the core of the sun brings the protons together for fusion.

The sun: the ultimate source of energy

Activity 9.2:

Study the given figure. Follow the arrow sign as shown in the figure and identify different sources of energy based on solar energy. List them. Discuss how they are the products of solar energy.

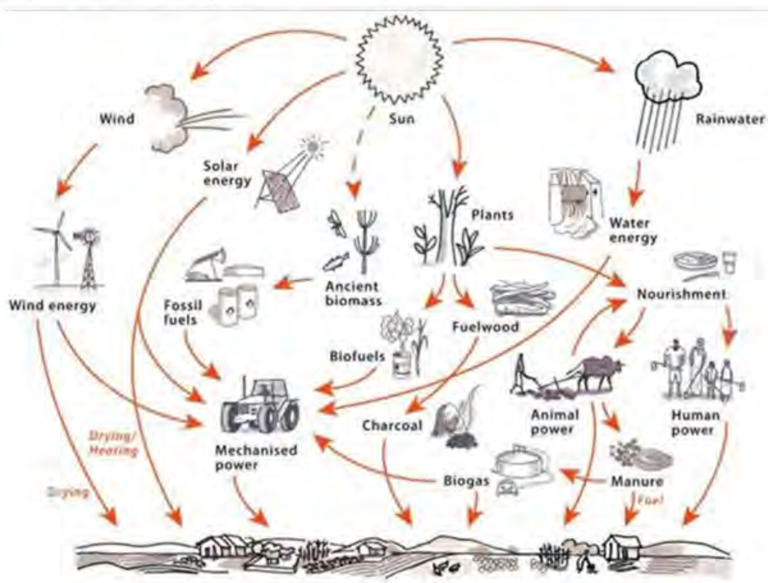


Fig. 9.6: The sun as the main source of energy

Most of the energy sources available on the earth e.g. hydroelectricity, wind energy, bio-energy, fossil fuel, etc. are formed by transforming solar energy. Hence, the sun is the ultimate source of energy. Some examples related to it are given below.

Water energy

The water cycle is also known as the hydrological cycle. In this cycle, snow and ice blocks melt due to solar energy, and water is filled in their sources. The water of lakes, rivers, ponds and sea evaporates into water vapour due to solar energy. The water vapour condenses to form clouds in the atmosphere and rainfall occurs. The rainwater flows through the river or collects in the reservoir. Hydroelectricity is produced from the water collected in reservoirs. Hence, hydroelectricity is an indirect form of solar energy.

Fossil fuel

During photosynthesis, green plants absorb a small portion of solar energy received by the earth. Carbon dioxide and water change into starch in this process. The solar energy is converted into chemical energy and stored in different parts of the plant. Animals consume the chemical energy stored in parts of plants. Hence, the energy obtained from food is an indirect form of solar energy. Fossil fuels like coal, petrol, diesel, natural gas, etc. are formed from dead plants and animals buried in the earth for millions of years. So, fossil fuel is the product of solar energy. Organic matters such as wood, plants, crop residue, etc. are used as a source of energy. They are also the products of solar energy.

Wind energy

Wind energy is also based on solar energy. Sun heats the air nearer to the earth's surface. The hot air becomes lighter and moves upward. It is replaced by cool air from another place. We can use wind energy produced by the movement of air in this process. Thus, wind energy is also a product of solar energy

Solar energy harvesting technology

solar panel

solar lamp

solar street lamp

solar dryer

solar water heater

solar cooker

The use of technology converts solar energy into other forms. For example, the solar panel converts solar energy into electrical energy. Some people install solar water heaters on their rooftops to heat water. This is an example of technology to utilize solar energy. Similarly, solar lamps, solar street lamps, solar dryers, solar cookers, etc. are some technologies used for harvesting solar energy in our daily life.

Solar Electricity

Different types of electric appliances can be run by changing solar energy into electrical energy with the help of solar panels. The solar panel is a combination Fig 9.7 of many photovoltaic cells. These cells are made up of semiconductors, mainly silicon. When solar light strikes the silicon atoms of the cell, free electrons are produced. Due to the accumulation of free electrons, an electric potential difference is developed between the two terminals of the cell. The series combination of small cells increases the amount of current in the circuit. As the intensity of light increases, the flow of current increases as well. For the maximum efficiency of the solar panel, it should be kept in a place facing the sun directly.

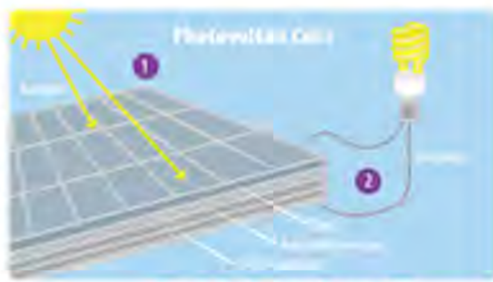


Fig 9.8: photovoltaic cell

Solar lamp

Photovoltaic cells are also used in solar lamps and solar street lamps. The LED lamp which glows with a small current is used in solar lamps. The series combination of a few photovoltaic cells is used in these lamps. Solar panels, batteries, LED lamps, and controllers

Fig 9.9: solar lamp

are the major components of solar street lamps as shown in the figure. The electric appliances are connected with the controller to charge the batteries with the current supplied by the solar panel during the daytime. Again, the controller supplies current from the battery to the LED lamp during the night and the lamp glows.

Solar dryer

Food like potato, radish, carrot, tomato, brinjal, cauliflower, gundruk, masyaura, etc. is dried directly under the sun traditionally. It takes more time to dry things this way. A solar dryer saves time. When food is dried in a solar dryer, there is a lesser chance of contamination. In a solar dryer, three sides are lined with a heat insulator and slanted transparent glass is placed on the upper surface. Its inner surface is painted black to absorb heat. A hole is made on the front side to let cool airflow into the dryer, and another hole is made on the upper part at the back to allow hot air to flow out.

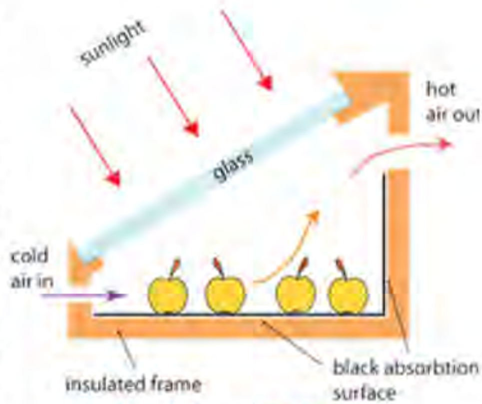


Fig 9.10: solar dryer

Solar water heater

In a solar water heater, evacuated tubes are connected to the water tank in a parallel position to absorb solar radiation. Coldwater is filled in these tubes from the lower part of the water tank. The sun heats water in the tube during the daytime, so the density of water decreases. Hot water with low density is collected in the upper part of the tank, and cold water with high density is filled in the tubes. A heat insulator is used to prevent the loss of heat from the tank. This keeps water hot even at night.

Solar cooker

In a solar cooker, a concave mirror with a wide and smooth surface is used to collect an adequate amount of solar heat required to cook food. It is made in such a way that the cooking vessel is placed in the spot where heat is converged. The outer surface of the cooking vessel is painted black to absorb more heat.

Project work:

Using materials available in your local area, prepare a model of appliances based on solar energy (eg. solar heater).

Bioenergy

Living beings have organic materials in their bodies. When they are decomposed or burnt, energy is produced. The energy obtained from animal wastes and parts of plants is called bioenergy. For example, the energy obtained from firewood, dung cake, straw, husks, etc. is bioenergy. It is a renewable source of energy. Bioenergy is used as fuel in transportation, heat, electricity production, etc.

Biomass energy

Biomass is a dry organic material obtained from living beings. Dry weeds, leaves, rice husk, sawdust, agricultural residue, dung cakes, etc. are examples of biomass. Traditionally, heat energy is obtained by burning biomass. It is difficult to store and transport non-compressed open biomass. Open biomass doesn't burn completely and produces more smoke but less heat. These problems can be solved by using compressed biomass.

Briquettes

A briquette is a compressed block of combustible biomass material. It is used to produce heat in homes and industries. Mainly, briquettes are of two types, as given below:

a. Carbonized briquette

Carbonized briquette is a compressed brick of charcoal. Charcoal is produced by burning carbon-containing materials such as firewood, husk, and weeds with insufficient oxygen. This process is known as charring. The dust of charcoal is mixed with a binder and is kneaded to form a thick paste. The paste is placed in a moulder and pressed to give a fixed shape. Clay, molasses, etc. are used as binders. Plant starch, such as starch in yam, can also be used

Fig 9.11: steps to form a carbonized briquette

b. Noncarbonized briquette

Fig 9.12: Noncarbonized briquette

In rural areas, a mixture of dung and husk is pressed by hand to a fixed shape. The mixture is then dried to form a dung cake. Dung cake is a type of non-carbonized briquette formed by the use of low pressure. Biomass like sawdust, paper, husk, etc. is compressed to form a non-carbonized briquette. Agricultural wastes like sugarcane husk, peanut shells, coconut, stems of sunflower, etc. are used as well. Compressing machine is used to create more pressure for the production of a non-carbonized briquette. In addition, heat and binder are also used as per the requirement. These briquettes are formed by the use of compressing technologies like piston press, screw press and roller press.

For information

In 1986 AD, a Japanese private company produced a briquette by using screw press technology in the agricultural complex of Khumaltar.

In 2078 BS, Nepal Rastra Bank imported a machine to compress old and damaged currency notes and make briquettes.

Use of briquettes

i. To heat rooms in winter

ii. To cook food and boil water

iii. To incubate baby chicks in poultry farms

iv. To dry vegetables, mushrooms, wool, etc. in industries

Advantages of briquettes

Briquette is a renewable source of energy. Its advantages are:

i. It releases less smoke, so it reduces air pollution.

ii. Different agricultural residues can be utilized.

iii. It reduces the use of firewood, and thus saves forests.

iv. It can be a source of income. One can earn a good income by selling briquette.

v. It produces more heat and is easy to transport and use. So, it saves time.

Although the use of briquette has multiple advantages, industrial production is costly. It may be damaged in the rainy season due to moisture if it is not stored properly. Some precautions to be taken while using briquettes are given below:

i. Briquettes should not be used in an unventilated room.

ii. Burning briquette should be kept out of the reach of children.

iii. Briquette should be burnt by placing it on bricks or metal containers, not directly on the ground.

Biogas

Biogas is the collection of gases formed by the decomposition of organic materials in the environment in absence of oxygen. In rural areas, biogas is collected especially from animal dung. Thus, it is also known as gobar gas. Biogas mainly contains methane, along with carbon dioxide, hydrogen, nitrogen, water vapour and hydrogen sulphide.

Construction of biogas plant

A biogas plant consists of three major parts: mixer, dome and an outlet chamber. The dung is mixed with water by a churner in the mixing tank to form slurry. The slurry is passed to the digester via an inlet pipe as shown in the figure. In the digester, the organic matter in the dung decomposes in absence of oxygen to form biogas. The gas is collected in the dome. The gas is supplied for use by opening the valve in the outlet pipe. The pressure of the biogas displaces the slurry in the digester to the outlet chamber. When the outlet chamber is full, the slurry passes to the compost pit. The slurry can then be used as a fertilizer.

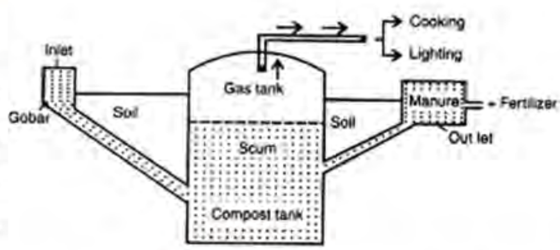


Fig 9.13

Advantages of biogas

i. The use of biogas is smoke-free, so it reduces air pollution.

ii. Although the initial cost to construct a biogas plant is high, it is a free source of energy for a long time.

iii. Biogas can be used to light lamps.

iv. It displaces the use of firewood, and thus saves forest.

v. The by-product of the biogas plant can be used as a good quality fertilizer. This fertilizer should be left in the open for some days before use.

Hydroelectricity

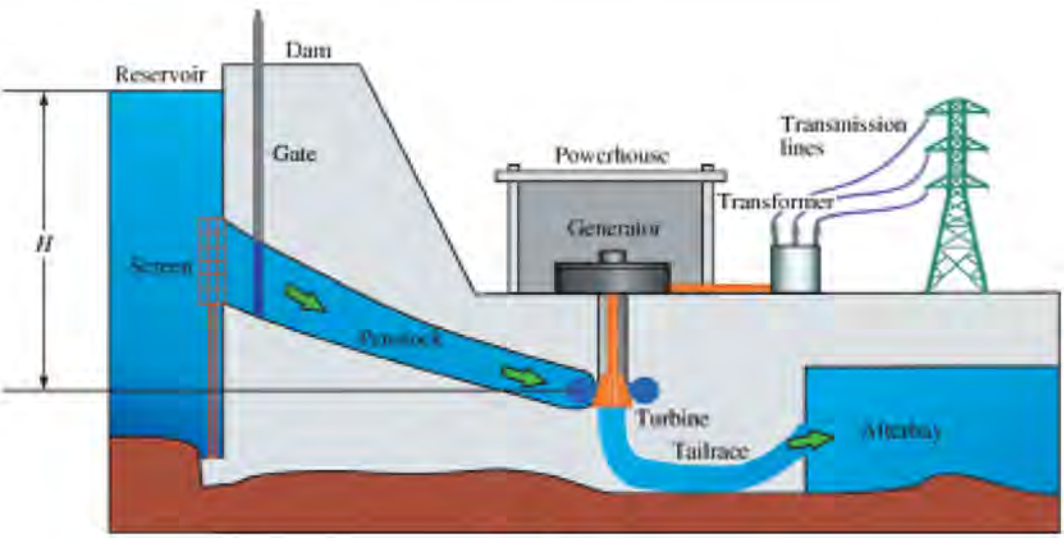


Fig 9.14

lowing water rotates the coil in a generator to produce a form of energy known as hydroelectricity. For the production of hydroelectricity, water collected in dams is passed at high speed from a tunnel to a turbine connected to the generator. When the turbine rotates, the coil held in a magnetic field also rotates, and an electric potential difference is produced between the two ends of the coil. By converting this into high voltage with the help of a transformer, electricity is transmitted to sub-stations for distribution in houses, offices and industries.

Advantages of hydroelectricity

Although the initial cost to construct a hydropower plant is high, it is cheaper in the long run. It is pollution-free in all aspects. Since this is a renewable source of energy, it never runs out. Modern appliances consume hydroelectricity, and consumption increases economic activities. Sufficient production and consumption of hydroelectricity reduces air pollution, reduces the import of petroleum and reduces the trade deficit. It promotes the economic growth of our country.

Use of alternative sources of energy in Nepal

Energy is provided by different sources in different areas of Nepal. In the present day, the use of hydroelectricity is increasing to replace petroleum products. The sources of energy that can be used instead of the traditional source are alternative sources of energy. For example, bioenergy, wind energy, and solar energy are alternative sources. Alternative Energy Promotion Centre (AEPC) was established on November 3, 1996, in Nepal, to develop and promote renewable and alternative sources of energy. It supports the production of biogas, solar panel, solar dryer, solar cooker, windmills, etc. as alternative energy sources.

As an alternative source of energy, briquettes are used mainly to heat rooms and cook food. Different government, non-government, private, and professional institutes, including AEPC, are working to produce and manage the use of bio briquettes. AEPC provides the training necessary for the production of briquettes.

Nepal government started to promote the use of biogas technology in our country in 2030 BS. Nepal government promotes farmers to build Gobar gas plants by providing aid under the Biogas Support Program. Gobar gas plants are constructed in the rural areas of almost all districts of Nepal. New biogas technology focused on urban areas is transformed to suit their lifestyle as shown in the adjoining figure. In this, the organic materials decompose in an oxygen-free environment.

Fig 9.15

AEPC takes the policy to construct huge biogas plants from degradable waste for biogas production in urban areas with the partnership of municipalities. In our country, large biogas plants are operated by private sectors as well. The biogas plant situated in Sukrauli of Nawalparasi is the first large-scale gas plant in Nepal that produces Compressed Natural Gas (CNG). It can be used as an alternative to Liquefied Petroleum Gas (LPG).

Wind energy is a renewable source of energy. Electricity can be produced from wind energy by using wind turbines. Electricity produced from it depends upon the speed of air, the direction of flowing wind, continuity of the flow of air, etc. Small wind energy production centres are established in the rural areas of Nepal. The turbines may be damaged by the strong energy during electricity production from wind. There is a high possibility to produce electricity from wind turbines in windy areas of Nepal like Mustang.

Fig 9.16: wind turbine of 20 kW situated in Hariharpur Gadhi of Sindhuli

Farmers can dry vegetables, fruits, etc. for domestic and industrial purposes by using solar dryers. Example: mango, orange, kiwi, gundruk, masyaura, mushroom, chilly, etc. are dried by using the solar dryer. It is also used to dry fish. The demand for the business products dried on the solar dryer, e.g. gundruk, sinki, bamboo shoots (taama), mushroom, etc. is high nationally as well as internationally. Dried herbs, ginger, tea, turmeric, and cardamom are exported to India.

Project work

What alternative source of energy do people in your surroundings use? Prepare a report

Exercise

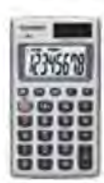
1. Select the best answers.

   a) Which is the non-renewable source of energy?

   i) Briquette ii) Biogas iii) Kerosene iv) Wind turbine

   b) Which of the following technologies is not included in solar technology?

(i)



(ii)

(iii)

(iv)

c) Which is the group of bio-energy?

   i) Alcohol, kerosene, biogas, husk

   ii) Firewood, biogas, husk, coal

   iii) Dung cake, biogas, alcohol, husk

   iv) Briquette, alcohol, petrol, biogas

d) Which of the following gases are constituents of biogas?

   i) Hydrogen, methane, oxygen, nitrogen.

   ii) Nitrogen, methane, oxygen, hydrogen sulphide.

   iii) Nitrogen, carbon dioxide, methane, hydrogen sulphide.

   iv) Water vapour, carbon dioxide, methane, hydrogen sulphide.

2. Give differences:

i) Renewable and non-renewable sources of energy.

ii) Solar energy and bioenergy

iii) Carbonized briquette and non-carbonized briquette

iv) Natural gas and biogas

3. Give reason:

i) The sun is the ultimate source of energy.

ii) The use of renewable sources of energy must be increased.

iii) Solar vehicles are a better alternative in the context of Nepal.

iv) Hydroelectricity is the most appropriate source of energy for Nepal.

v) Biogas is the most suitable alternative energy source in our rural village.

4. Answer the following questions.

a. Define the source of energy with examples.

b. What is thermonuclear fusion?

c. Write the necessary conditions for nuclear fusion in the Sun.

d. Justify that the following sources of energy are the product of solar energy.

   i) Hydroelectricity ii) Fossil fuel iii) Wind energy

e. Describe the process of energy production in the Sun.

f. Describe with a diagram the working principle of any two equipment based on solar technology.

g. What is an alternative source of energy? Give any two examples.

h. Identify the equipment from the given figure and also mention their working principle.

i. What is biofuel?

j. Give any four examples of biofuel.

k. Why are briquettes used? Write any two advantages of it.

l. How is biogas produced? Explain the construction of the biogas plant with an appropriate diagram.

m. Write any two advantages of biogas as a source of energy.

n. Describe any two alternative sources of energy used in your surroundings.

o. Write an essay on 'Potential of development of alternative energy in Nepal'.

10

Wave

Wave network

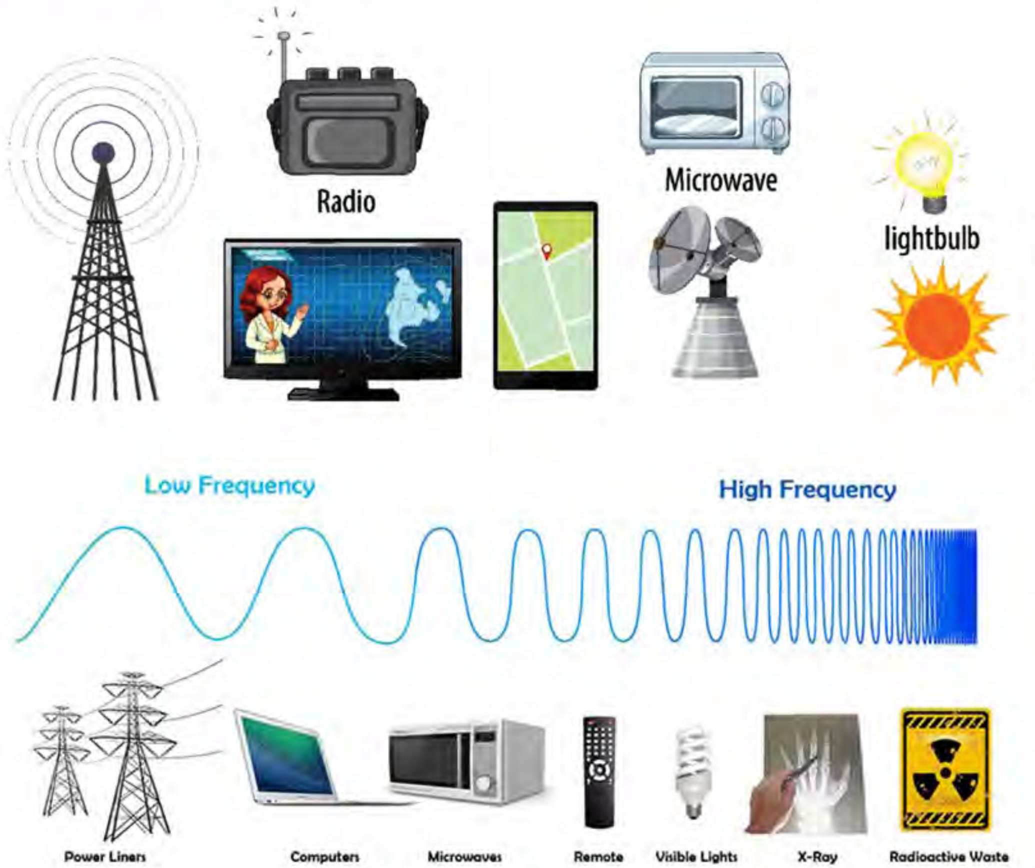


Fig 10.1: use of waves

As shown in fig 10.1, we are surrounded by waves. They are striking our bodies as well.

We are using the energy carried by light waves, heat waves from the sun, communication waves from different FM radio transmitters, waves used in mobile technology, waves from Wi-Fi routers, and others. A network of waves is used in carrying out tasks such as security checking, distance calculation, etc. Sound waves and X-rays are being used for checking the internal organs in the human body.

Wave

Activity 10.1:

Objectives: To observe the motion of molecules in waves transmitted on the water surface.

Materials required: a half-filled water bucket, a paper boat, rope and ribbon

Method:

1. Let the water in the bucket come to rest.
2. Place the paper boat on the water.
3. Create ripples on the water surface by tapping your fingers repeatedly.
4. Observe the direction in which the wave moves in the water and the motion of the paper boat.
5. Tie a piece of ribbon on a rope. Tie one end of the rope on a fixed object and move the other end up and down continuously.
6. Observe the direction in which the raised part of the rope moves and the direction of motion of the ribbon.

Discussion and conclusion: Are the directions of motion of the paper boat and the wave on the water surface the same? Are the directions of the motion of the raised part of the rope and the ribbon the same? Discuss it in your classroom and draw a suitable conclusion.

fig 10.2: wave produced in water

fig 10.3: wave produced in rope

If we tap the water surface with our fingers, water molecules vibrate. When the water molecules are oscillating up and down, the neighboring molecules get pulled downward and pushed upward. The energy transfers from oscillating molecules to neighboring molecules. This creates a ripple on the water surface and thus, energy is transmitted. If we place a paper boat on the surface of the water, we can observe the fact that molecules of water oscillate up and down about their mean positions. As the molecules oscillate about their mean positions, the ripples appear to be moving along the water surface.

When we fix one end of the rope and move the other end up and down, molecules of rope move along the direction of the hand's motion because of kinetic energy. Neighboring molecules also follow the motion of the first molecule. As we continue the process, some segments of the rope are raised and others are depressed. If we tie a piece of ribbon on the rope, we can see that the molecules oscillate at a fixed place whereas the ripples move forward.

The periodic disturbance in electric and magnetic fields also transmits energy. A wave is a periodic disturbance that transmits energy.

Earthquake waves bring the energy produced by the collision of rocks inside the Earth to its surface.

Types of waves

Types of waves
- **Mechanical Wave**
  - **Longitudinal wave**
  - **transverse wave**
- **electromagnetic wave**

Transverse wave and longitudinal wave

Activity 10.2

Objective: To demonstrate longitudinal and transverse wave

Materials required: meter tape, slinky, piece of colourful string

Procedure:

1. Lay a meter tape on a flat surface and fix it.
2. Tie a piece of colorful string on any part of the slinky.
3. Place the slinky on top of the meter tape, and observe the wave produced by pulling and pushing the slinky uniformly. This wave is a longitudinal wave.
4. Again, move the slinky left and right and observe the wave produced. This wave is a transverse wave.
5. Fill in the information related to both types of waves in the table below:

Quality	longitudinal wave	Transverse
Motion of thread and frequency (f)	Time taken to move the thread back and forth 10 times = Frequency shifted back and forth in 1 second (f) = ... Hz	The time it takes for the thread to run left right 10 times = frequency shifted left right in 1 second (f) = Hz

Wave length is denoted by λ	The distance from one compress to another nearest compress = … m	The distance from one crest to the nearest crest = ….m
Velocity of wave $v = f \times \lambda$	……………. = …. m/s	………… = …= m/s

Discussion and conclusion: Differentiate between longitudinal and transverse waves.

In the process of pushing a slinky forward and pulling it backward uniformly, rings at a certain part move forward and compression occurs. The rings then expand and rarefaction occurs. This repeats continuously. During this process, waves produced in slinky also move forward. In a longitudinal wave, the direction of transmission of the wave and the direction of periodic disturbance or vibration is the same. The sound wave is an example of a longitudinal wave. Longitudinal waves can be created in all media: solid, liquid and gas.

In the process of moving the slinky left and right uniformly, rings of certain parts of the slinky move to the left while the rings of the other parts move to the right continuously. During this process, waves produced in slinky also move forward. In a transverse wave, the direction of transmission of the wave and the direction of periodic disturbance or vibration are perpendicular to each other. The wave produced on the water surface, the wave produced in rope, etc. are some examples of a transverse wave. Transverse waves can be created in solid and liquid mediums but not in gas.

Terminologies related to transverse and longitudinal waves

Longitudinal waves transmit in the form of compression and rarefaction. The segment of the wave where molecules are crammed is compression, and a segment where the molecules are spread out is rarefaction. Transverse wave transmits in the form of crest and trough. The raised part of the wave is the crest and the depressed segment is the trough. The amplitude of the wave indicates the maximum displacement of molecules from the rest position or distance from the mean position to the crest or trough.

During the transmission of waves in a slinky, we can observe the pulse moving forward by creating many wave cycles. The number of waves produced per second is frequency. The SI unit of frequency is Hertz (Hz). The time taken to produce a complete wave is the period of the wave. It is denoted by T.

$$\text{Frequency (f)} = \frac{\text{Numberofwaves (n)}}{\text{Time (t)}}$$

If one complete wave is produced in 'T' second, then

$$\text{Time (T)} = \frac{1}{\text{Frequency (f)}}$$

Distance between the midpoint of one compression to the midpoint of its nearest compression or distance between the midpoint of one rarefaction to the midpoint of its nearest rarefaction is called wavelength. Similarly, the distance between one crest to its nearest crest or the distance between one trough to its nearest trough is the wavelength. It is denoted by the Greek letter lambda (λ).

Not all waves are transmitted in the same way. The rate of wave transmission depends upon energy provided by the source, medium, nature of the wave, etc. During the transmission of the wave, the distance covered by the wave in unit time is wave velocity. It is the product of wavelength and frequency.

Velocity (v) = Wave length (λ) × Frequency (f)

Mechanical wave and electromagnetic wave

Some waves require a medium to propagate, while others don't. A wave that requires a medium to travel is a mechanical wave and a wave that does not require a medium is an electromagnetic wave. The sound wave is an example of a mechanical wave. A mechanical wave is the propagation of energy produced by the vibration in molecules of a matter. During propagation of energy, matter in which vibration occurs is medium. The energy of the mechanical wave goes on decreasing during the transmission due to absorption by the medium. Thus, the mechanical wave propagates up to a certain limit according to the medium. The velocity of a mechanical wave is different in solid, liquid and gas mediums. For example: under normal conditions, the velocity of sound waves in air, water and iron is 343 m/s, 1481 m/s and 5120 m/s respectively. Mechanical waves are longitudinal or transverse waves.

The light of the sun and other stars in space enter the earth by passing through a vacuum. Light propagating without medium, ultraviolet rays and the invisible heat-carrying infrared rays are electromagnetic waves. Radiation is a method of energy transmission in the form of electromagnetic waves. Energy is conserved when these waves transmit without a medium. So, the electromagnetic wave propagates to a huge distance at the speed of light. For example, light waves radiated by the sun transmit at the velocity of $3x10^8$ m/s and reach the earth in 8 minutes 20 seconds. Electromagnetic waves are transverse waves because the vibration of electric and magnetic fields are perpendicular to the direction of propagation of the wave. Radio transmitters, X-ray machines, etc. produce electromagnetic waves artificially.

Electromagnetic spectrum

Activity 10.3

Discuss the source and characteristics of electromagnetic radiation that you know, for example, light waves, ultraviolet waves, etc.

Light waves from electric lamps and communication signal waves from the radio broadcasting center are both electromagnetic waves. They have different frequencies and wavelengths. The entire range of waves from very low frequency to very high frequency is called the electromagnetic spectrum. Radio waves, microwaves, infrared rays, light, ultraviolet rays, X-rays and gamma rays are the different parts of the electromagnetic spectrum.

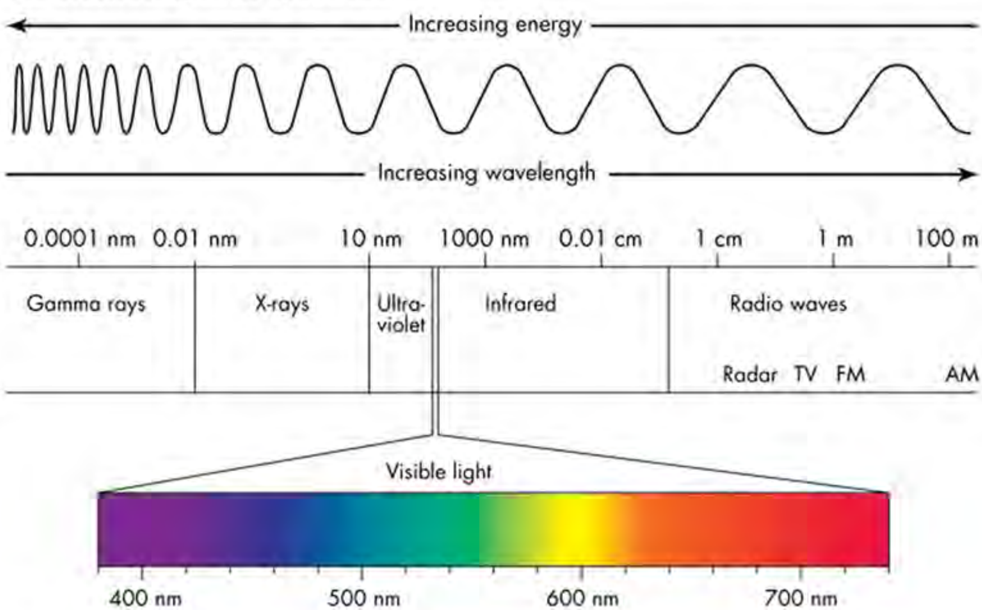


Fig 10.4: electromagnetic spectrum

One end of the electromagnetic spectrum contains radio waves having the longest wavelength and the least frequency. Gamma rays having the shortest wavelength and the maximum frequency are kept at the other end. Waves having shorter wavelengths such as X-ray and gamma-ray carry more energy.

Application of electromagnetic waves

Radio Waves

The wavelength of radio waves ranges from 1 meter to hundreds of kilometers. It does not affect any living cell and it is safe for living beings. It is used in the following ways:

Radio waves are produced by a transmitter and transmitted in the form of a communication signal on radio and TV.

A radio telescope helps to study the universe by capturing radio waves emitted by outer space.

Fig 10.5

Microwave

The wavelength of microwaves ranges from 1 mm to 30 cm. It is used in the following ways:

Due to microwaves produced in a microwave oven, water molecules vibrate and heat up. So, food is cooked.

Microwaves are used in radar communication. It is used in Airport Surveillance Radar to control air traffic. The radar speed guns measure the speed of vehicles.

Microwaves are used as a signal of communication technology. These waves are used in Satellite communication, Mobiles, Wi-Fi, and Bluetooth technology.

Fig. 10.6. Microwave oven

Fig. 10.7. Surveillance radar in airports

Fig. 10.8. Radar speed gun

Infrared wave

Infrared means below red. The frequency of infrared waves is less than red light, but their wavelength is comparatively more. When infrared waves with high-intensity strike our body, we feel the sensation of heat. Their wavelength ranges from 10^{-3} m to 7.5×10^{-7} m. Infrared rays are used in the following ways:

Heat is produced in a cooker, infrared heater, etc. by infrared rays.

A radiation thermometer measures the body temperature based on the intensity of the infrared ray radiation.

Infrared rays are used in infrared closed-circuit television cameras (IR CCTV) and thermal imaging cameras to detect nighttime activities.

Infrared rays are used in remote sensing technology. The signals are produced by a remote to switch the TV on/off, operate a toy car, and control a drone.

Astronomers observe different objects across the universe by studying the infrared rays they emit.

Fig. 10.9. Infrared heater

Fig. 10.10. Infrared CCTV camera

Fig. 10.11. Remote control technology (toy car, TV)

light waves

The retina of the human eyes can recognize visible light waves. Among the visible light waves, red light has the longest wavelength (7.5×10^{-7}) m), and violet has the shortest wavelength (2×10^{-7}) m). The light waves from the source reflect when they strike a certain object. When those reflected rays enter our eyes, we can see the objects. Visible light waves are used in the following ways:

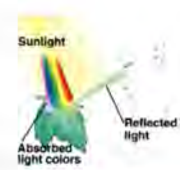


Fig10.12: reflected waves of green light

We use it for vision.

The photosynthesis process occurs in plants by absorption of visible light.

Visible lights are used on display screens such as mobiles, televisions and others.

We can transmit signals of communication through optic fibers by using visible light.

Ultraviolet waves

The wavelength of ultraviolet waves ranges from 4×10^{-7} m to 10^{-7}. Although these waves are not visible to the naked eyes, they cause sunburn on the skin after long exposure. High exposure to UV waves may cause skin cancer. Sun is the main source of UV waves for the earth. Ultraviolet waves can be produced by UV tubes as well. Ultraviolet waves are used in the following ways:

The fluorescent powder inside the CFL lamp glows due to ultraviolet rays produced in the lamp. This emits visible light.

Ultraviolet rays can be used to kill microbes and sterilize food, clothes and utensils by placing them in the sunlight directly.

Fig1 0.13: Water purification by SODIS process

Under the Solar Disinfection (SODIS) process, a water-filled transparent bottle is placed under direct sunlight to kill microbes.

Vitamin D is formed in the skin in presence of UV rays from the sun. That's why babies are kept in morning sunlight every day for some time.

X-ray

The wavelength of X-ray ranges from 10^{-9} m to 10^{-12} m. X-rays enter the atmosphere of the earth naturally from outer space. Artificially, X-rays can be produced by the X-ray machine. X-rays are used in the following ways:

X-rays are used in X-ray photography and CT scan machines to check bone fractures or internal injuries.

An X-ray security scanner is used to check for hidden dangerous objects. For example: In airports, security personnel use X-rays to examine luggage.

In X-ray therapy, powerful X-ray beams are directed to cancer cells to destroy them.

Fig10.14:

X-rays are used for various research purposes. We can study the molecular structure of objects by the use of X-rays. It is also used for the identification of the earth's inner layers and minerals.

Ɣ-ray (Gamma-ray)

Gamma rays are the powerful rays emitted during radioactivity. Radioactivity is the process in which energy is produced by breaking the nucleus of an atom. Gamma rays are powerful electromagnetic waves having a maximum frequency. Such rays are deadly. These can destroy living cells and cause cancer as well. ϒ -rays are used in the following ways:

- Controlled use of gamma rays can destroy cancer cells. This treatment method is called radiotherapy.
- Gamma rays are used to sterilize surgical equipment.
- Gamma rays are used to sterilize the food materials, so that food can be stored for a long time.
- In nuclear medicine, medical diagnosis is done by entering a gamma-ray tracer into the body.

Reflection of sound

The sound produced by the sources is transmitted through any medium. During sound transmission, the wave that returns after striking a rigid surface is called reflected sound. The echo that we hear when we shout in front of a tall wall is a reflected sound.

Application of reflected sound

Different animals use the reflection of sound naturally. Bats produce ultrasounds, which reflect after striking nearby obstacles. Based on these reflected sounds, bats locate the obstacles and prey. This process of navigation by using reflected sound is called echolocation. Dolphins also use echolocation to find out about invisible locations in the water.

The sound that has a frequency of more than 20,000 Hz (20 kHz) is called ultrasound. The human ear cannot detect this sound. Since they have a higher frequency, they carry more energy.

We can calculate the distance by using artificially produced ultrasound. To measure distance using an ultrasonic ruler, ultrasound is sent from the sender towards an obstacle. After a certain period, the receiver of the ruler receives the sound wave reflected from the obstacle. Distance is calculated based on the interval of time between sending the sound wave and receiving it back. Sound navigation and ranging (SONAR) is the technology of calculating distance by measuring the time between sending ultrasound produced by an instrument and receiving the wave after it strikes the obstacle. This technology is used by a fathometer installed in ships to measure the depth of the sea. Ultrasonography, based on SONAR technology, uses reflected ultrasound to examine the internal organs in medicine.

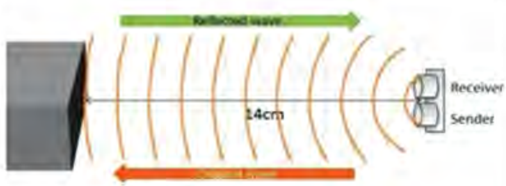


Fig 10.15: Ultrasonic ruler

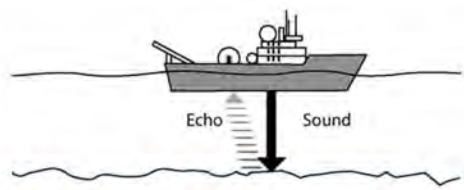


Fig 10.18: Use of fathometer attached to a ship

Security alarms can be built based on reflected ultrasound. For example, burglar alarms used on doors of the houses, ultrasonic sensors used in car parking, etc.

Acoustic protection

The sound becomes indistinct inside a room due to the reflection of sound. Reflection of sound in smooth walls is more than reflection in soft and porous walls. Acoustic protection is the technology of using soft and porous materials in walls to absorb unnecessary sound waves. This controls sound reflection in cinema halls, music rooms, seminar halls, etc. We can make the walls rough or attach foam boards to the walls for acoustic protection.


Fig 10.17: Acoustic protection used on the walls to absorb sound waves

Fig 10.18: Radio Nepal recording studio.

Use of waves in human organ diagnosis

Activity 10.5

Observe the medical technologies based on waves given below by visiting a nearby hospital or medical center or through audiovisual materials. Collect the information about their working procedure.

Ultrasonography	X-ray photography	CT scan
Diagnostic report..... Process of showing pictures of internal organs by using a transducer and computer..... Use... Diagnostic report.....	Name of equipment producing X-ray.... Process of taking photos... Use.... Diagnostic report.....	Process of making 2D and 3D pictures from collection and processing of data using an X-ray machine and computer.... Use....

Ultrasonography

Fig. 10.19: Use of USG and two-dimensional sonogram

Ultrasonography is the technology used in medical checkups of internal organs of our body by using ultrasound waves. It is commonly known as a video X-ray. A part called transducer produces ultrasound of high frequency. This ultrasound wave is targeted at internal organs. Then, the transducer receives the ultrasound reflected from different layers of the body. A computer collects and analyzes the intensity and time interval of the reflected ultrasound. The computer prepares images of internal structure based on the obtained data. The image is known as a sonogram.

Ultrasound does not harm the cells of the body. We can obtain the image of soft tissues and body fluid with this technology. Stones of kidneys and gallbladder, tumors of the brain and pancreas, liver disease, intestinal problems, uterine diseases, etc. are checked by using ultrasound. Ultrasound is also used to check the size and condition of the fetus, the motion of organs, and its abnormalities. By using three-dimensional (3D) ultrasonic technology, the condition of the fetus can be observed more clearly. It is also used to check the heartbeat, condition of valves and their functions. This technology is called echocardiography.

X-ray imaging

X-ray is an electromagnetic wave. X-ray imaging is a type of technology that uses X-ray to create an image of internal organs for diagnostic purposes in medicine.

X-ray photography is simply called X-ray. It is a technology that produces a beam of X-rays and creates an image of internal organs based on the shadows formed by the rays. Traditionally, to take an X-ray photo, the patient is positioned at a certain distance in front of the X-ray machine. When the machine is turned on, X-rays passing through the human body strike the X-ray film placed behind the patient and form a shadow. An X-ray photo is prepared from the X-ray film based on the shadow. In the X-ray photo, the shadowed portion appears white, and the remaining portion appears black. Instead of photographic film, the electronic recording device is used to record shadows in modern technology.

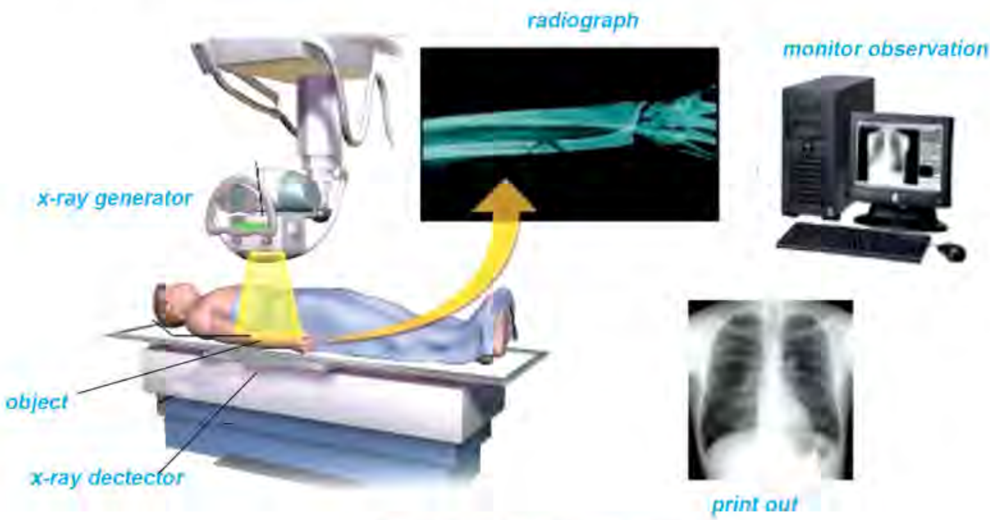


Fig 10.20: Use of X-ray recorder

The bones of our body absorb more X-rays. So, their shadows appear white in the X-ray photo. Other tissues like muscles, fat, etc. absorb a lesser amount of X-ray, and more X-ray penetrates them. So, these parts produce a faint shadow. X-rays can easily pass through air-filled organs like lungs, and they appear black in X-ray photographs. We use X-rays to check fractured bones, roots of teeth, infections, tumors, arterial blockage, etc.

High-powered X-rays are harmful to health. High exposure to X-rays may cause problems like damage to cells and genetic abnormality. It increases the risk of cancer. X-rays are scattered throughout the room when X-ray machines are on. So, lead aprons are used to minimize X-ray exposure.

Physicist Wilhelm Roentgen discovered X-ray in 1895 AD when electric current was passed through gases kept at low pressure in the lab.

CT scan

A computerized tomography scan (CT scan) is an advanced form of X-ray photography. For this, the patient is sent into a doughnut-shaped machine. The X-ray source in this machine can rotate through 360^0 around the patient. X-ray detectors are placed right in front of the source. It is made in a way that the detector also rotates when the source rotates.

Fig 10.21: CT scan method

To take a CT scan, a powerful X-ray beam is targeted to the body part that is to be checked. When the X-ray source is rotated around the patient during the checkup, it collects information by targeting the specific organ at 00, 450 , 900 and 1350. A computer processes this data and prepares 2D cross-sectional images. These are called tomographic images. For a more detailed view, data of these X-ray slices are combined to form a 3D image.

Tomographic images contain more detailed information than traditional X-ray photographs. The soft internal organs can also be observed in tomographic images. It is easier to identify internal organs in 3D images. It helps to detect changes and irregularities inside the body. CT scan is used to check internal wounds, blood clots, tumors, and conditions of the lungs, brain, etc.

Exercise

1. Select the correct answers.

a) Which is an example of a longitudinal wave?

i) Sound wave ii) The wave produced on the water surface

iii) Lightwave iv) Radio wave

b) Which of the following statements is completely true for waves having longer wavelengths?

i) It has a low speed. ii) It has a shorter wavelength.

iii) It has large amplitude. iv) It has a longer period.

c) Which of the following groups of waves are arranged according to increasing wavelength?

i) X-ray, ultraviolet ray, red light, violet-ray

ii) Violet ray, red light, ultraviolet ray, X-ray,

iii) Ultraviolet ray, Violet ray, red light, infrared ray

iv) Violet ray, red light, infrared ray, ultraviolet ray

d) Which of the following electromagnetic waves is used in the remote control technology of a television?

i) Ultraviolet wave ii) Infrared wave

iii) Lightwave iv) Radio wave

e) Hari slips on the stairs and suffers from some external head injuries. Which of the following technologies is used for in-depth checkups of brain injury?

i) Traditional X-ray photography ii) CT scan

iii) Echocardiography iv) Ultrasonography

f) Which sentence among the following is related to ultrasonography and X-ray imaging?

   i) One is more reliable, and the other is less reliable

   ii) One uses computer technology, the other uses simpler technology

   iii) One is based on the use of transverse wave, the other is based on the use of longitudinal wave

   iv) One is used to check bones; the other is used to check soft organs.

2. Differentiate between:

a) Longitudinal and transverse wave

b) Electromagnetic and mechanical wave

c) Traditional X-ray photography and CT scan

d) Infrared and ultraviolet rays

3. Give reason:

a) When a rope is fixed at one end and the other end is moved in up-down motion continuously, the wave produced is called a transverse wave.

b) As the distance from the epicenter of a seismic wave during an earthquake increases, a lesser effect is felt.

c) In a CT scan, the source of the X-ray in the machine is kept in such a way that it rotates around the patient.

d) Although a CT scan gives a detailed three-dimensional report of the internal organs of our body, ultrasonography is used to check the fetus in the uterus.

4. Answer the following questions.

a) What is a wave?

b) Draw a detailed and well-labeled diagram of a wave produced on the water surface and sound wave transmitted when we speak.

c) What is the electromagnetic spectrum?

d) Mention the name of waves having maximum and minimum frequencies in the electromagnetic spectrum. Give two uses of each.

e) X-ray photograph and CT scan photo of the pelvic region are given below:

A

B

i) Distinguish X-ray photograph and CT scan photo.

ii) Mention the steps to check from both technologies.

iii) Write the uses of X-ray photography and CT scan.

f) Mention any four uses of the reflection of sound.

g) Rohan calculated the distance between his house and his neighbor's house rightin front using the reflection of sound. Describe his method.

h) Prepare a model of security technology based on sound reflection by connecting ultrasound sender, receiver, and other components. Sketch the diagram of the technology.

i) What is acoustic protection? Write its uses.

j) What is ultrasonography? Mention its procedure and uses.

k) Write an essay titled 'Role of electromagnetic waves in modern life'.

11

Electricity

Figure 11.1 Use of current electricity

Electricity is a major source of energy. It is transmitted through conducting wires. Domestic electrical appliances are connected by conducting wires as shown in fig. 11.1. Two separate wires are connected with each instrument to form a complete circuit of the electrical appliance. All electrical instruments that we use convert electrical energy into other forms of energy. The rate of transformation of energy differs from one appliance to another. A heater transforms more electrical energy than a light bulb. The electric resistance of the appliance affects the rate of energy transformation. A meter is used in the circuit to measure the amount of transformed electrical energy. The meter helps to calculate the bill of electrical consumption.

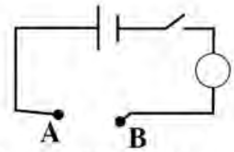
Electric current

Activity 11.1

Objective: To observe the role of conducting wire, battery and solution

Materials required: conducting wires, battery, salt, water, glass rod, plastic jug, switch and bulb

Method:



1. Prepare an electric circuit as shown in the figure.
2. Immerse the two endpoints A and B of conducting wires in the jug filled with water.
3. Gradually add the salt to the water, stirring the solution with a glass rod. Observe the brightness of the bulb and fill up the table given below.

Role of battery	Role of solution	Role of conducting wire	Conclusion

Discussion and conclusion:

i. What type of change occurs in the brightness of the bulb with an increment of salt in the saltwater solution?

ii. Replace salt with sugar. Will the bulb glow? Discuss it in the classroom.

The nuclear force of attraction between the nucleus and electron of the outermost orbit in a metallic atom is comparatively very low. Thus, these electrons can move easily from one atom to another. So, they are called free electrons. Positive ions and negative ions can travel freely in an electrolytic solution. When the ends of the two conducting wires connected to a battery are dipped in the solution, these ions move in a particular direction. Hence, the flow of charge occurs. The flow of charges produces current electricity. The rate of flow of positive charge per unit time is electric current. The flow of electrons in a particular direction is equivalent to the flow of the positive charge of the same amount in the opposite direction.

The S.I. unit of electric charge is coulomb and denoted by C. One electron contains charge. One coulomb charge is the total charge of electrons.

In an electric circuit, if conducting wire conducts 'Q' charge in 't' second, then the amount of current flowing on it is given by:

$$\text{Current (I)} = \frac{\text{Electric charge (Q)}}{\text{Time (t)}}$$

The S.I. unit of current is ampere. Milliampere (mA) and microampere (μA) are smaller units of electric current.

1 mA=10^{-3}A,

1 μA=10^{-6}A

Ampere is the flow of one coulomb in one second. The electric current is measured by an ammeter, which is connected in a series combination in the circuit.

The arrow sign shows the direction of the flow of current from the positive terminal to the negative terminal of the cell in figure 11.2. The direction is the conventional direction of the current.

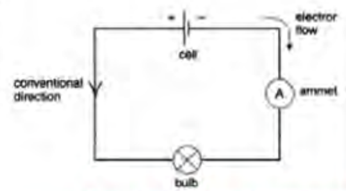


Fig 11.2: flow of electron through conducting wire

Example 1:

If 0.2 C charges flow in a closed circuit in 5 s, find the amount of current.

Solution: According to given condition,

Charge (Q) = 0.2 C

Time (t) = 5 s

Formula,

$$\text{Current (I)} = \frac{\text{Charge (Q)}}{\text{Time (t)}} = \frac{0.2}{5} = 0.04 \text{ A}$$

$$I = 0.04 \times 1000 = 40 \text{ mA}$$

When 0.2 C charges flow in a closed circuit in 5 s, the amount of current is 40 mA.

Electromotive force (e.m.f.) and potential difference (p.d.)

Two plastic bottles are filled with water up to different levels. They are joined together with a pipe. In which direction does the water flow? Does the water flow continuously? When the water flow stops, what should be done to resume the flow of water?

Just like how a water pump continues the flow of water, the flow of charge in an electric circuit is continued by the cell.

The similarity between the working function of a water pump to make water flow in a pipe and the cell to make charge flow in an electric circuit

Water flows from a high level with high potential to a lower level with lower potential.	Electric charges flow from the positive terminal with high potential to the negative terminal with lower potential.
If the level of water is the same, water stops flowing. To resume the flow, a water pump provides energy to make the water flow from a lower to a higher level.	For a continuous flow of charges, the cell uses chemical energy to generate a negative terminal with a lower potential at one end and a positive terminal with a higher potential at the other end.
The water pump provides energy to make water flow.	The chemical reaction in the cell provides energy to make the charge flow.
When the water pump stops providing energy, the difference in water level ceases to exist and water flow stops.	When the chemical reaction in the cell stops, the potential difference between two terminals ceases to exist, and the flow of charge stops.

To flow water in a pipe, one end of the pipe should be joined with the source of water at a higher level and another end at the lower level. When water is flowing, potential energy is converted into other forms of energy and work is done. If a turbine is connected with the pipe, it rotates and works done occurs. Similarly, in an electric circuit, when a positive charge is moved from a point at a higher potential to a point at a lower potential, energy is liberated at connecting wires and electric loads, and work done occurs. The capacity of a cell to provide energy per unit charge is called potential. The positive terminal of a cell has higher potential and the negative terminal has lower potential. Hence, to provide current in the electric circuit, one end of the electric load should be connected with higher potential and another point with the lower potential of the electric source.

Activity 11.2

Objective: To compare e.m.f. and p.d.

Materials required: Voltmeter, crocodile clips, conducting wire, dry cell and bulb

Method: Prepare an electric circuit as shown in the figure and measure the required quantities.

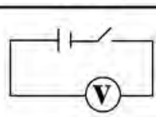
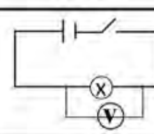
Circuit	Observation	circuit	Observation	Conclusion
	Value measured by voltmeter= ....**volt**		Value measured by voltmeter=..**volt**	

Fig 11.3

Discussion and conclusion: Compare the value measured by voltmeter between two circuits.

Energy is required for a charge to flow in a conductor. Electric sources like generators, batteries, solar panels, etc. provide the energy for the change to flow. Electric source converts other forms of energy into electrical energy. A battery converts chemical energy into electrical energy. The amount of energy provided by the source to each coulomb of charge to flow in the circuit is called electromotive force (emf).

Electromotive force creates the potential difference between two ends of an electric load connected in the circuit. When one end, A, of an electric load is connected with the positive terminal of a battery and the other end, B, with the negative terminal, then the potential of A will be more than that of B. Due to the difference in potential, the positive charge flows from A to B. Due to potential differences, electric energy transforms into another form when charges flow through the electric load. The potential difference is the amount of energy transformed when a unit charge is transferred from one point of the circuit to another. It is commonly known as voltage.

$$\text{Potential difference } \mathbf{(p.d.)} = \frac{\text{Amount of energy transformed(W)}}{\text{Charge transferred (Q)}}$$

A voltmeter measures electromotive force and potential difference. In the measurement of both quantities, energy per coulomb is calculated. So, both of them have the same SI. unit, i.e. volt. If current does not flow in the external circuit, the potential difference and electromotive force between two terminals are equal. Voltmeter in the first circuit shown in fig. 11.3 measures the e.m.f. of the cell, and the voltmeter in the second circuit, which is connected parallel to the load, measures the potential difference across the bulb.

When current is flowing in a circuit with an electric load, some electrical energy is used up within the battery. Thus, the potential difference between two poles of a battery is less than its electromotive force. For example, a battery with 3 V e.m.f. may produce 2.5V p.d. between the two ends of the load (A and B). That means the maximum energy provided by the battery to every coulomb charge is 3 J, but the bulb converts only 2.5 J of electrical energy into other forms of energy (heat and light) per coulomb charge.

The differences between electromotive force and potential difference are given below.

Electromotive force	Potential difference
It is the amount of electrical energy provided by the source to unit charge so that it can flow in the circuit.	It is the amount of electrical energy transformed when a unit charge flows in the external circuit.
It is independent of the external resistance connected in the circuit.	It depends on the external resistance connected to the circuit.
It is the cause of the potential difference.	It is the effect of e.m.f.

Questions for discussion:

i. In the commonly used dry cell, e.m.f. is indicated as 1.5 V. What does it mean?

ii. While using electrical appliances in a domestic circuit, why is one end connected to the live wire and the other to the neutral wire? What is the p.d. of the domestic circuit in general?

Ohm's law

Activity 11.3

Objective: To demonstrate Ohm's law

Materials required: Four dry cells of 1.5 V, a light bulb of 6 V, an ammeter, voltmeter, crocodile clips and conducting wires

Method:

1. Prepare an electric circuit.
2. Measure the potential difference (V) across one, two, three and four cells and also measure the current (I) in the circuit in each case.
3. Record the data in the table below. Also, draw a graph by plotting V on the x-axis and I on the y-axis.

No of cell	potential difference (V)	Electric current (I)	V/I = ...	Conclusion
1	....	....	....	

Discussion and conclusion: Discuss the nature of the graph and draw an appropriate conclusion.

A German scientist George Simon Ohm established a relation between the potential difference between two points of a circuit and the amount of electric current flowing through it. According to Ohm's law, the amount of current flowing through a conductor is directly proportional to the potential difference applied across the ends of the conductor provided that temperature and all the other physical conditions remain constant.

If a current 'I' flows through a wire when the potential difference applied across the ends of the wire is 'V' then Ohm's law can be stated mathematically as,

$$I \propto V$$

or, $\frac{V}{I} =$ Constant

or, $\frac{V}{I}$ (R) where R is the resistance of the conductor

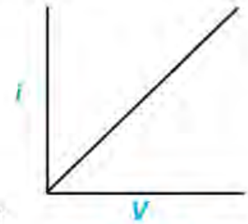


Fig 11.4.

Hence, resistance is defined as the ratio of potential difference to current.

Plotting V on the x-axis and I on the y-axis in a graph, we obtain a straight line. The slope of the straight line $\frac{V}{I}$ is equal to the resistance (R)

Electric resistance

When a thick copper wire and a thin copper wire of the same length are connected with a source of electricity, electric charges flow easily through the thick wire. When electric charges flow through a conductor, the conductor offers some obstruction. This obstruction is known as electrical resistance. The collision between the atoms of a conductor and the flowing charges on it creates resistance. The SI. unit of resistance is the ohm, named after physicist Simon Ohm. It is denoted by the Greek symbol omega (Ω). The fundamental units included in ohm (Ω) are given below:

$$R = V/I = \frac{\text{Energy/charge}}{\text{charge/time}} = \frac{\text{Force} \times \text{displacement}}{\text{charge}^2\text{/time}}$$

$$R = \frac{m \times a \times s}{\left(\frac{Q}{t}\right)^2 \times t} = \frac{m \times \left(\frac{v}{t}\right) \times s}{I^2 \times t} = \frac{m \times \left(\frac{s}{t}\right) \times s}{I^2 \times t^2} = \frac{m \times s^2}{I^2 \times t^3}$$

Substituting the symbol of physical quantities by their fundamental units in the above equation, we get:

$$\Omega = \frac{\text{kg x m}^2}{\text{A}^2 \text{ x S}^3} = \text{kgm}^2 \text{ A}^{-2}\text{S}^{-3}$$

Unit of mass 'kg', unit of distance 'm', unit of current 'A' and unit of time 's' are included in the unit of resistance. Hence, it is a derived unit.

1 Ωresistance: According to Ohm's law, $R = \frac{V}{I}$ $1\ \Omega = \frac{1\ V}{1\ A}$

If 1 A current is flowing through a conductor having a 1 V potential difference between its two ends, then its resistance will be 1Ω.

Example 2

An immersion rod used to heat water has 40 Ω resistance. It is connected to a power plug of 220V. Calculate the current flowing through it.

Fig 11.4

According to given question,

Potential difference (V) = 220 V

Resistance (R) = 40 Ω

According to Omhs Law,

$$\text{current (I)} = \frac{\text{Potential km/s (V)}}{\text{Resistance (R)}}$$

$$I = \frac{220}{40} = 5.5\ A$$

Fig 11.5: formula triangle (Ohm's law)

Current electricity passing through the immersion rod is 5.5 A.

factors affecting resistance

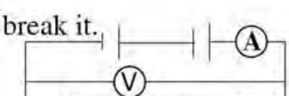
Activity 11.4:

Objective: To study the relationship between the length of the conductor and resistance

Materials required: Two dry cells of 1.5 V, bulb, ammeter, voltmeter, crocodile clips, conducting wires and a pencil

Method:

1. Take out the graphite rod from a pencil carefully. Try not to break it.
2. Prepare a circuit as shown in the figure.



3. Connect both ends of the graphite rod to one cell and measure the potential difference

(V) and current (I) in the circuit.

4. Now, connect both ends of the graphite rod to two cells and measure the potential difference (V) and current (I) in the circuit.

5. Slide any one clip slightly towards the middle part of graphite, and repeat steps 3 and 4.

S.N.	Distance between two clips in graphite rod (cm)	potential difference (V)	Electric current (A)	Resistance (Ω)
1a.				
1b.				
2a.				
2b.				

Discussion and conclusion: Calculate the ratio between V and I in both cases. Analyze the obtained result and draw an appropriate conclusion.

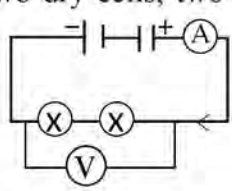
The resistance of a conductor depends on its length, cross-sectional area, temperature and composition. Between long and short wires of the same diameter, the longer wire has more resistance. The resistance of a thin wire is more than that of a thick wire. Increasing temperature of conducting wire increases its resistance. The resistance of the object depends on its composition. For example, between the copper wire and nichrome wire of the same shape, size and length, nichrome wire has more resistance. Although the resistance of a conductor depends upon many parameters, the V/I ratio always remains constant for the given physical conditions.

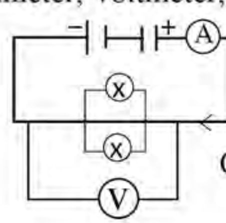
combination of resistors

Objective:

Materials required: Two dry cells, two bulbs, an ammeter, voltmeter, crocodile

Circuit A





Circuit B

clips and conducting wires

Method:

1. Connect the bulbs in series combination one after another for the first circuit as in circuit.
2. Connect the bulbs in parallel combination for the second circuit as shown in circuit B.

3. Measure potential difference (V) and electric current (I) in each circuit. Record the data in the table below.

Circuit	potential difference across each bulb		potential difference between two bulbs (V)	Relation between V_1, V_2, and V
	First bulb (V_1)	Second bulb (V_2)		
A	....	....	....	V = …
B	....	....	....	

Circuit	Current through each bulb		Current through the total circuit I	Conclusion
Relation between I_1, I_2, and I	First bulb (I_1)	Second bulb (I_2)		
A	....	....	....	I = ...
B	....	....	....	

Discussion and conclusion: Analyze the obtained data and draw a suitable conclusion.

Add a bulb to each circuit above and observe the brightness of the bulbs. Is there any change? Discuss the cause based on your observations.

Series combination of resistors

In a series combination, resistors are joined end-to-end, and the first and the last resistor is connected with the electric source. There is only one path for the current in series combination. So, the same current flows through each of them, but the p.d. is divided in each resistor. If an error occurs in any one resistor in this type of combination, the circuit becomes open and all resistors stop working. Separate switches cannot be used for each resistor in this combination. Such type of combination is used in decorative lights such as the ones used in Deepawali.

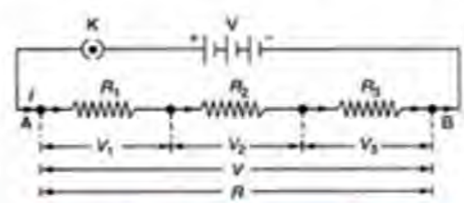


Fig 11.6 Series combination of resistors

Suppose V_1, V_2 and V_3 are the potential difference across three resistors respectively. Their respective resistances are R1, R2 and R3. The total resistance of the circuit is R.

Since p.d. is divided in each resistor, it can be written as:

$$\mathbf{V = V_1 + V_2 + V_3}$$

From the definition of resistance,

$$IR = IR_1 + IR_2 + IR_3$$

$$R = R_1 + R_2 + R_3$$

Hence, in a series combination, the total resistance of the circuit is the sum of individual resistances of the resistors.

Parallel combination of resistors

In a parallel combination, two or more resistors are connected with the electric source separately. All resistors have the same potential difference, and there is a separate path for current to each resistor. So, the current is divided into each resistor. If an error occurs in any one resistor in this type of combination, the flow of current continues in other resistors and they continue to work. Separate switches can be used for each resistor in this combination. Such type of combination is used in domestic wiring for different electric loads.

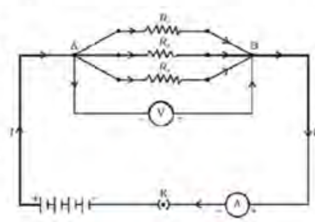


Fig 11.7 Parallel combination of resistors

Suppose I_1, I_2 and I_3 are the currents flowing through three resistors respectively. Their respective resistances are R1, R2 and R3. The total resistance of the circuit is R. Since the current is divided in each resistor, it can be written as

$$I = I_1 + I_2 + I_3$$

From the definition of resistance,

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\therefore \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Hence, in parallel combination, the reciprocal of the total resistance of the circuit is the sum of the reciprocal of individual resistances of the resistors.

Example 3:

If resistors of 10 Ω, 20 Ω and 30 Ω resistance are connected with a 12 V battery at first in series combination and then in parallel combination. Calculate the current in both cases and compare these values.

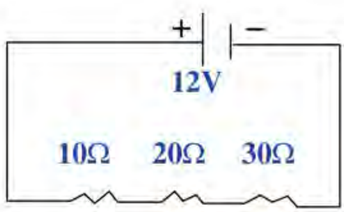
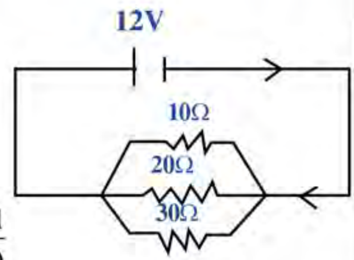
According to the given question,

Resistance of the first resistor (R1) = 10 Ω

Resistance of the second resistor (R2) = 20 Ω

Resistance of the third resistor (R3) = 30 Ω

Potential difference (V) = 12 V

<table>
<tr><th>Series combination</th><th>Parallel combination</th></tr>
<tr><td>कुल अवरोध $R = R_1 + R_2 + R_3$
$R = 10\Omega + 20\Omega + 30\Omega = 60\Omega$
विद्युत् धारा $I = \frac{V}{R} = \frac{12}{60} = 0.2\ A$
श्रेणीक्रम जडानमा कुल अवरोध 60Ω हुन्छ र परिपथमा विद्युत् धारा 0.2 A हुन्छ ।

</td><td>कुल अवरोधका लागि
$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$


$\frac{1}{R} = \frac{1}{10} + \frac{1}{20} + \frac{1}{30}$
$\frac{1}{R} = \frac{6+3+2}{60} = \frac{11}{60}$
$R = 5.45\ \Omega$
Current (I) $= \frac{V}{R} = \frac{12}{5.45} = 2.202\ A$
The total resistance is 5.45 Ω and the current in the circuit is 2.202 A.</td></tr>
<tr><td colspan="2">If we change the series combination of resistors to the parallel combination, then the total current in the circuit increases. In the given example, the current increased by approximately 11 times in the parallel combination than that in the series combination.</td></tr>
</table>

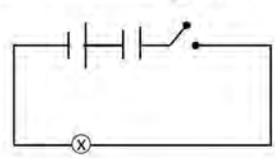
Heating effect of electric current

Activity 11.6

Objective:

Materials required: Two dry cells, bulb of torchlight, switch and conducting wires

Method:



1. Prepare a circuit connecting the materials given above.
2. Switch on the circuit, and turn it off after a while.
3. Observe the temperature of the bulb.

Discussion and conclusion: Discuss the result and its cause.

Electrical energy is converted into other forms of energy due to the resistance of the electric load. The resistance of Nichrome wire used in electric heaters transforms the electric energy into thermal energy. Nichrome wire in a heating element is a mixture of Nickel and Chromium. It has a high melting point. It does not oxidize at temperatures up to 9000C in presence of oxygen. Thus, it is suitable for use in heating appliances. We can convert electrical energy into thermal energy in a short period by using a resistor. A thin filament of Tungsten wire is used in a filament bulb to convert electrical energy into heat and light energy. The conversion of electrical energy into heat by using electric loads is known as the heating effect of electric current. Electric heater, electric kettle, immersion rod, electric iron, and rice cooker are examples of appliances based on the heating effect of current. The heating effect also depends on the amount of current in a circuit. A sudden increment in p.d. of the circuit may overheat the conducting wire, causing it to melt.

electric heater

electric iron

rice cooker

electric jug

Fig. 11.8

electric power

Activity 11.7

The power of the appliance shown in the figure is written as 145 W. Note the power of electric appliances (LED bulb, fan, etc.) used in your school. Fill up the collected data in the table below.

Appliance	Power (P)	Amount of energy transformed in 1 second
LCD TV	145 W	145 J
.....	.....	......

Among the fully functional appliances you have observed, which one converts more electrical energy into another form in 1 second?

Electrical energy is converted into other forms by the electric load. While using an appliance, the amount of energy converted into another form in 1 second is the power of the appliance.

$$\text{ljElectric Power } (P) = \frac{\text{Energy transformed by the appliance } (E)}{\text{Time } (t)} \quad \text{.............(i)}$$

The flow of charge caused by the potential difference across the two ends of the appliance makes electrical energy change into other forms.

According to the definition of potential difference,

$$\text{Potential differences } (V) = \frac{\text{work done in moving charge across two ends of the appliance } (W)}{\text{Charge } (Q)}$$

Work done by the appliance (W)=Q×V=electrical energy transformed by the appliance

From equation (i),

$$\text{Electric Power } (P) = \frac{QV}{t}$$

$$\text{Electric Power } (P) = IV \qquad \text{because electric current } (I) = \frac{Q}{t}$$

Example 4:

Rohan found the power of the rice cooker in his kitchen to be 900 W. Find the current required to operate the rice cooker. (P.d. of the domestic circuit is 220 V).

According to the given question,

Potential difference of the circuit (V) = 220 V

Power of rice cooker (P) = 900 watt

Fig 11.9

According to the formula,

Power (P)=V×I

$$\text{Current } (I) = \frac{P}{V}$$

$$\text{Current } (I) = \frac{900}{220} = 4.09 \text{ A}$$

4.09 A current flows in the coil of the rice cooker.

Electricity consumption

The amount of electrical energy transformed while using electric appliances is called electricity consumption. The electricity consumption by the different instruments is measured by an electric meter. The commercial unit of electricity consumption is a kilowatt-hour (kWh). A one-kilowatt hour is energy consumed by an electrical device of one-kilowatt power in one hour. In common terms, the one-kilowatt hour is simply called a unit.

Fig 11.10: Electric meter

$$
\begin{aligned}
1 \text{ unit} &= 1 \text{ kWh} \\
&= 1000\text{w} \times 3600\text{s} \\
&= 3.6 \times 10^6 \text{ J} \\
&= 3.6 \text{ MJ}
\end{aligned}
$$

According to the definition of electric power, energy consumed by electrical appliances depends upon their power and the duration of their use.

Energy converted by the appliance (E) = Electric power (P) x Time (t)

Electricity bill

Activity 11.8

Fill up the information about the electrical appliances used in your house in the table below.

According to the information, calculate the daily electricity consumption and monthly electric bill.

Appliance	CFL lamp	LED bulb	......	......	....
Power (P) in KW	15 W=15/1000 kW				
Number (n)					
Time of daily usage in hr (t)					
Electricity consumption = P x n x t					

Add the daily electric consumption of all appliances. Multiply it by 30 to obtain monthly electricity consumption. Find the monthly electric bill by multiplying the monthly electricity consumption with a unit cost of electricity.

We use electrical appliances and pay the bill for electricity consumption. The consumption unit is calculated by subtracting the reading of the previous month from the reading of the present month shown on the electric meter. The number of units is multiplied by the unit cost to calculate the electric bill. The electric energy consumption is calculated by using the formula;

Where 'P' is the power of each load (in kW), 'n' is the number of loads, and 't' is the time for which the load was operated (in an hour).

Energy consumed (E) = $P \times n \times t$ unit (kW h)

Example 5

A house uses 6 CFL bulbs of 15 W for 5 hours daily, 4 LED lamps of 7 W for 6 hours daily, 2 heaters of 1 kW for 2 hours daily, a rice cooker of 900 W for 50 minutes daily and an iron of 800 W for 30 minutes weekly. Calculate the monthly electricity consumption. What will be the monthly bill if the cost of energy per unit is Rs 10?

According to the given question,

Appliance	CFL bulb	LED lamp	heater	Rice cooker	Iron
Power (P)	15 W = 15/1000 kW	7 W = 7/1000 kW	1 kW	900 W =900/1000=9/10 kW	800 W=800/1000=8/10 kW
Number (n)	6	4	2	1	1
Time of daily usage (t)	5 h	6 h	2 h	50 min = 50/60=5/6 h	30 min per week=0.5/7 h

According to the formula,

Daily electricity consumption by CFL = P x n x t = 15/1000 × 6 × 5 = 0.45 kWh

Daily electricity consumption by LED = P x n x t = 7/1000 × 4 × 6 = 0.168 kWh

Daily electricity consumption by heater = P x n x t = 1× 2 × 2 = 4 kWh

Daily electricity consumption by rice cooker = P x n x t = 900/1000×1×50/60=0.75 kWh

Daily electricity consumption by iron = P x n x t = 800/1000×1×0.5/7 = 0.057 kWh

Total electricity consumption in a day, = 0.45+0.168+4+0.75+0.057 = 5.425 units

Energy consumption in a month = 5.425 units × 30 = 162.75 units

Amount of electric bill = Rs.10 × 162.75 = Rs.1,627.50

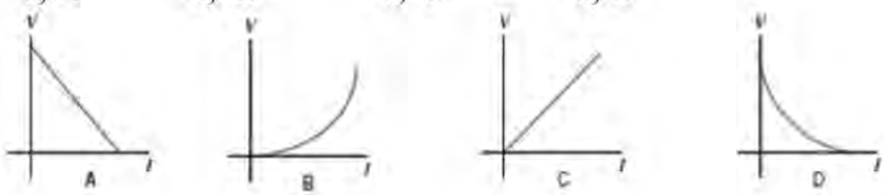
Hence, the monthly electricity consumption of the house is 162.75 units and the monthly bill is Rs 1627.50.

Exercise

1. Select the best answers.

i. Which of the following graph demonstrates Ohm's law?

a) A b) B c) C d) D



ii. From which substance is the heating element in the electric heater made from? substances?

a) tungsten b) copper c) iron d) nichrome

iii. Which of the following is the reason for combining electric loads in parallel combination in the domestic circuit?

a) to flow the same current in all loads

b) to connect all loads in the same potential difference

c) to maintain the same resistance in the circuit

d) to increase the resistance in the circuit

iv. 220 V, 0.5 A is written on bulb A and 220 V, 0.45 A on bulb B. Which of the following statements is true when both bulbs are working at their full capacity?

a) B consumes more electricity per hour than A.

b) A transforms more energy per second than B.

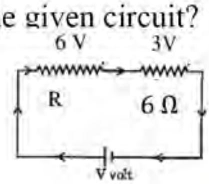
c) B produces more heat per second than A.

d) When B is used more than A, the electric bill will be larger.

v. Which of the following is the value of R in the given circuit?

a) 6 Ω b) 12 Ω

c) 18 Ω d) 24 Ω



vi. How much electric energy is transformed when1 kW heater is used for 1 hour?

a) 3.6×10^5 J   b) 3.6×10^4 J

c) 3.6×10^3 J   d) 3.6×10^6 J

2. Differentiate between.

a) Electromotive force and potential difference

b) Parallel combination and series combination of electric loads

3. Give reason.

a) A bulb connected in series to two cells is brighter than a bulb connected to a single cell.

b) Nichrome wire is used in the heater.

c) Parallel connection of loads is used in the domestic circuit.

4. Answer the following questions.

a) Define electric current.

b) What is electromotive force? Is it similar to other forces in reality? Explain it.

c) Mention the meaning of 1.5 V written on a dry cell.

d) Mention Ohm's law and establish the relation V = IR.

e) What is electric resistance? Define 1 Ω.

f) Between thick and thin wires of the same length, which one has more resistance?

g) What is meant by the heating effect of electricity? Mention any two appliances based on it.

h) What is electric power? If power is rated as 5 W on a mobile phone, write its meaning.

i) Suraj removed a bulb from a circuit connected to a 3V source, and the remaining bulbs glowed brighter. Identify the type of connection of bulbs in that circuit. Give a reason for your answer. Also, draw the diagrams of the circuit.

j) Two identical bulbs, two dry cells, and some connecting wires are given to you. How do you connect these to obtain the maximum light? Explain it with a suitable circuit diagram.

5. Solve the following numerical problems:

a) 10 mA current is flowing in a conducting wire. Calculate the time for 0.2 C charges in it. (20 s)

b) 5 mA current is flowing in a conducting wire. Calculate the charge flowing through the circuit in 1 minute. (0.3 C)

c) 3 V, 500 mA is mentioned in the torchlight. Calculate the power and resistance of the torchlight. (6 Ω, 1.5 W)

d) A heater of 1100 W and a CFL of 11 W are connected in a domestic circuit of 220 V. If the resistance of conducting wire is negligible, calculate the current passing through each appliance and their resistances.

(Heater - 5 A, 44 Ω, CFL- 0.05 A, 4400 Ω)

e) The given figure shows an electric kettle which is used to heat water. Observe its sticker. If the potential difference in the domestic circuit is 220 V and the kettle is connected to the circuit, what will be the maximum current passing through it? If it takes 4 minutes to boil water, calculate the maximum number of units of electricity consumed. (13.63 A, 0.2 units)

f) A list of electric appliances connecting with a domestic circuit, their power and duration of usage are given below:

i. 10 LED bulbs with 7 W power for 6 hours per day

ii. A TV with 150 W power for 8 hours per day

iii. 4 fans with 150 W power for 10 hours per day

iv. An iron with 750 W power for 40 minutes per week

Calculate the monthly electric consumption. If the cost per unit of electricity is Rs. 10, what will be the electric bill in a month? **(Ans: 230.7 kW h, Rs. 2037)**

Project work

Survey any five households in your locality to study the daily electricity consumption. Collect the data and tabulate it as given below. Discuss the result in your classroom.

House No.: ....

Electric load	Electric power (kW)	Number (n)	Duration (t)	Electricity consumption ($P \times n \times t$)	Electric bill
....	....	....	....	.... kWh	....

12

The Universe

Fig 12.1: Milkyway Galaxy with its reflection on the surface of Gosainkunda Lake

Source : *YEVHEN SAMUCHENKO*

The universe is a boundless expansion of space. All matter, energy and time are contained in the universe. Infinite stars of the Milky Way Galaxy, visible to the naked eyes in a clear night sky, are shown in fig 12.1. Heat and light are produced in these stars as well, just like the Sun. They all have a certain life. Different incidents like the explosion of stars and the revolution of stars with another body having infinite gravity can be seen by telescopic observation. Scientific facts about the universe are discovered from such observations.

Life cycle of stars

Activity 12.1

The adjoining figure of the Sun shows the core in which energy is produced by nuclear fusion, the radiating zone in which energy is distributed outside by conduction and radiation, and the convective zone in which energy is transmitted through convection.

Fig 12.2: The inner structure of the sun

Star	Distance from the solar system	Size (radius)	Mass	Colour	Temperature of the surface	Age
Sun	-	695,700 km	2×10^{30} kg	Yellow	5778 K	4.6 billion years
Sirius A	8.6 light year	1.711 times of the sun	2.063 times the solar mass	Bluish white	9940 K	24.2 million years
Proxima Centauri	4.2 light year	0.1542 times of the sun	0.122 times the solar mass	Faint red	3042 K	4.2 billion years

Note: Sirius A, nearer to the Orion constellation, is the brightest star seen in the night sky. Proxima Centauri is the nearest star from the Sun. (1 light year=9.46×10^{15} m).
Study the given table and discuss the given questions.

i. How many years ago was the Sun formed?
ii. Are the size, temperature, colour and age of the stars in the universe different from that of the Sun?
iii. The core of the Sun in which heat is produced is separate from other parts. What may be the structure of other stars like?
iv. Will the heat be produced by the core of the sun continuously forever?

The Sun is a star of our solar system. Stars are the celestial masses that produce light and heat energy. There are uncountable stars in the universe. Light and heat are formed in the star due to the fusion of hydrogen atoms into helium. The fusion of atoms is a continuous process in stars from its birth (formation) to death (explosion). The process of formation of a new star starts after the explosion. So, stars have a life cycle similar to the life cycle of living beings on Earth. According to the stages of the formation and phases of the life cycle, the size, shape, colour and temperature of stars differ from each other.

Birth of a star

Fig 12.3: Orion nebula
Credits: NASA, ESA and the Hubble Space Telescope Orion Treasury Project Team

Stars are born in a nebula. Nebula is a giant cloud of dust and gases. Nebula mainly contains hydrogen and helium gas. These gases and dust particles are formed from the explosion of other stars. Some nebulas in the universe can be observed through powerful telescopes. For example, the Orion nebula nearer to the Orion constellation can be observed easily.

During the formation of a star, dust particles and gases in the nebula collect into a spherical mass due to gravitational force. Its size increases by attracting additional gas and dust particles from its surroundings. The increasing mass increases the pressure at its centre. This increases the temperature of the core. The huge mass formed by the collection of gases and dust particles is protostar. It takes millions of years to form a protostar. When the temperature and pressure of the core of the protostar are very high, nuclear fusion starts and a star is born. From the nuclear fusion reaction in the newly formed star, heat and light are produced for billions of years.

There are numerous masses having hydrogen and helium in the universe. But all these masses cannot turn into a star because they do not meet the required minimum temperature and pressure to start the nuclear fusion. A temperature of about 107 K is required to start nuclear fusion.

Death of a star

The core of a newly formed star contains plenty of hydrogen for the thermonuclear fusion to continue for a very long time. However, as the age of stars increases, the hydrogen of its core is continuously changing into helium. Finally, the core runs out of hydrogen. Then, nuclear fusion enters another stage. In this stage, atoms of helium fuse to form carbon atoms. Thus, heavier atoms are continuously formed in the core. However, since the amount of nuclear fusion is decreasing, the temperature of the core gradually decreases. As the temperature decreases, the colour of the star also changes. Hence, the colour of a star and its temperature indicate its age. The newly born star is blue, and the colour of the star on its final stage is red. The colours of stars and their temperature are given below:

Colour of star	Blue	Yellow	Orange	Red
Temperature	**11,000°C- 25,000 °C**	**5,000°C- 6,000°C**	**3,500°C- 5,000°C**	**3,000°C- 3,500°C**

Due to the heat generated in the core, the gases of its outer layer expand. Hence, the size of the star increases with age. Since the older stars are red and seem to be very large, they are also known as Red giants. A red giant formed from a very large star is called Red Super Giant. Smaller stars may not form red giants.

During the expansion of gases in the outer layer in very old stars, the outer layer cannot be attracted enough by the core, and an explosion occurs. Such an explosion is called a nova. If the explosion is tremendous, it is called a supernova. After the explosion, dust and gases from the outer layer of the star are scattered into the universe. Those scattered dust and gases form another nebula. Only the core remains after the explosion of the outer layer. What happens after that depends on the initial mass of the star?

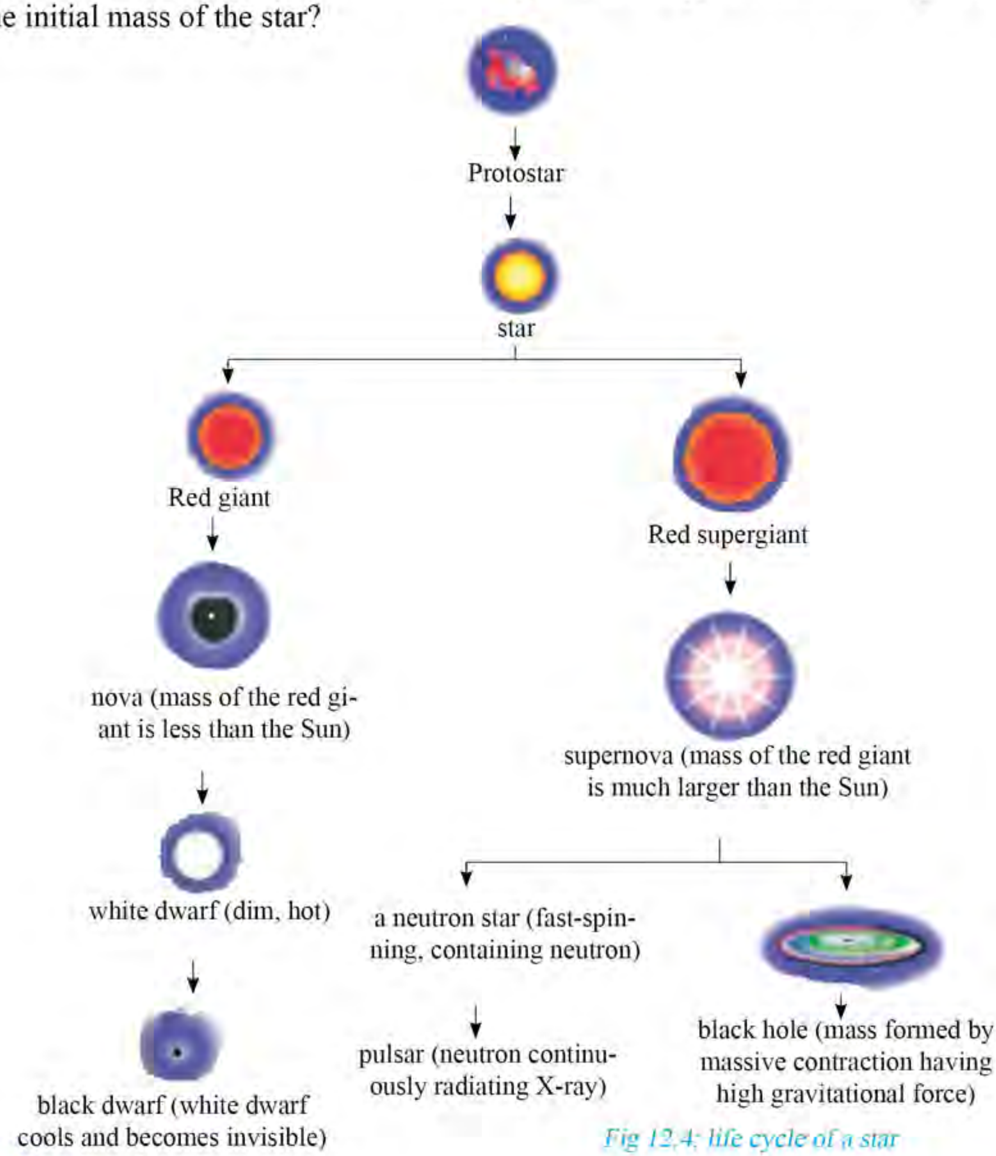


Fig 12.4: life cycle of a star

a. If the mass of the star is less than the solar mass, nuclear fusion in the core stops after a certain time. Then, it converts into a small mass without light. It is called a black dwarf.

b. If the mass of the star is almost equal to the solar mass, nuclear fusion in the core continues for a long period. This small mass is called a white dwarf.

c. If the mass of the star is 1.4-5 times the solar mass, then its core contracts into a mass of smaller size containing only neutrons. It is then called a neutron star.

d. If the mass of the star is more than 5 times the solar mass, the core contracts into negligible volume and excessive mass. It has such a large gravitational force that even light cannot escape from it. It becomes an invisible mass known as a black hole. Scientists have found that it emits X-rays.

scientific facts about the universe

Although concrete evidence of the origin of the universe is unavailable, expansion of the universe indicates that the universe originated from the explosion of highly compact mass. The explosion is known as the Big Bang. In 1990 AD, Belgian scientist Georges Lemaitre found that galaxies including the Milky Way are moving away from each other. According to this theory, the universe originated about 13.8 billion years ago. Stars and galaxies cover only a small portion of the mass of the universe. Hence, the universe is formed from matter and energy. No mass of the universe is at rest. They are moving constantly around a certain reference point. The moon revolves around the earth and the earth revolves around the Sun. At the same time, the Sun moves around the galactic centre.

There are numerous galaxies in the universe. Andromeda is a galaxy near the Milky Way. It is about 2.5 million light-years away from the Earth. The stars in the galaxy are of different ages. The solar system is situated at one end of the Milkyway and originated about 4.6 billion years ago. Zircon crystal is the oldest matter ever found on the Earth. Its age is calculated to be approximately 4.4 billion years.

Other planets similar to the Earth in shape, size and habitable zone have been found in the system of different stars of the universe. TOI 700 D planet, which revolves around the star TOI 700 in the Dorado constellation, was discovered on January 5, 2020. This planet is about 101.4 light-years away from the Earth. Research on the universe and various other areas helps in the discovery of new information.

Questions: Are scientific theories changing with time?

Cosmology is the branch of science related to the study of the origin and evolution of the universe. With the development of the technology used for universal studies, new facts are being discovered. Some facts displace old theories. For example, the geocentric theory established by ancient science is displaced by the heliocentric theory of modern science. Before 2006 AD, Pluto was recognized as a planet of the solar system. The norms about the planets were established in 2006 AD, and the astronomical mass named Pluto was removed from the list of planets. As new studies, discoveries and research are constantly going on in the field of science, science is progressing and changing.

Scientists have given different hypotheses about the future of the universe. The expansion of the universe stops after a certain limit and contraction starts. All the matter will contract to a point and Big Crunch will occur. After the big crunch, another Big Bang will be started

Units to measure distance between celestial bodies

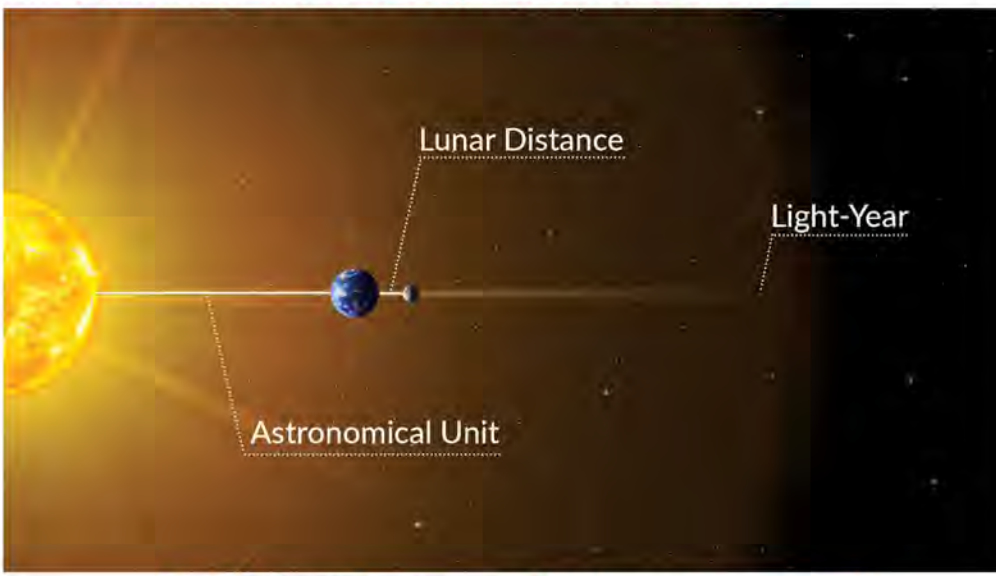


Fig 12.5: distance between some celestial mass (not in actual scale)

Question: Fig 12.5 has tried to show the distance between celestial bodies. Can the distance between the Earth and the Moon, and the distance between the Sun and the Moon be expressed in units like meter, kilometer, etc. as in our daily life?

The celestial bodies are very far from each other. It is impossible to measure the distance between these bodies from methods and units used in our daily life. So, different units are determined to measure these distances. The value of these units is many times more than a meter. Some units are used to measure the distance between celestial bodies, their definition, symbol and their relationship with the meter are given below in the table.

Unit	Definition	Symbol	Value in meter
Astronomical unit	The average distance between the Earth and the Sun is known as the Astronomical unit.	AU	1 AU = 1.5×10^{12} m
Light Year	The distance travelled by light in one year is called one light-year.	lyr	1 lyr = 9.46×10^{15} m

Astronomical units are used to measure the distance between various planets. For example, Mars is at a distance of about 1.5 AU from the Sun. Distances between the Sun and various planets are shown in fig 12.2. Similarly, the distance between stars and galaxies is measured in light-years. The kilometer is too small to measure such large distances, so the light-year is the unit of choice. For example, the star Proxima Centauri is about 4.246 light-years away from the earth.

Calculation of meters in 1 light year

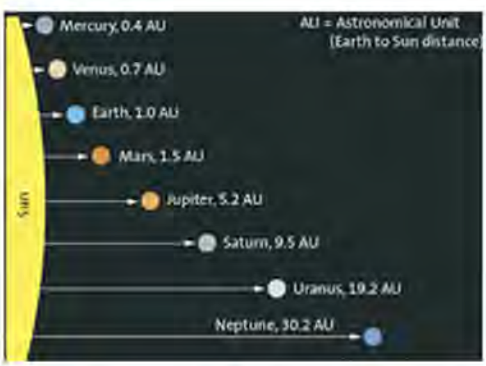


Fig 12.6: distance of different planets from the Sun **www.jpl.nasa.gov/edu**

Fig 12.7: the star closest to the earth after the Sun
Source European Southern Observatory (ESO)/ BBC

The speed of light is 3×10^8 m/s. So, one light-second is equal to 3×10^8 m. There are 365 days in 1 year, 24 hours in 1 day, 60 minutes in 1 hour and 60 seconds in 1 minute. Thus, the distance covered by the light in one year is

1 light year = $365 \times 24 \times 60 \times 60 \times 3 \times 10^8$ m = 9.46×10^{15} m

Some national and international organizations working in the field of astronomy

Nepal Academy of Science and Technology (NAST)

NAST is an autonomous body established to promote science and technology in Nepal in 2039 BS. This is a national organization involved in research in the field of science and technology. This organization has four major objectives:

- advancement of science and technology for all-round development of the nation
- preservation and further modernization of indigenous technologies
- promotion of research in science and technology
- identification and facilitation of appropriate technology transfer

NAST has been promoting research and promotion of different fields of science and technology. It is currently working to establish the National Space Research Centre for study and research on astronomy.

Some international organizations working in the field of astronomy

International Astronomical Union (IAU)

The International Astronomical Union is an international non-governmental organization founded in 1919 in Paris, France. It aims to promote education, research and access necessary for the development of science with worldwide support. It spans more than 100 nations with the participation of about 12,131 renowned astronomers.

IAU conducts scientific meetings as its main role. Every year, IAU organizes an international IAU general assembly, which gives recognition based on certain criteria to organizations working in the field of astronomy worldwide. IAU names and defines celestial bodies. Based on the new definition of planets by IAU, Pluto was removed as a planet and categorized as a dwarf planet on 24 August 2006 AD. Similarly, IAU also defined Ceres (considered to be the largest asteroid) as a dwarf planet.

Fig 12.8: IAU general assembly, 2019

International School for Young Astronomers (ISYAs), established in 1967, is one of the projects of IAU. ISYA aims to broaden the perspective of participants in astronomy by exchanging experiences through international seminars. IAU has conducted many activities in the field of education. It has been working to spark interest in science and mathematics at the school level and encourage research at the bachelor's level.

National Aeronautics and Space Administration (NASA)

NASA is the pioneer organization working worldwide in the field of space exploration. It was established under the United States space program in 1958 AD. When Russia and USA were competing against each other regarding space research, NASA started multiple projects of space research. When Neil Armstrong and Buzz Aldrin landed on the moon on 20 July 1969, NASA became the first organization to take a man to the Moon. NASA builds and launches various satellites and spacecraft into space for study and research purposes. It has launched International Space Station for the scientific and astronomical studies. International Space Station revolves around an orbit at the height of about 354 km from the Earth. Under the space search mission, NASA has already sent a space probe to study various planets, satellites, dwarf planets, asteroids, comets and the Sun.

Parker Solar Probe sent by NASA for the study of the Sun entered the corona layer of the sun in December 2001 AD. This has enabled the study of the particles and magnetic field of the Sun. Under the "Possibility of life outside the Earth search mission," NASA has landed a robot on the surface of Mars for exploration. With plans to bring the samples excavated from Mars back to the Earth for research, the Perseverance rover landed on Mars surface on 18 February 2021AD.


Fig 12.9: Perseverance rover

NASA has launched various telescopes under space study missions. The Hubble Space Telescope launched in 1990 AD has made it easy to unravel many mysteries of the universe. In collaboration with the European Space Agency and Canadian Space Agency, NASA has built a modern James Webb space telescope that can identify infrared rays. It was launched on December 25, 2021 AD. We can find new information about different cosmological mysteries with the help of this telescope.

Project work

Find out about the works of national and international organizations involved in the study of astronomy, and prepare a report.

principle of conservation of energy

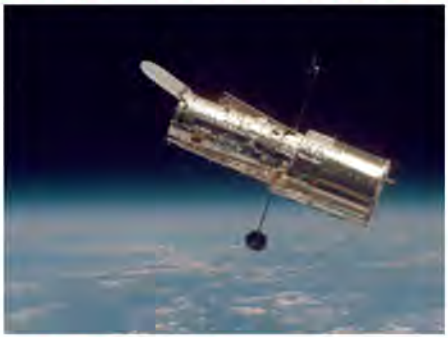


Fig 12.10: Hubble space telescope

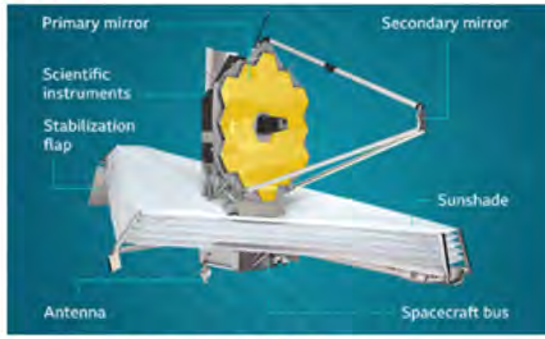


Fig 12.11: James Webb space telescope

Activity 12.2

Discuss the transformation of energy in some living and non-living objects in the universe after their lifespan:

Living / non-living object	Lifespan	Transformation of mass and energy after death/ destruction
Human		
Wood		
Stars		Blends back to the universe after the death of the star

The elements present in the earth are the same matters dispersed during the origin of the universe. All the energy and matter present in the universe have been here ever since the origin of the universe. Energy can neither be formed nor be destroyed but can be transformed from one form to another. From the lifecycle of living beings, the water cycle, the chemical cycle on the Earth, and the lifecycle of stars, we can conclude that all the objects of the universe have a certain lifespan. After that, they are absorbed in the universe in other forms of energy and matter.

Project work

There is more influence of astrology than astronomy in our society. By consulting different reference materials, write an essay on this topic. Discuss it in your classroom.

Exercise

1. Select the best answers.

a) Which is the main element found in the nebula?

i) Helium ii) Carbon iii) Nitrogen iv) Hydrogen

b) What is the large explosion that occurs during the death of a star called?

i) pulsar ii) neutron star iii) supernova iv) black hole

c) Which is the correct order for the lifecycle of the star?

i) nebula → protostar → star →red giant → supernova → black dwarf

ii) nebula → protostar →star → supernova→ red giant →black hole

iii) nebula → protostar →star → red super giant → supernova →black hole

iv) nebula → protostar →star →red supergiant → supernova →white dwarf

d) Which of the following fact is related to the universe?

i) The universe expands to a certain limit.

ii) All matters and energy of the universe originated from a common mass.

iii) The amount of energy in the universe is changing.

iv) The amount of energy decreases when the matter is destroyed.

2. Differentiate between:

a) Protostar and star

b) Red giant and red supergiant

c) Nova and supernova

Give reasons:

a. Nebula is also known as a stellar nursery.

b. All stars are not of the same colour.

c. A black hole is invisible.

d. The gaseous giant planet Jupiter of the solar system is also known as a failed star.

4. Answer the following questions.

a) What is a nebula?

b) What is a black hole?

c) Explain, with a figure, the life cycle of a star.

d) Explain the death of the Sun after the fuel finishes.

e) Mention some scientific facts about the universe.

f) Why are the units of distance like a light year and astronomical unit used in astronomy?

g) Describe the condition of cosmological study in Nepal.

h) Describe the role of NASA in astronomy.

13 Information and Communication Technology

Expansion of telecommunication in three rural municipalities of Jajarkot district

Fig: 13.1 Symbol receiver and transmitter of telecommunication

Launching Nepali satellite (Nepalisat-1), Nepal in astrologic age

Fig: 13.2 First satellite of Nepal launched from Virginia of America

Satellite radio collar has set in Dhrube Elephant

Figure: 13.3 Setting radio collar in neck of elephant

Changed version of TV due to internet

Figure: 13.4: Broadcasting Nepal television through three means terrestrial, satellite and internet

Activity 13.1

News headlines given above are taken from different online news portals which are related to communication technology. Open a browser (browser-e.g. chrome) in a computer which has the internet and search these news by typing the key words in the search engine (search engine: www.google.com). Discuss about the types of technology, reason of uses, advantages etc. based on the information obtained after reading the related news.

We are in the age of Information and Communication Technology-ICT. With the speedy development of ICT, telephone, cell phone, fax machine, computer and internet has connected different places of the world through the medium of communication. Sound, word, figure, video etc. which are used for communication, can be stored in computers, then transferred and used in distant places due to the internet. ICT is a medium which can store large amounts of information, process data and communicate information by the help of electronic devices. Development of ICT has become more modernized by the use of communication satellites.

Artificial satellite and its application

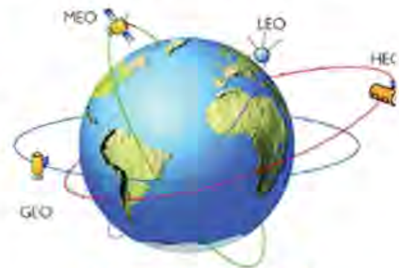


Figure: 13.5 orbit of artificial satellite

The bodies which revolve around the earth in a particular orbit are called satellites. Artificial satellites are the objects made by man which revolve around the earth. They are taken up to a certain height keeping them in the rocket and are launched at a certain speed in the perpendicular direction to the gravity. Then, it revolves around the earth continuously remaining at that height. Due to lack of atmospheric friction, the artificial satellite does not need additional energy for continuous revolution. The solar energy conducts computers and other equipment inside it.

> The first artificial satellite is Sputnik-1. The USSR had launched it on October 4, 1957.

The relationship between the satellite and ground station present on earth is established through the microwave. Satellite gets a signal from the ground station which is called an uplink signal. The transmitter present in the satellite amplifies the wave into energetic waves and returns back to the earth. The signal is called a downlink signal.


Figure: 13.6: uplink and downlink

Orbit of artificial satellite

Low Earth Orbit	Medium Earth Orbit	Geostationary Earth Orbit
(LEO) – (180 km-2,000 km)	(MEO) – (2,000 km-35,786 km)	(GEO) –35,786 km)

Activity: 13.2

Collect information about artificial satellites by the help of audio-visual materials and fill the following table.

Orbit	Characteristics	Purpose	Example
Low Earth Orbit-LEO	....	....	....
Medium Earth Orbit-MEO	....	....	....
Geostationary Orbit-GEO	....	....	....

On the basis of objectives, satellites are launched in various orbits. Satellites are launched in Low Earth Orbit to observe earth, to take photos of earth surface, to do scientific research. This orbit is near to the earth surface, so it takes a very short time to revolve around the earth. Due to this, the satellite remains for a very short time above the particular place of the earth and can observe many places even in a day. The International Space Station-ISS, which is revolving at 408 km from the surface of the earth, is the LEO satellite. It completes a round in about 90 minutes. It is a scientific laboratory and scientists do scientific experiments and research living in it for months.

The navigation satellites, which are launched at about 20,200 km, take approximately 12 hours to revolve at medium earth orbit. To access above all parts of the earth, 24 navigation satellites are launched as the figure given alongside. Location of the objects of the earth can be found by the help of a navigation satellite. This system is called Global Positioning System-GPS.

Figure: 13.7 Satellite network in MEO

Artificial satellites present at Geostationary Earth Orbit above the equator revolve the earth in 23 hours 56 minutes and 4 seconds. This is the time taken by the earth to rotate in its own axis (rotational period). Due to this, satellites are always relatively stationary with the earth surface. These satellites help to transfer signals of television, telephone, mobile and internet in telecommunication. LEO and MEO also communicate with ground stations by the help of satellites. Many countries of the world have launched communication satellites at GEO.

Figure 13.8 Applications of satellite

NepaliSat-1

Activity:13.3

Discuss the information collected by using audio-visual materials about first satellite of Nepal

NepaliSat-1 is the first satellite of Nepal. This satellite was constructed with the economic assistance of Nepal Academy of Science and Technology (NAST). Aavash Maskey, who is studying space technology and Hariram Shrestha who is doing masters in electrical engineering at Kyutech University constructed the satellite. The mass of this cubical nanosatellite is 1.33 kg. It was launched on 18th April, 2019 from the Virginia of USA. After a month, on 17 June 2019, the satellite had left at about 400 km from the earth surface by international space station. It revolved around the earth in 90 minutes. It remains above the earth approximately 6-10 minutes. It was launched to take photos of geo-structure, forests, glaciers, mountains, and streets of Nepal.

Figure: 13.9 NepaliSat-1

Use of information and communication technology

Activity 13.4

For what purposes are magazine, radio, television, telephone, fax, mobile, phone, Wi-Fi, email, internet, GPS etc. used in your daily life? Discuss their uses in the classroom and prepare a poster or presentation as a group work. Present the prepared material in the classroom.

Magazine, radio and television

Magazines provide information about your surroundings and other different parts of the world and provide general knowledge as well. Economic activities, political incidents, game activities, entertainment, including knowledgeable news and articles are published in it. Out of them, we can get information by reading the subject matter of our own interest. Radio is more accessible than magazines to get information. Since the radio waves spread through electromagnetic waves in the sky, notices, news, knowledge based subject matters,

चित्र 13.10.

songs for entertainment; stories, poem, etc. are broadcasted very fast and they reach to the audiences.

Italian Guglielmo Marconi had proved for the first time that the radio waves signal can be sent to long distances.

We can daily observe the activities of the world, information about weather, education, investigation, science, nature, entertainment related programs through television. We can watch live streaming of the different games played around the world on television. The programs telecasted from the different countries come through radio waves.

Fig: 13.11

Telephone, Fax and mobile phone

microphone spoken by a person and converted into an electrical signal. That signal is transferred through wire and in the form of sound is heard as a transforming signal in another telephone. We can receive and send the documents by telephone line through the fax machine. The information transmitted in the form of pictures and letters can be transferred from one place to another place. The picture or letters are converted into electrical signals by the machine while using fax. That signal is transmitted through the electrical line to the machine at which we are expecting to send. The machine which receives the fax converts the signal into a real picture or letter and prints. It becomes easier to talk and to send messages after the invention of the mobile phone. Mobile phone is a device which can transform an audio signal into a radio wave and transform the signals received in the form of radio waves into sound again.

Fig: 13.12

Alexander Bain, of Scotland in 1842, invented the fax machine. The photo was sent using fax from Cleveland to New York in 1924 for the first time.

Internet, wi-fi and email

The Internet is the largest computer network in the world. We can connect computers on the network with the help of a service provider, which provides mobile data, Wi-Fi, internet through wire or telephone line. We can receive information stored in the internet connected computer using suitable internet tools. For example, we can get information about our subject of study by the help of search engines like Google, yahoo. Bing. Some applications of the internet are communication, search of learning materials, entertainment, use of online services etc.

Fig: 13.13 Mobile banking through QR code

Activity 13.5

Observe the transfer of data from one smartphone to another by using 'Share it', 'Bluetooth', or any other internet tools in your mobile in the classroom.

Wi-Fi is the short form of wireless fidelity. It is a wireless networking system. In Wi-Fi, contact is established through radio waves between the devices. By using it, we can transfer data and connect the internet among devices. Wi-Fi facilities are available in devices like laptop, smartphone, smart television, and router. Email can be sent using the internet. It is the reliable medium of modern communication since it reaches destiny in a short time. Files can also be sent along with email.

Figure: 13.14 Wi-Fi devices

Global positioning system-GPS technology

Activity 13.6

Connect internet service on a smartphone. Turn on GPS location in your smartphone by swiping down on the screen. Observe the location of your mobile turning on map application.

Any device with GPS service calculates the distance by the help of wave signals obtained from two or more than two satellites and finding location of the place is called GPS technology. GPS is a navigation system conducted by the United States Space Force. Many countries of the world have launched navigation systems of their own. Russian Global Navigation Satellite System(GLONASS), European Union Galileo Positioning System, Chinese Compass Navigation System, Indian Regional Navigation System etc. are the navigation systems launched by various countries.

Fig: 11.15

Fig: 11.16 GPS Tracking

Fig: 11.17 GPS car navigationleu];g

At the beginning the navigation system was used in military action but it is used in many other sectors now. For example, tracking of vehicles, tracking of paths walked by man, finding way and location, controlling flight, tracking of cattle, study of tectonic plate movement, survey of the surface of the earth are the uses of GPS.

Telecommunication

Telecommunication is a system in which a communication signal is transferred from one place to another using various types of technologies through wire, optical fiber, wave etc. Telephone, fax, mobile phone, internet broadcasting through radio and television are the examples of telecommunication. Electricity and electromagnet are used in telecommunication. Signals are sent in the form of electrical signals on the telephone. Radio waves carry the signals of local radio and television. Microwaves are used to communicate with satellites of space and mobile phones and with radar.

Alexander Graham Bell invented a simple telephone model which can send the signals of sound to electrical signals from one place to another in 1875.

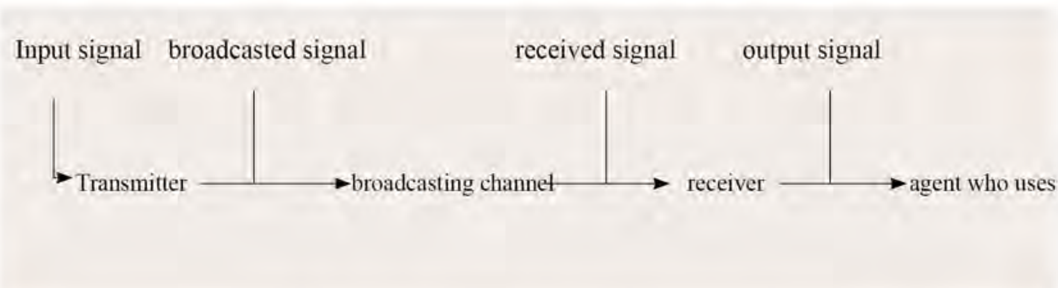
Working principle of telecommunication technology

Activity 13.7

Study about telecommunication technology visiting a station of radio, television or audiovisual material, posters, etc. Collect the information as mentioned below in the table.

Method of recording and materials used for it, transmitter (radio-signal generator, mixture), modulation etc.	Broadcasting channel (Wave, frequency, height of the tower)	Receiver (antenna, signal coverage)
....	....	....

In telecommunication systems information is transferred through various electronic and optical devices. The below chart shows three parts of telecommunication: transmitter, broadcasting channel and receiver.



In telecommunication technology, information received from, TV, camera or computer are input. Transmitter produces the broadcasting signals by using electrical devices and transfers from one place to another place by processing the input signals. Such communication signals carry sound, picture or computer data. Such signals are broadcasted through any kind of channel. The channel of communication may be radio waves, microwave beam, metallic cable or optical fiber. At last, by the use of suitable devices, the broadcasted signals are used by transferring the signal in the required form.

Modulation and demodulation

Being the information signal which we use, is less energetic, it is not transmitted in a broad area. Therefore, highly energetic radio-waves are used for telecommunication. For the transference of radio-waves, according to the nature of information communication amplitude or frequency is changed.

Activity 13.8

From which place are the radio waves transferred so that you can hear the radio at your local place? Investigate the information about communication of these waves, fill the table.

Name of the broadcasting center of radio wave and address	Frequency of wave	Type of modulation AM/FM	The name of the places and district from where these waves can be heard
....	....	....	....

The communication signals produced from the antenna of the transmitter reach directly to the receiver antenna through electromagnetic waves. Some signals are scattered by reflecting from the ionosphere to a particular distance. The local FM radio signals that we listen to are carried by space signals. To broadcast for long distance, communication signals are sent to the communication satellite in the form of electromagnetic waves and are broadcasted into the large area of the earth returning from the communication satellite. Communication satellites have made global communication and live streaming easier.

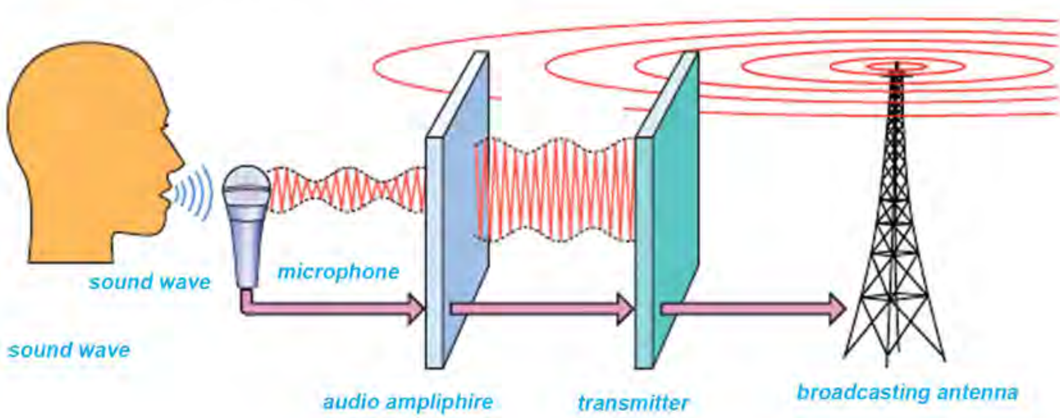
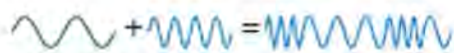


Fig: 13.18 radio transmitter and radio

Audio frequency is very much less than radio frequency. Therefore, uniform frequency radio waves are produced to broadcast radio signals. Such signals are called carrier signals. Wave frequency or amplitude of such waves is changed according to the displacement of the audio signal. This process is called modulation. The modulated wave is broadcasted through various channels. Such signals are reached far away because they are very powerful. Signals of information are received again according to the nature of carrier waves in radio, TV, router etc. This process is called demodulation. Due to differences in the nature data of audio signal and video signal, individual modulation is done and broadcasted through the same channel.

Amplitude modulation-AM	**Frequency modulation-FM**
According to the displacement of the audio signal, the frequency of the carrier signal is kept static and amplitude is changed.	According to the displacement of audio signal amplitude of carrier signal is kept static and frequency is changed.
 Audio signal + carrier wave =	
Waves of long wavelength and medium wavelength are transferred through amplitude modulation. For example, the frequency range of AM radio is 535 kHz to 1705 kHz. In Kathmandu radio Nepal broadcasts the AM radio in the frequency of 792 kHz. In radio broadcasting such waves are transferred directly from one antenna to another. From the ionic layer of the atmosphere, the waves are easily reflected and scattered in a large distance. There is the influence of the external environment in broadcasting AM. Therefore, it is clearly heard at night more than in day time.	The frequency produced from frequency modulation is more, so these waves do not reflect from the ionic layer of the atmosphere. The waves of broadcasting TV, FM radio which have high frequency are sent in a fixed distance from one antenna to another but the broadcasting is fixed in a certain distance, which depends upon the landscape and transmitter. Such broadcasts can be heard clearly. The frequency range of such FM radio is from 88 MHz TO 108 MHz. Radio Nepal broadcasts FM in 100 MHz.

Activity 13.9

Differentiate the elements of telecommunication technology from the class discussion of radio, television, telephone, fax, mobile phone, Wi-Fi, email, internet and GPS and fill the related devices in the given table. Does the use of such devices fall upon telecommunication technology? Why? Discuss.

Technologies of telecommunication	Transmitter	Channel (wire, wave, optical fiber)	Receiver
Television telecast	....	....	....
Radio broadcast	....	....	....
....	....	....	....

Project work:

Prepare a model of broadcasting radio/television to demonstrate the principle of action of telecommunication technology from the materials available at the local level.

Internet as a modern communication tool

Activity 13.10

Investigate the changes in communication technology due to development of technology along with time. Fill in the table as given below. Finally, write the conclusion obtained from the discussion of the activity.

Communication activities	Old method (before the use of internet)	Present method (after expansion of internet)		
		Method	Communication tool	Advantages
Letter/to send notices	Post office, fax		Gmail	
To talk			Social network, (......, ...) messenger	
....	....	....	....	....

Communication activities are being changed along with the development of computers, smartphones and the internet. By the use of the internet, we can do video calling instead of audio call. Online calls are very cheap from the point of view of cost. We can send email instead of letters, or faxes. The communication done by using email is fast and reliable.

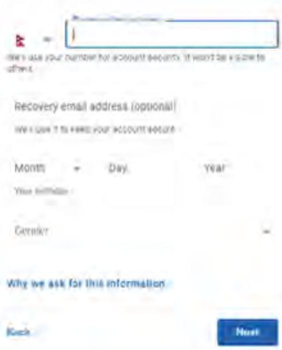
People can read newspapers online instead of paper newspapers through the medium of internet. Online news can be sent immediately after the incident to the readers. IPTV-Internet Protocol Television is used instead of cable TV. The audiovisual materials broadcasted through internet television are of high quality. Aforementioned activities are examples of the use of modern technology in communication.

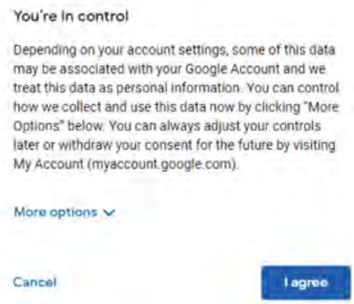
Activity 13.11

Work in pairs and create a Gmail account on the basis of steps given below. Then send email to each other and check the email sent by your friend.

1. Open browser icon clicking twice seen in screen of your computer (eg. Chrome icon). Click on the search bar and type www.gmail.com.
2. Click on create an account seen in the windows.
3. Fill all the information demanded in blank boxes in the newly opened window. Enter username and password that can be memorized since it is required to open the account ne

4. Fill all the information in the window and click next. Some conditions of Gmail will be seen. Scroll down the screen and click on 'I agree' seen at the bottom of the page. Your Gmail account is ready now.





5. To come out from the account sign out your account. For this click on the sign out window present in the circle at the right top corner of the screen as shown in the figure.

6. To send mail we need to sign in the Gmail opening Gmail account. We have to type email id (……………..@gmail.com) and need to click next, then sign in typing password. You will see your email window opened.

7. Click on 'compose' seen at top left side of Gmail window to send email to your friend from your Gmail account. A small window will open. In this window, type the mail ID of your friend (…………………@gmail.com, or …………………..@yahoo.com) and type the subject. Finally, click on the send button.

8. Click on the inbox to see the mail sent by your friend in your mailbox. You can read the email by clicking on the mail sent by your friend.

Use of internet to find study materials

Activity 13.12

Search the study materials in google search engine (google.com.np) using search operators given below and find the authenticity of these search engines through discussion. Find whether copyright is applicable in the materials searched. Prepare a powerpoint/ presentation document from the authentic materials (text and image) searched by you that are related to learning. Present the document prepared in your class.

Use of google search operators

Search operator	The materials that want to present obtained from search activity	Related example
Site:	The materials published from search special website	Site:moecdc.gov.np
Inurl:	The link in which the words are in search special	Inurl:firewall
*:	The websites containing searched word	*:firewall
Or	First or second or both searched word	Inurl:firewall or antivirus
And	First and second searched word	Inurl:firewall or antivirus
-	First and second searched word	Inurl:firewall or antivirus
" "	The websites which are similar that we search	"cyber bullying in Nepal
Filetype	The special type of file, which consists of necessary information. For example, docx, power point(ppt.) pdf	Cyber bullying in Nepal filetype:docx
Map:	The websites including related information about map	Map:rara lake
Weather	The website which includes information about the weather of related places	Weather:bidur

Search engine is a software system which searches the information contained in a webpage from the internet and presents all the relevant information searched by a person. Google search engine, Bing search engine are examples of it.

It is possible to search the relevant information in a short time due to a search engine since it presents necessary subject matter only. We can identify authenticity and require copyright or not by such search. On the internet, e-library of any educational institution or other authentic institute keeps proven materials only. The websites end at .edu, .gov, .org, .com etc. are conducted through authentic institutes. The materials published in them are authentic. We can get information looking at the amendment of published date/or not in the reader's comment or feedback about the materials searched in the internet.

Copyrighted materials are not allowed to be used in other places freely. For example; in the books found in google, there is copyright of the books. We can only read the books kept in it. The person who has the copyright can file a case if the figures, whole texts in the book are directly copied and used in other places. Some websites provide the materials for free. For example, the materials published in phet (http://phet.colorado.edu/) do not have copyright. We need to mention the source if we are preparing presentations, referring to materials which do not have copyright from the internet. For example, if we take the figure from the internet, then we have to mention the name of the website.

Online security measures

Activity 13.13

Prepare a PowerPoint presentation or a chart from the points given below and present in the class.

a. Privacy of personal information that we enter online

b. Unsocial activities online that happen in various age groups

c. The online activities that are related to remain safe which are used by any person that can be found at the time of necessity

The access and use of the internet is increasing. The need for online security in the persons who use the internet has also increased. Online security means the data stored or shared on the internet or information should be secured.

If the photos shared in social sites, the messages typed in it, password, the password used in internet banking, the online forms fill in various websites etc. are misused, the problem is created.

Hacking internet browser, stealing personal information are the results of weak online securities. Due to weak online security, incidents like, personal terror as well as the money can be stolen by taking or hacking the banking information.

Online privacy checking

The website that is used for online services should be secure. Before entering personal information on the internet, authenticity and security of the website should be checked. To know about the security certificate, click on the front signal of the web address as given in the figure 13.19. The information about the security is expressed whether it is secure to enter personal information or not at the pop up window.

Figure 13.19: website security certificate checking

The unnecessary links sent in the social media in the name of gifts, lottery etc. may not be secure. There are possibilities of stealing the information by clicking on such links as well as filling the information in such websites. We need to find the authenticity of the website before filling the forms. We need to sign out if all the tasks of sign in are completed.

Cyberbullying awareness

Cyber bullying is the abuse of information and communication technology. The activities that create mental tension by using electronic devices like mobile, phone, computer, tablets etc. by the medium of internet are in cyber bullying. Harassment of publishing personal information, sending sexual material containing messages, creating nervousness in persons, spreading rumors about persons online etc. are the examples of cyber bullying through the internet.

Figure 13.20: cyber bullying

The cyber bullying happen to be with adolescence is mostly by the use of social network, messenger, email etc. We should not accept unknown persons in social media (network) to be safe from cyber bullying. Personal information and private things should not be shared, when we talk and send messages. Photos and other information shared in social media needs to be secure. If any person starts the activities of cyber bullying, we need to inform guardians keeping the record of such activity.

Digital footprint awareness

Digital footprint is data evidence generated in various electronic devices while using the internet. It consists of the evidence of details of websites used, details of email sent, information submitted in online facilities, like, share, comment, status written in social media etc. We can search such information if we want. For example, we can find the address of an unknown person on the basis of activities done, by looking at the IP address given by the internet service provider. Likewise, if a person posts the material that creates terror in social media and removes it after sometime, the post remains safe in the database of the social media. Police can arrest on the basis of the evidence thus found.

Figure: 13.21 digital footprints

The details of the websites remain safe in the devices, which use the internet facilities. Similarly, the password also can remain saved. To remove such data we need to clear cache files opening history of the browser. We should not click the save button if the notification 'do you want save password' comes in other devices except personal devices. If a password is saved, it might be misused through the data collector.

Figure: 13.22 removing browsing history

Firewall and antivirus protection

Activities 13.14

Type the firewall in the search box of your computer. Observe the firewall doing on and off. Discuss the written details and function of the firewall. Observe the computer whether antivirus is installed or not. Discuss the reason of using computer antivirus. Search for examples of cyber-attack held in various places using the internet.

Function of firewall	Causes of use of antivirus	Example of cyber-attack
....	....	....

Firewall is necessary to block unauthentic networking signals and to allow the safe data to our computer, which can be exchanged from computer (internet) networking.

Firewall, related to software, is installed with operating software (operating software; example, MS-Windows) in the computer. The internet should be used by turning on the firewall. Much personal information is found in databases of websites of banks, data servers and some institutions. Stealing money from ATM hacking, stealing data by website hacking etc. are the result of weak firewalls. Such activities are called cyber-attack. We have also the examples who are arrested involving in such activities.

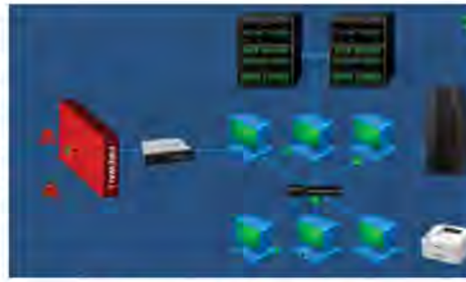


Figure: 13.23 computer networking and firewall

Computer virus is a program. It creates the copies involved in the program that conduct the computer and infect necessary programs. It directs the computer on the basis of its program gradually, due to which problems like opening the program itself, deleting the data itself, and taking a long time for processing in the computer memory are seen in the virus infected computer.

Computer viruses do not transfer from one computer to another. Computer virus is transferred when we transfer data from virus infected computer to another computer. Virus can be entered from an unauthentic website along with the data that comes to the computer while using the internet. Antivirus is a program that can remove searching for viruses for computer security. It is applicable to find, differentiate and remove the viruses that come from the internet or other media like pen drive. For example, windows defender is antivirus software that is received while installing computer windows. Other computer antiviruses can also be installed purchasing in the market.

Project work

a. Study the various incidents held due to unsafe use of the internet. Find the reasons for such incidents and the precautions to be taken to prevent happening such incidents. Present the information obtained from your study and discuss it in your class.

b. Prepare a study report searching various examples of main cybercrimes like ATM attack, spear phishing, privacy leaking, social media crime like harassment, identity theft, dissemination of false information etc. that are held in Nepal.

Exercise

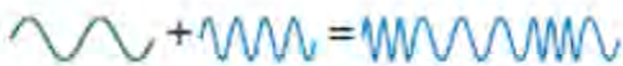
1. Choose the correct answer.

i. On which orbit of the earth does the launched satellite remain relatively static and revolve above the equator?

a. Low earth orbit c. medium earth orbit

b. Geostationary orbitd. geosynchronous orbit

ii. Which is the similar modulation characteristic shown in the figure for radio wave transference?



a. Frequency of the broadcasted wave is more.

b. Broadcasted waves are reflected easily from ionic layer of the atmosphere.

c. Broadcasted waves are limited for a fixed distance.

d. There is less effect of external environment in broadcasting.

iii. Which syntax is suitable to search PowerPoint presentation slides of plant tissue by the use of a search engine?

a. Filetype: plant tissue.pptx b. Plant tissue filetype.pptx

c. Plant tissue filetype:pptx d. Filetype plant tissue:pptx

iv. What do we understand from the term email?

a. Emergency mail b. Electronic mail

c. Early mail d. Effective mail

v. If a student removes a message from social media harassing a friend, and feels safe. Which awareness does he/she lack?

a. Online privacy b. Digital footprint

c. Computer virus d. Computer firewall

2. Write the differences between:

a. Firewall and antivirus

b. Amplitude modulation and frequency modulation

3. Give reasons:

a. Many countries of the world have launched communication satellites at geostatic orbit.

b. To broadcast long distance, astronaut waves are sent to communication satellites.

4. Answer the following questions.

a. What is information and communication technology?

b. How do satellites revolve around the earth continuously without the use of energy?

c. What is the name of the first satellite of Nepal?

d. What is telecommunication? Write examples of telecommunication technology.

e. For what purposes do you use telecommunication technology?

f. Explain the action principles of telecommunication technology with examples.

g. Identify the modulation for broadcasting radio-wave in the given figure. Write the purpose of such a modulation?

h. 'Internet communication is a modern communication technology'. Clarify the statement with an example.

i. How do we get knowledge and information by the use of the internet? Explain with examples.

j. What is online security? Write the ways of online security.

k. What kind of suggestions would you like to provide for a new user of the internet who has just started online banking, online trade and using social media,? Write with reasons.

l. Write an essay on 'Use of Information and Communication Technology in Education'.

14 Atomic Structure and Chemical Bond

Various kinds of matter are found around us. Some of them are elements and some are compounds. Gold, silver, copper etc. are metals and Sulphur, iodine etc. are non-metal elements. 118 elements have been discovered yet. The scientists are discovering the elements continuously. Millions of compounds are formed even if there are limited elements. One or more than one atom is present in a compound

Introduction to an atom

What is the smallest particle of an element called? Are there smaller particles than it? Discuss.

Element is a pure substance. We cannot convert it into other substances having different properties by breaking it. Iron is an example of an element. We cannot make different substances by breaking it into smaller particles continuously. Element is formed by combining many similar atoms. Therefore, the smallest particles which can take part in chemical reactions are called atoms.

Most of the atoms of an element take part in the chemical reaction of the atoms of other elements. Some atoms of elements are chemically inert. All the atoms of the same element are similar but atoms of different elements are different. For example, all the atoms present in the ring of gold are similar but the atoms of silver are different. Similarly, the atoms of copper are different from the atoms of silver.

Structure of an atom

The average diameter of atom is approximately 10^{-10} m. An atom constitutes three smaller particles. They are called subatomic particles. electron, proton and neutron are the subatomic particles of an atom. Out of them proton and neutron are present in the nucleus and electrons revolves around the nucleus in a particular orbit (shell) with a fixed speed.

Figure: 14.1

Activity 14.1 construction of atomic model

Materials required: local materials like, wire, rope, table tennis ball, or small balls of mud etc.

Procedure:

1. Divide responsibilities in group or individually to prepare a model of atoms of atomic number from 1 to 20.
2. Prepare the models according to the division of responsibilities.
3. Prepare a table of symbol, atomic number and electronic configuration by studying the structure of the atomic model from hydrogen to calcium.

Observation and discussion: Present the prepared atomic models and table in your class. Discuss atomic models on the basis of the prepared model and table.

Duplet and duplet rule

In the atom of helium, there is only one shell (K-shell). It is the first and last shell of the helium atom. The electronic configuration of atoms is done by using the formula $2n^2$ where n represents shell number. According to the $2n^2$ formula, the K shell accommodates only two electrons. The state of becoming stable by attaining two electrons in a K-shell is called the duplet state. The atom of helium is inert due to duplet state. It does not take part in any chemical reaction. So, the atom of helium can be found in a free state in nature.

Figure: 14.2: atomic structure of helium

The atoms of the elements like hydrogen, lithium and beryllium take part in chemical reactions actively by gaining or losing or sharing the electron to gain duplet state. This is called the duplet rule. Therefore, the state of attaining two electrons in the K-shell of an atom is called duplet state and the rule to attain two electrons is called duple rule.

Octet and octet rule

Except helium atom, atoms of other elements present in the inert gas group or 18th group of modern periodic table like Ar, Kr, Xe and Rn have 8 electrons in their valence shell (outermost shell). This state of the atom is called octet state.

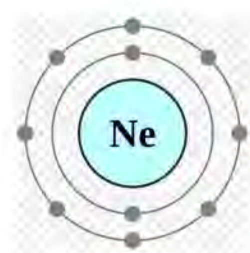


Figure: 14.3 Atomic structure of neon

The atoms of the elements, which are in octet state do not take part in chemical reaction and are found in gaseous state in nature. Therefore, these elements are called inert gases.

The elements which have less than 8 electrons in their outermost shell take part in chemical reaction by losing, gaining or sharing the electron to gain octet state. This rule is called the octet rule. Therefore, the state of bearing 8 electrons in the outermost shell of an atom is called octet state and the rule to gain stable state is called octet rule.

Valence shell and valence electron

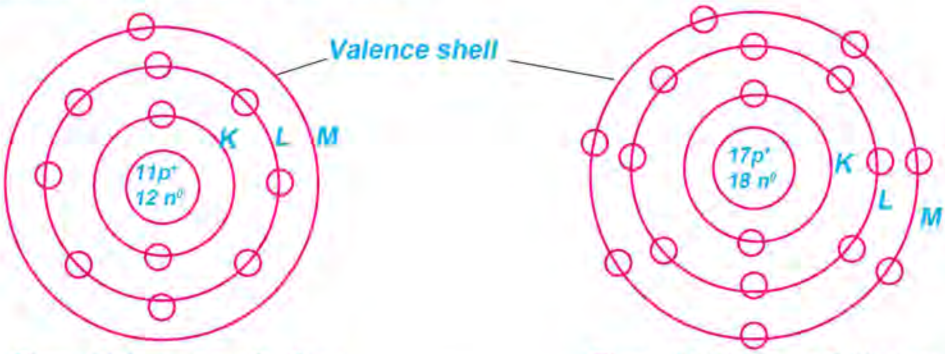


Figure 14.4: a) atom of sodium

Figure 14.4 b) atom of chlorine

In the figure 14.4 a) atom of sodium is given. Sodium atoms consist of 11 electrons. However, not all of these electrons take part in chemical reactions. The one electron present in the valence (outermost) shell (M-shell) takes part in chemical reaction. Thus, the M-shell of sodium is a valence shell and the electron present in this shell is called valence electron. Likewise, the M-shell of chlorine in the figure given in 14.4 b) is called valence shell and the 7 electrons present in this shell are called valence electrons. Thus, the outermost shell of an atom is called valence shell and the electrons present in valence shell are called valence electrons

Valency

The electrons present in the outermost shell are the possible valence electrons that can take part in chemical reaction. During chemical reaction one or more electrons present in the valence shell can be shared or exchanged. The electron(s), which can be exchanged or shared during chemical reaction is called valency. The combining capacity of one atom with another atom is called valency of that atom.

Electronic configuration and valency of the atoms from atomic number 1 to 20 are given in the table below.

Name of element	Symbol	Atomic number	Electronic configuration on the basis of shell				Valency
			K	L	M	N	
Hydrogen	**H**	**1**	**1**				**1**
Helium	**He**	**2**	**2**				**0**
Lithium	**Li**	**3**	**2**	**1**			**1**
Beryllium	**Be**	**4**	**2**	**2**			**2**
Boron	**B**	**5**	**2**	**3**			**3**
Carbon	**C**	**6**	**2**	**4**			**4**
Nitrogen	**N**	**7**	**2**	**5**			**3**
Oxygen	**O**	**8**	**2**	**6**			**2**
Fluorine	**F**	**9**	**2**	**7**			**1**
Neon	**Ne**	**10**	**2**	**8**			**0**
Sodium	**Na**	**11**	**2**	**8**	**1**		**1**
Magnesium	**Mg**	**12**	**2**	**8**	**2**		**2**
Aluminium	**Al**	**13**	**2**	**8**	**3**		**3**
Silicon	**Si**	**14**	**2**	**8**	**4**		**4**
Phosphorous	**P**	**15**	**2**	**8**	**5**		**3, 5**
Sulphur	**S**	**16**	**2**	**8**	**6**		**2, 6**
Chlorine	**Cl**	**17**	**2**	**8**	**7**		**1**
Argon	**Ar**	**18**	**2**	**8**	**8**		**0**
Potassium	**K**	**19**	**2**	**8**	**8**	**1**	**1**
Calcium	**Ca**	**20**	**2**	**8**	**8**	**2**	**2**

Activity 14.2

Draw structure of atoms from atomic number 1 to 20 in a chart paper. Now, discuss valence shell, valence electron and valency constructing a table in the class.

Generally, the elements which have low valency are more reactive while the elements with high valency are less reactive. For example, the sodium has valency 1 is more reactive than the magnesium metal that has valency 2.

Some of the elements have variable valencies according to the conditions of making compound. For example, iron has valency 2 and 3 as well as gold has valency 1 and 3. At the time of taking part in chemical reaction if the valence electron only takes part it has valency one as well as if the electron of inner shell also takes part in chemical reaction such elements have valency more than 1. For example, copper can have valency 1 and 2. Valency of some such elements has been given in the table below.

Elements	**Valency**
Iron (Fe)	2 and 3
Silver (Ag)	1 and 2
Gold (Au)	1 and 3
Mercury (Hg)	1 and 2

Ion

Every atom has the same number of positively charged protons and negatively charged electrons. Therefore, electrically atoms are neutral. When the atom or group of atoms gains or loses electrons from their valence shell, in such cases the atom is converted to a charged ion. Such charged atoms are called ions.

For example, Na+, Mg++, Al+++, K+, Ca++, Zn++, Cu+, Cl^-, O-$^-$, N^- - - etc. are ions. The number of negative or positive charges present in ion is their valencies.

Type of ions

On the basis of charge, ions are of two types.

Positively charged ions When an atom of an element loses an electron from its valence shell, then the atom acquires positive charge. Therefore, the ion formed by losing one or more electrons from the valence shell is called a positively charged ion or cation. Some positively charged ions and their valencies are given in the table below.

Ions having valency 1		Ions having valency 2		Ions having valency 3	
Ion	Symbol formula	Ion	Symbol formula	Ion	Symbol formula
Hydrogen	H^{+}	Berrylium	Be^{++}	Boron	B^{+++}
Lithium	Li^{+}	Magnesium	Mg^{++}	Aluminium	Al^{+++}
Sodium	Na^{+}	Calcium	Ca^{++}	Ferric	Fe^{+++}
Potassium	K^{+}	Manganese	Mn^{++}	Auric	Au^{+++}
Ammonium	NH_4^{+}	Cupric	Cu^{++}		
Cuprous	Cu^{+}	Mercuric	Hg^{++}		
Silver	Ag^{+}	Ferrous	Fe^{++}		
Mercurous	Hg^{+}				
Aurous	Au^{+}				

Negatively charged ion When an atom gains electrons from other atoms, the atom becomes negatively charged. Therefore, the ions formed by gaining electrons from other atoms are called negatively charged ions or anions. Some negatively charged ions and their valencies have been given in the table below.

Ions having valency 1		Ions having valency 2		Ions having valency 3	
Symbol formula	Ion	Symbol formula	Ion	Symbol formula	Symbol formula
Fluoride	F^{-}	Oxide	O^{--}	Nitride	N^{---}
Chloride	Cl^{-}	Sulphide	S^{--}	Phosphate	PO_4^{---}
Bromide	Br^{-}	Sulphate	SO_4^{--}		
Iodide	I^{-}	Carbonate	CO_3^{--}		
Nitrate	NO_3^{-}				
Hydroxide	OH^{-}				
Bicarbonate	HCO_3^{-}				
Bisulphate	HSO_4^{-}				
Chlorate	ClO_3^{-}				
Nitrite	NO_2^{-}				

Activity 14.3

Prepare a model of various atoms using cardboard paper, thread, colored pieces of beads (pote). Demonstrate the process of becoming positively charged ions and negatively charged ions from the model of these atoms.

Chemical bond

Look at the figure and discuss

Figure 14.5

a. Which compound's molecular model has been shown in the figure?

b. What are the differences between molecular models of H^2 and H_2O?

c. What are the differences between the molecular model of O_2 and NaCl?

d. As the molecular formula of water is H_2O and the molecular formula of table salt is NaCl, like this, how do the elements bind in millions of compounds?

Atoms elements are bound by a special type of force in a compound which is called chemical bond. Similar types of bonds are not contained in all compounds. A kind of force is applied to bind the atoms of elements to form a compound by chemical reaction. That force is called a chemical bond. For example, in edible salt (table salt) atoms of sodium and chlorine are bound by chemical bonds.

Except inert gases (He, Ne, Ar, Kr, Xe and Rn) atoms of other elements are not in duplet or in octet state. Therefore, the outermost shell of atoms of other elements than inert gases is incomplete. To gain a duplet or octet state in the outermost shell these elements take part in chemical reaction.

Chemical bonds are various types. But in this unit, we are going to study electrovalent bond or ionic bond and covalent bond only.

Electrovalent bond

Generally, in valence shells of atoms of metals consist of 1 or 2 or 3 electrons. Therefore, atoms of these elements acquire an octet of duplet state by losing 1 or 2 or 3 electrons.

Similarly, in the valence shell of atoms of nonmetals consist of 5 or 6 or 7 electrons. Thus, atoms of these elements acquire octet or duplet state by gaining 3 or 2 or 1 electron.

During the chemical reaction between metal and non-metal, metals lose one or more than one electron from its valence shell and become positively charged ions. Likewise, the non-metals gain electrons to its valence shell from other atoms and become negatively charged ions. At this condition, frictional force is developed between two oppositely charged ions and remains in the form of a molecule.

In this process, the bond formed between metal and non-metal is called electrovalent bond. Thus, the bond formed by transference of electrons from the valence shell of metal to the valence shell of non-metal is called electrovalent bond.

The compound formed by an electrovalent bond is called electrovalent compound. Sodium chloride (NaCl), calcium chloride ($CaCl_2$), Magnesium oxide (MgO) etc. consists of electrovalent bonds. Therefore, these compounds are called electrovalent compounds.

Process of formation of some electrovalent compounds

a. Process of formation of sodium chloride (NaCl)

In sodium chloride, an electrovalent bond is formed by the exchange of one electron between sodium and chlorine. The electronic configuration of sodium is 2,8,1. Only one electron is present in the valence shell of it. The electronic configuration of chlorine is 2,8,7. Seven electrons are present in the valence shell of it.

Sodium atom loses one electron from its valence shell and becomes a positively charged ion (Na+). $Na - 1e^- \rightarrow Na^+$

Likewise, chlorine atoms gain one electron in its valence shell and become negatively charged ions (Cl^-). $Cl + 1e^- \rightarrow Cl^-$

An electrovalent bond is formed due to the attraction force generated between two oppositely charged ions. As a result, by the combination of sodium and chlorine sodium chloride is formed.

$Na^+ + Cl^- \rightarrow NaCl$

Atoms of both elements acquire octet state while forming electrovalent bonds.

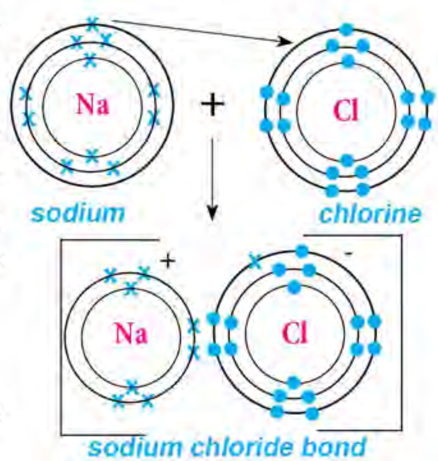


Figure: 14.6

b. Process of formation of magnesium oxide (MgO)

In magnesium oxide, magnesium is metal and oxygen is non-metal. Electronic configuration of magnesium is 2,8,2. Only 2 electrons are present in the valence shell of its atom. As well as, the electronic configuration of oxygen is 2,6. 6 electrons are present in the valence shell of its atom. Therefore, magnesium loses 2 electrons from its valence shell and becomes a positively charged ion (Mg++).

$Mg - 2e^- \rightarrow Mg^{++}$

Similarly, an atom of oxygen gains two electrons from magnesium and becomes negatively charged ion (O- -).

$O + 2e^- \rightarrow O^{--}$

Electrovalent bond is formed between these two oppositely charged ions. As a result magnesium oxide is formed.

$Mg^{++} + O^{--} \rightarrow MgO$

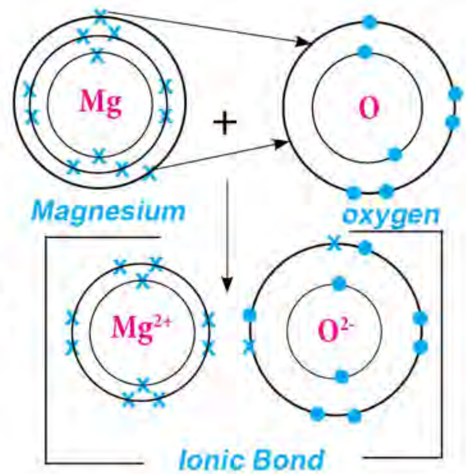


Figure 14.7

c. Process of formation of calcium chloride (CaC_{l2})

Calcium chloride is formed by the electrovalent bond formed between 1 atom of calcium and 2 atoms of chlorine. Atom of calcium consists of 2 electrons in the valence shell. It becomes a positively charged ion (Ca++) by losing these two electrons.

$Ca - 2e- \rightarrow Ca++$

During the formation of a bond, out of two electrons of the valence shell of calcium one electron is transferred to the valence shell of one chlorine atom and another electron of calcium transfers to another atom of chlorine. Thus two chloride ions are formed.

$2Cl + 2e^- \rightarrow 2Cl^-$

Electrovalent bond is formed due to the attraction force generated between these two oppositely charged ions. As a result, calcium chloride (CaC_{12}) is formed by the combination of calcium and chlorine.

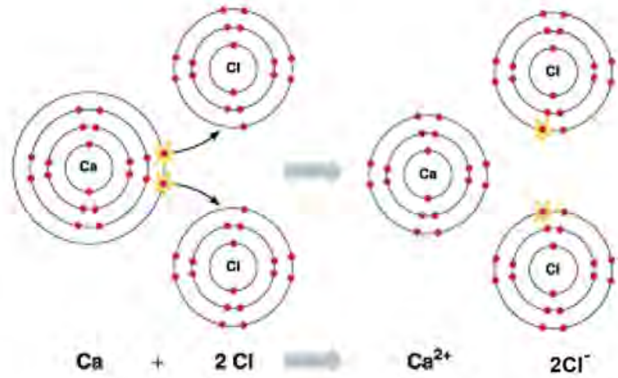


Figure 14.8

Activity 14.4

Objectives: To study the electrovalent bond constructing atomic model.

Required materials: a cardboard paper, marker, compass, pencil, thread, glue and pea, ball of mud, beads (pote) of different color.

Procedure:

1. Collect all the required materials.
2. Prepare an atomic model of sodium, magnesium, calcium, chlorine and oxygen individually by using collected materials.

   Observation and discussion: Present and discuss the method of formation of electrovalent bonds by the transference of electrons in the prepared atomic models of sodium, magnesium, calcium, chlorine and oxygen.

Characteristics of electrovalent compounds

Electrovalent compounds have following characteristics:

a. Electrovalent compounds are formed from metal and non-metal.

b. Electrovalent compounds are soluble in water. When they dissolve in water, they form positively charged ions and negatively charged ions.

c. The boiling point and melting point of such compounds is high.

Covalent bond

Non-metals have 5, 6,or 7 electrons in their valence shell except hydrogen. Therefore, atoms of these elements try to acquire octet or duplet state by gaining 3, 2 or 1 electron. When a chemical reaction occurs between atoms of two or more than two non-metals, it is impossible to exchange electrons because both the atoms want to gain electrons.

In such cases, they share electrons to gain octet or duplet state and chemical bonds are formed. This type of chemical bond is called covalent bond. The chemical bond formed between two or more than two atoms of homogeneous or heterogeneous non-metals by sharing an equal number of electrons is called covalent bond.

Covalent bond is represented by a straight line (–) between the atoms. Non-metals can share 1 pair, 2 pairs or 3 pairs of electrons when they form covalent bonds. Covalent bond is formed in molecules of water (H_2O), hydrogen chloride (HCl), methane (CH_4), ammonia (NH_3) etc. Such compounds are called covalent compounds.

Process of formation of hydrogen chloride (HCl)

A molecule of hydrogen chloride is formed by combining a hydrogen atom and an atom of chlorine. In the K –shell of hydrogen atom there is only one electron and in the valence shell of chlorine there are seven electrons. Hydrogen atoms and chlorine atoms share one electron of each to form a bond. In this condition hydrogen acquires duplet state and chlorine atom acquires octet state. By this way molecules of hydrogen chloride are formed. Hydrogen chloride is formed from a covalent bond so it is called covalent compound.

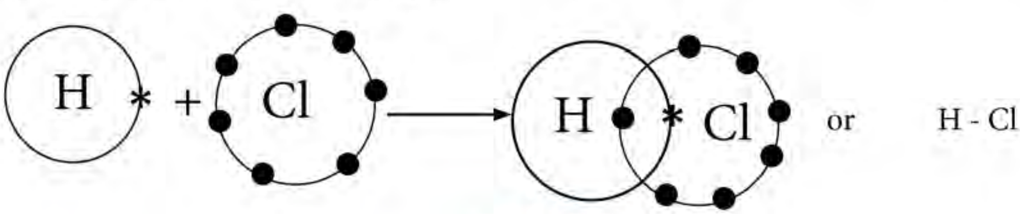


Figure: 14.9

Process of formation of water molecule (H2O)

A molecule of water consists of one atom of oxygen and two atoms of hydrogen. Hydrogen atom consists of one electron and oxygen atom consists of eight electrons. The electronic configuration of these atoms is as follows.

Element: Hydrogen

Shell	
K	**L**
1	

Element: oxygen

Shell	
K	**L**
2	**6**

Hydrogen atom consists of one electron and oxygen atom consists of eight electrons. Therefore, one oxygen atom shares two electrons with two atoms of hydrogen. Hence, hydrogen atom acquires duplet and oxygen atom acquires octet state. By this way, covalent bonds are formed in water molecules. Water is called a covalent compound because it is formed from a covalent bond.

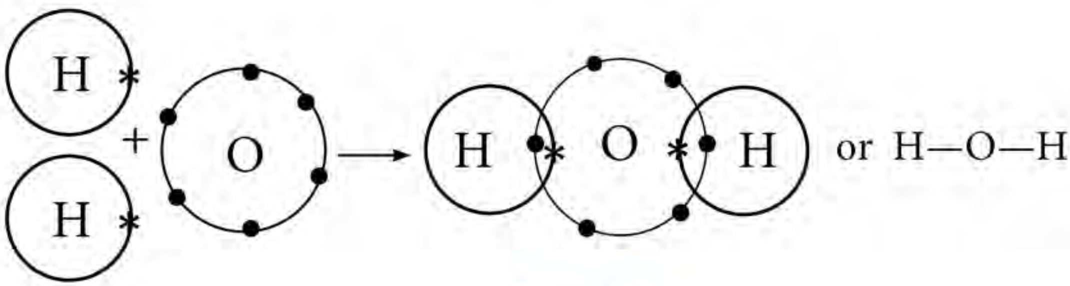


Figure : 14.10

Process of formation of methane (CH4)

Molecule of methane is formed by sharing four pairs of electrons between one carbon atom and four hydrogen atoms. In the K- shell of hydrogen atom is one electron as well as in the valence shell of carbon consists of four electrons. Therefore, one atom of carbon shares four electrons with four hydrogen atoms and carbon acquires octet state as well as hydrogen atoms acquire duplet state. As a result, molecules of methane are formed. Molecule of methane is formed by the covalent bond between carbon and hydrogen so it is called a covalent compound.

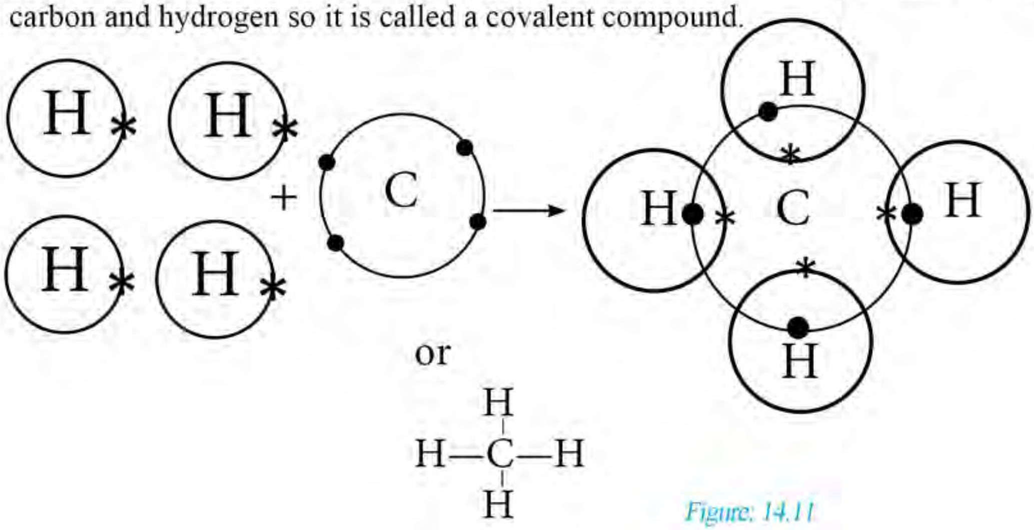


Figure: 14.11

Process of formation of ammonia (NH_3)

Ammonia molecule is formed by sharing three pairs of electrons between one atom of nitrogen and three atoms of hydrogen. Five electrons are present in the valence shell of nitrogen. It gains octet state receiving three electrons from atoms of other elements. Hydrogen atoms contain only one electron. Therefore, one atom of nitrogen shares three electrons with three atoms of hydrogen hence nitrogen acquires octet state and hydrogen acquires duplet state. As a result, molecules of ammonia are formed. Ammonia molecule consists of a covalent bond so it is called covalent compound.

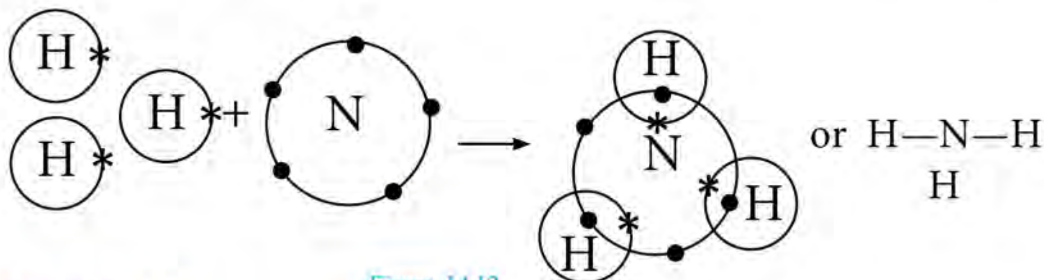


Figure: 14.12

Activity 14.5

Objectives: To study the covalent bond preparing atomic model

Required materials: cardboard paper, seed of pea, small balls of mud, marker, compass, pencil, glue, thread, beads (pote) etc.

Procedure:

1. Collect all the required materials
2. Prepare atomic model of hydrogen, carbon, nitrogen and oxygen by using collected materials
3. Present the sharing method of electrons in covalent bonds formed in the molecules of water, methane, ammonia and hydrogen chloride by using the prepared atomic model.

Observation and discussion: Present on sharing method of electron in covalent bond formed in the molecules of water, methane, ammonia and hydrogen chloride by using the prepared atomic model and discuss in classroom.

Characteristics of covalent compounds

Covalent compounds have following characteristics:

a. Covalent compounds are formed by combining two or more than two non-metallic elements.

b. Most of the covalent compounds are insoluble in water.

c. Covalent compounds do not dissociate into positively and negatively charged ions.

d. Melting point and boiling points of covalent compounds are low.

Molecular formula

The smallest particle of the compound is called a molecule. Molecules are formed by the combination of two or more than two atoms. For example, a water molecule (H_2O) is formed from the two atoms of hydrogen and one atom of oxygen. Similarly, a molecule of sodium chloride is formed from the combination of sodium (Na) and chlorine (Cl). Molecule of hydrogen is formed by two atoms of hydrogen. Likewise, molecules of oxygen are formed by the combination of two atoms of oxygen. Like a symbol of element, molecules are also written in short in symbols or groups of symbols. This symbol is called a molecular formula. Therefore, the group of symbols of atoms that represent molecules is called a molecular formula. For example, some molecules and their molecular formula are given in the table below.

SN	Name of molecules	Molecular formula
1.	Hydrochloric acid	**HCl**
2.	Sulphuric acid	H_2SO_4
3.	Sodium hydroxide	**NaOH**
4.	Magnesium hydroxide	$Mg(OH)_2$
5.	Ammonia	NH_3
6.	Sodium chloride	**NaCl**
7.	Magnesium carbonate	$MgCO_3$
8.	Magnesium chloride	$MgCl_2$
9.	Water	H_2O
10.	Calcium carbonate	$CaCO_3$
11.	Carbon dioxide	CO_2
12.	Potassium nitrate	KNO_3
13.	Sodium bicarbonate	$NaHCO_3$
14.	Calcium carbonate	$CaCO_3$
15.	Potassium sulphate	K_2SO_4
16.	Ammonium phosphate	$(NH_4)_3PO_4$

Method of writing molecular formula

We can write molecular formulas of various types of compounds by criss-cross method. Method of writing molecular formula by this method is given below.

1. First of all, write the name of the molecule of which the molecular formula is to be written.

   For example, Magnesium chloride

2. Write symbols under the name of the atoms by which the molecule is formed.

   For example, Magnesium Chloride

   Mg **Cl**

3. Write valencies of the atom just above the symbols.

   For example, Magnesium Chloride

   2 **1**

   Mg **Cl**

4. Exchange the valencies within the atom or ions by criss-cross method. Which is indicated by arrow( )

   For example, Magnesium Chloride

   2 **1**

   Mg **Cl**

5. Write the valencies under the symbols after exchanging valencies.

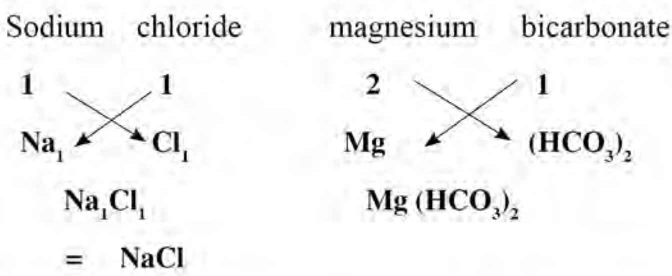
   For example, Magnesium Chloride

   2 **1**

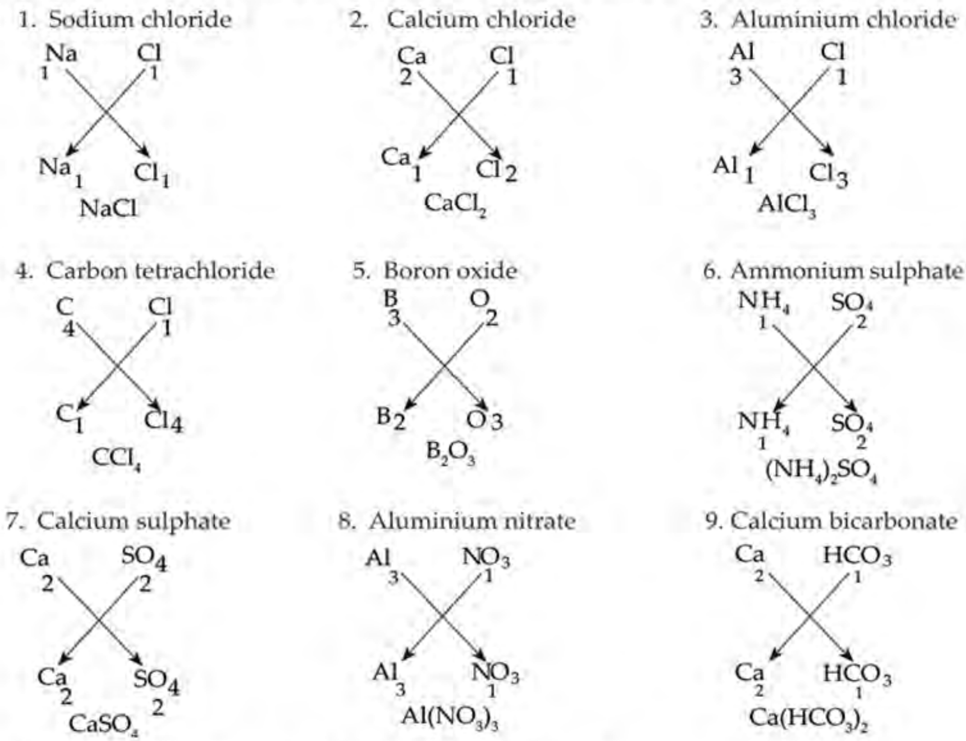
   Mg **Cl**

   Mg_1Cl_2

   But if the valency of an element or ion is 1 it is not necessary to write. If both valencies can be divided by any number, it is to be written by dividing them. Similarly, if ion is formed by two or more than two atoms, the symbol of such ion is to be kept inside bracket ( ) and valency should be written at bottom right side.



Molecular formulas of some compounds are given below.



The facts we can understand from molecular formula

1. Name and symbol of elements present in the molecule
2. Valency of element or ion
3. Number of atoms present in molecule

Atomic weight and Molecular weight

The sum of protons and neutrons present in the nucleus is called atomic mass of an atom. Atomic mass and molecular mass is expressed in atomic mass units (amu).

Atomic mass = number of proton + number of neutron

Atomic mass of some atoms

An atom of oxygen contains 8 protons and 8 neutrons.
Atomic mass of oxygen = no. of proton + no. of neutron

$$= 8 + 8$$
$$= 16 \text{ amu}$$

Therefore, atomic mass of oxygen = 16 amu.

An atom of sodium consists of 11 protons and 12 neutrons

Therefore, atomic mass of sodium is (11+12)= 23 amu.

Molecular weight

The sum of atomic mass of atoms present in a molecule is called molecular mass. Molecular mass can be calculated by adding atomic mass of atoms present in the molecule. For example,

1. Molecular mass of water = 2 x atomic mass of H + 1x atomic mass of O

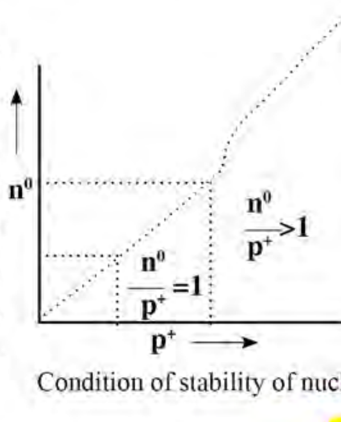
$$= 2 \times 1 + 1 \times 16$$
$$= 2 + 16$$
$$= 18 \text{ amu}$$

2. Molecular mass of ammonium phosphate(NH_4)3PO_4

$$= 3 \times N + 12 \times H + 1 \times P + 4 \times O$$
$$= 3 \times 14 + 12 \times 1 + 1 \times 31 + 4 \times 16$$
$$= 42 + 12 + 31 + 64$$
$$= 149$$

Nuclear stability

Nucleus of an atom is formed by the combination of proton and neutron. If the ratio of neutron to proton is more than 1, the nucleus becomes unstable. Generally, nuclei of atoms which have higher atomic numbers are unstable. Hence, the instability increases with the increase in atomic number. Such elements want to go stable state from unstable state. In this condition, these atoms emit energetic radiation. This is called radioactive emission.



Condition of stability of nucleus

Radioactive elements and radioactive emission

The nucleus of an atom, which has a high atomic number, is unstable. To gain stability, these atoms emit powerful alpha (α), beta (β) and gamma (γ) radiations. Such elements are called radioactive elements. The elements which emit radiation are called radioactive elements. Uranium, plutonium etc. are examples of radioactive elements. Mostly, the atomic number of radioactive elements is more than 83. The emission of radiation from the radioactive element is called radioactive emission. The radiation emitted from radioactive elements is harmful to human health. Radioactivity and radioactive instabilities were studied by French scientist Henri Becquerel in 1896 AD.

Nuclear fission

The process of splitting unstable atoms (nucleus) with high atomic number into smaller atoms (nucleus) is called nuclear fission. In this process, the atoms of uranium, plutonium etc. are bombarded by high speed neutrons, then these atoms get split into smaller atoms. Thus, in the process of obtaining smaller atoms from unstable atoms, some mass may be lost. The lost mass produces an enormous amount of energy in the form of alpha (α), beta (β) and gamma (γ).

For example, an atom of uranium is bombarded by a high speed neutron and it is decomposed into lighter atoms of barium and krypton along with 3 neutrons and a large extent of energy is released from lost mass.

Uranium + neutron $\rightarrow$ Barium + krypton + neutron + energy (in the form of radiation)

$92U^{236} + n^0 \rightarrow Ba^{141} + Kr^{92} + n^0 + 236$ kcal

Nuclear fusion

The process of formation of heavy nucleus (e.g. helium) by the combination of atoms of lighter elements like hydrogen in presence of high pressure and heat is called nuclear fusion. This process continuously occurred in the sun and stars. Nuclear fusion is possible in the sun and stars due to the presence of abundant amounts of hydrogen, and high pressure, and heat. In this process, four atoms of hydrogen combine to form an atom of helium, and an enormous amount of energy is produced.

Hydrogen $\rightarrow$ Helium + Energy{

$4\,{}_1H^1 \rightarrow {}_2He^4 + 2\,{}_1e^0$ + energy

Atomic energy or nuclear energy

Energy is produced from the nuclear fission process by artificial method. It is impossible to produce energy by artificial nuclear fusion process because high pressure and heat is required for this process. Molecular thermal plants (kiln) are made to produce heat energy by nuclear reactions. Steam engine is conducted by the steam produced by boiling water from heat produced by a kiln. Enormous amount of electricity is produced by a conducting generator with the help of a steam engine. Electricity is generated in most of the developed countries by this technology.

Similarly, atomic energy is used to sterilize drinking water, food materials, medical weapons etc. by the use of radiations emitted from nuclear reactions. Atomic energy is used to cure various types of diseases like cancer. There is a high risk of radiation emitted from the misuse of molecular weapons and leakage of radiation during production of nuclear energy for human beings.

Project work

1. Investigate about the use of atomic energy and its harmful effects from books, magazines and on the internet.
2. Write the information investigated in chart paper in an artful way, present it in your class and discuss.
3. Organize a debate competition in your class in the topic "Atomic Energy is a Blessings or Sin of Science"
4. Prepare a short report including the things learned from discussion and debate on the topic "Nuclear Energy in Nepal"

Exercise

1. Tick (√) in the correct answer.

i. What is the name of the smallest part when an element is split?

a. Molecule   b. Atom

c. Nucleus   d. Proton

ii. What is the average diameter of an atom?

a. 10^{-10} m   b. 10^{10} m

c. 100 m   d. 1000 m

iii. Which of the following is a radioactive element?

a. Uranium b. Plutonium

c. Thorium d. All of the above

iv. Which of the following compounds consist of a covalent bond?

a. NaCl b. H_2O

c. $CaCl_2$ d. MgO

v. Which of the following atom has valency 3?

a. Oxygen b. Aluminium

c. Calcium d. Chlorine

vi. Which is the molecular formula of magnesium bicarbonate?

a. $MgCO_3$ b. $Mg(HCO_3)$

c. $MgHCO_3$ d. $Mg(CO_3)$

2. Fill in the blanks with suitable answers.

a. There is fixed energy in the shell or orbit of an atom. The scientist who found this fact is........

b. The process of formation of smaller nuclei by splitting the unstable atoms having high atomic number is called................

c. To gain octet state atoms of the number of calcium losses from its valence shell is......

d. In a molecule of ammonia ....bond is formed.

e. The molecular formula of calcium chloride is ....

f. The molecular mass of sodium bicarbonate is ....

3. Write the differences between.

a. Duplet and octet

b. Electrovalent bond and covalent bond

4. Give reasons.

a. Atomic energy has both boons and banes.

b. He and Ne elements do not take part in chemical reactions.

c. Methane is a covalent compound.

5. Answer the following questions.

a. What is an atom?

b. What do you understand by subatomic particles?

c. Explain about atomic models.

d. What is radioactive emission? Write its type.

e. Write about nuclear fusion and nuclear fission in short.

f. What is octet and duplet state? Write with an example.

g. What is a chemical bond?

h. Explain the process of formation of electrovalent bond and covalent bond with one example of each.

i. Explain about the process of formation of molecules of ammonia, sodium chloride, and magnesium chloride with figure.

j. Define valency.

k. What is ion? How are positive and negative ions formed? Write with an example.

l. How do we write molecular formulas? Explain with examples.

m. What is molecular mass? Calculate the molecular mass of the following compounds.

   i. Sodium chloride

   ii. Calcium carbonate

   iii. Ammonia

   iv. Carbon dioxide

   v. Magnesium sulphate

15 Chemical Reaction

Turning milk into curd when we mix lemon juice, rusting in iron, formation of ash when firewood burns, etc. are some examples of chemical reactions. These facts have been studied in our previous lesson. In all of these chemical changes, new substances are formed with different properties. Do the following activity

Activity 15.1

Take about half a glass of milk; stir for some time by keeping some drops of lemon juice in it. Observe the changes in the milk before and now. Taste the milk by taking a few drops in a spoon. Is the taste of milk in both conditions the same? Explain.

During chemical change within the atoms of matter, either the exchange, combination or decomposition occurs. This process is called chemical reaction. For example,

1. Hydrogen gas + oxygen gas $\rightarrow$ water

   (Combination between atoms of hydrogen and oxygen)

2. Calcium carbonate $\rightarrow$ calcium oxide + carbon dioxide

   (Decomposition of calcium carbonate)

3. Magnesium + hydrochloric acid $\rightarrow$ magnesium chloride + hydrogen gas

   (Exchange of atoms between magnesium and hydrochloric acid)

Reactants and products

See the chemical reaction given below and discuss which product is formed by the combination of reactions.

Carbon + oxygen $\rightarrow$ carbon dioxide

In the chemical reaction given above, carbon dioxide has been formed by the reaction between carbon and oxygen. Carbon and oxygen are the reactants in the reaction. Carbon dioxide is a product formed from the reaction. Thus, the substances which take part in chemical reactions are called reactants and the substances obtained due to chemical reactions are called products.

Sodium + chlorine $\rightarrow$ Sodium chloride

Reactants *product*

Chemical equation

Activity 15.2

Take dilute hydrochloric acid more than half in a test tube. Observe keeping a piece of zinc in that hydrochloric acid.

1. *Which are reactants in this chemical reaction?*
2. *What are the products formed after a chemical reaction and how do we write that chemical reaction? Ask with your teacher.*

When a piece of zinc is kept in dilute hydrochloric acid, we can understand zinc chloride and hydrogen gas are formed from the activity 15.2. The chemical reaction is written in the following ways:

Zinc + hydrochloric acid $\rightarrow$ zinc chloride + hydrogen gas

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

The equation which represents the chemical reaction is called the chemical equation. In chemical reactions, reactants are written in the left hand side of an arrow and products are written in the right hand side. The chemical reaction between zinc and dil. hydrochloric acid is given above. In this equation, zinc and hydrochloric acid are reactants and zinc chloride and hydrogen gas are the products. The method of representing chemicals which take part in chemical reaction and the products formed after reaction with word or formula is called chemical equation.

Word equation

Look at the following chemical reaction:

Calcium carbonate $\rightarrow$ Calcium oxide + carbon dioxide

In this chemical reaction calcium oxide and carbon dioxide are formed when calcium carbonate is heated. The reaction is expressed with words. Thus, the method of representing the chemicals that take part in chemical reaction and the products formed after reaction by word is called word equation.

Formula equation

Writing the above reaction with formula equation

$$CaCO_3 \xrightarrow{\text{heat}} CaO + CO_2$$

In this reaction, the chemicals that take part in the chemical reaction and the products obtained after reaction are expressed with formula. Thus, the process of representing the substance included in chemical reaction and the products formed after reaction with symbol and formula is called formula equation.

Unbalanced chemical equation

Counting the number of atoms of the same kind present in reactants and products of the following chemical reaction are given in the table below.

1. $Zn + HCl \rightarrow ZnCl_2 + H_2$

Element	No. of atoms of reactant	No. of atoms in product
Zinc	1	1
Hydrogen	1	2
Chlorine	1	2

In this equation, the number of zinc is the same in the left hand side and right hand side but the number of hydrogen and chlorine is not the same.

2. $Mg + O_2 \rightarrow MgO$

Element	No. of atoms of reactant	No. of atoms in product
Magnesium	1	1
Oxygen	2	1

In this reaction, the number of magnesium atoms is the same in reactant and product but the number of oxygen atoms is not the same.

3. $KClO_3 \rightarrow KCl + O_2$

Element	No. of atoms of reactant	No. of atoms in product
Potassium	1	1
Chlorine	1	1
Oxygen	3	2

In this equation, the number of atoms of potassium and chlorine in the right hand side and left hand side is the same but the number of oxygen atoms is not the same.

Such type of chemical reactions is unbalanced chemical reaction.

Thus, the chemical reaction, which is written without making the number of atoms of reactant and product the same, this type of chemical reaction is called unbalanced chemical equation. Such chemical reactions need to be balanced.

Balanced chemical equation

Look at the chemical equations given below once again. Count the number of atoms of reactants and products of the same kind.

1. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

Element	No. of atoms of reactant	No. of atoms in product
Zinc	1	1
Hydrogen	2	2
Chlorine	2	2

In this equation, the number of atoms of zinc, hydrogen and chlorine is equal in reactant and in product.

2. $2Mg + O_2 \rightarrow 2MgO$

Element	No. of atoms of reactant	No. of atoms in product
Magnesium	2	2
Oxygen	2	2

In this equation, the number of magnesium and oxygen atoms is equal in both sides.

3. $2KClO_3 \rightarrow 2KCl + 3O_2$

Element	No. of atoms of reactant	No. of atoms in product
Potassium	2	2
Chlorine	2	2
Oxygen	6	6

In this reaction, the number of atoms of potassium, chlorine and oxygen is the same on both sides.

This type of chemical reaction is balanced chemical equation.

Therefore, the chemical equation which is written by making an equal number of atoms in reactants and in products of the same kind is called a balanced chemical equation. It is necessary to express the state of reactants and products in a balanced chemical equation. It is written if the substance is in solid state (s), if the substance is in liquid state (l) and if the substance is in gaseous state (g).

The method of writing balanced chemical equation

principle is called conservation of mass. Based on this principle the chemical equations are balanced. Hit and trial is the general method of balancing chemical equations. Attention should be paid to the following things while balancing chemical equations by this method.

a. First of all, the chemical reaction is expressed in a word equation.

b. Molecular formula of reactants and products is written.

c. The molecular formula present in the subscript of molecules should not be changed.

d. Finally, the number of atoms of the same kind should be equal by keeping a suitable coefficient in front of the molecular formula.

For example, look at the following chemical equation:

Hydrogen + oxygen → water

$H_2 + O_2 \rightarrow H_2O$

Finding the unbalanced atoms counting every atom in the chemical equation,

Element	No. of atoms of reactant	No. of atoms in product
Hydrogen	2	2
Oxygen	2	1

Number of hydrogen atoms at reactant and product side is equal in this equation, but oxygen has 2 atoms at reactant side and 1 atom at the product side. Molecule of water is multiplied by 2 to make the number of oxygen atoms equal on both sides. Hence, the hydrogen atom is unbalanced. To make it balanced, hydrogen at the left hand side is to multiply by 2. Then, the equation is written like this,

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

Now the number of atoms in above equation is as follows:

Element	No. of atoms of reactant	No. of atoms in product
Hydrogen	4	4
Oxygen	2	2

Therefore, the chemical equation is balanced now. Some examples of balanced chemical equation are given as follows:

1. Calcium carbonate $\xrightarrow{\Delta}$ C

   $CaCO_3 \rightarrow \Delta CaO + CO_2$

2. Hydrogen peroxide heat $\xrightarrow{\Delta}$ water + oxygen

   $2H_2O_2 \rightarrow 2H_2O + O_2$

3. Sodium hydroxide + hydrochlΔric acid $\rightarrow$ Sodium chloride + water

   $NaOH + HCl^{\Delta} \rightarrow NaCl + H_2O$

4. Aluminium + nitrogen heat $\rightarrow$ Aluminium nitride

   $2Al + N_2 \rightarrow 2AlN$

5. Sodium + oxygen $\rightarrow$ Sodium oxide

   $4Na + O_2 \rightarrow 2Na_2O$

Information obtained from balanced chemical equation

Activity 15.3

Study the balanced chemical equation given below and discuss the questions given.

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

a. What are the reactants and products in the chemical reaction?

b. What are the number of atoms present in reactant and product?

c. What is the additional information that we know from the balanced chemical equation?

The following are the information obtained from balanced chemical equation:

a. Name and molecular formula of reactant and product

b. Number of molecule and atoms of reactant and product

c. Ratio of mass of molecules of reactant and products.

d. Types of chemical reaction

Importance of chemical reaction in our daily life

How do the foods we eat get digested? How does the medicine that we eat work? How is curd obtained from milk? All of the activities above are possible due to chemical reaction. Without chemical reactions our daily life is impossible. Digestion of food in our stomach, getting cured by having medicine, production of energy by respiration, preparation of food by photosynthesis process, production of energy by the combustion of fuel, turning into curd are the daily activities in which chemical reactions occur.

Project work

What is the importance of chemical reactions in our daily life? Prepare a list and present in your class.

Exothermic reaction

Activity 15.4

a. Take water in a test tube. Mix calcium hydroxide or sodium hydroxide in the water and touch the test tube from outside. What do you feel? Cold or hot?

b. What changes will occur when lime is kept in water? Observe. Then, touch it with your hand. What change occurred? Share with your friend.

On the basis of production of heat or absorption of heat during chemical reaction, it is divided into two groups. For example: in activity 15.4 (a) and (b) heat is produced by the chemical reaction. Such types of chemical reactions are called exothermic reactions. Thus, the chemical reaction which releases heat during a chemical reaction is called an exothermic reaction.

Additional examples of exothermic reactions:

$$\underset{(aq)}{C_6H_{12}O6} + \underset{(ag)}{6O_2} \rightarrow \underset{(g)}{CO_2} + \underset{(l)}{6H_2O} + \text{Heat}$$

$$\underset{(s)}{CaO} + \underset{(l)}{H_2O} \rightarrow \underset{(ag)}{Ca(OH)_2} + \underset{(ag)}{\text{Heat}}$$

$$\underset{(s)}{C} + \underset{(g)}{O_2} \rightarrow \underset{(g)}{CO_2} + \text{Heat}$$

$$\underset{(s)}{NaOH} + \underset{(l)}{HCl} \rightarrow \underset{(l)}{NaCl} + H_2O + \text{Heat}$$

Endothermic reaction

Heat is required to cook food. In this process, burning (combustion) of gas is an exothermic reaction but cooking food is an endothermic reaction. The chemical reaction in which absorption of heat occurs is called endothermic reaction.

Additional examples of endothermic reaction

$$\underset{(s)}{C} + \underset{(l)}{H_2O} \xrightarrow{\text{Heat}} \underset{(g)}{CO} + \underset{(g)}{H_2}$$

$$\underset{(g)}{N_2} + \underset{(g)}{O_2} \xrightarrow{\text{Heat}} \underset{(g)}{2NO_2}$$

$$\underset{(s)}{CaCO_3} \xrightarrow{\text{Heat}} \underset{(s)}{CaO} + \underset{(g)}{CO_2}$$

Exercise

1. Choose the correct answer from the given alternatives.

i. Which of the following groups provides the examples of chemical change only?

a. Forming curd from milk when lemon juice is mixed, rusting of iron, forming ice from water

b. Formation of ash when wood is burnt, formation of vapor from water, formation of curd from milk

c. Cooking rice from rice, decaying dead animals, and digestion of food in the stomach

d. Preparation of toys from wood or mud, rusting of iron, formation of ash when wood is burnt

ii. Which of the following occurs during chemical reaction?

A. Exchange of atoms | B. Association of atoms
C. Dissociation of molecule | D. Friction between atoms

a. A, C and D | b. A, B and D
c. B, C, and D | d. A, B and C

iii. What are the reactants in the incomplete reaction given below?

$Zn + \ldots\ldots\ldots\ldots \rightarrow ZnCl_2 + H_2$

a. Zinc and sodium chloride | b. Zinc and chlorine
c. Zinc and water | d. Zinc and hydrochloric acid

iv. We can catch the substance A and B easily if we keep them in individual test tubes but when these two substances are mixed in a test tube, we cannot catch it due to excessive heating. What is the reason for it?

a. Due to exothermic reaction

b. Due to endothermic reaction

c. Due to both endothermic and exothermic reaction

d. Due to exothermic after endothermic reaction

2. Write the differences between:

a. Balanced and unbalanced chemical equation

b. Endothermic and exothermic chemical reaction

3. Answer the following questions.

a. How does chemical change different from physical change?

b. What is the chemical equation? Clarify with an example.

c. 'Our daily life was nearly impossible if there was no chemical reaction', Explain this statement connecting it with the importance of chemical reaction.

d. A person is cooking food in an oven by using firewood. Which are exothermic and endothermic chemical reactions?

4. Change the following word equation into formula equation.

a.	Nitrogen + hydrogen	→	ammonia
b.	Sodium + oxygen	→	sodium oxide
c.	Magnesium + nitrogen	→	magnesium nitride
d.	Calcium carbonate	→	carbon dioxide + calcium oxide
e.	Zinc + hydrochloric acid	→	zinc chloride + hydrogen
f.	Aluminium + nitrogen	→	aluminium nitride
g.	Potassium + chlorine	→	potassium chloride
h.	Hydrogen + chlorine	→	hydrogen chloride

5. Write balanced formula equation from the following unbalanced chemical equation

a.	$Na + O_2$	→	Na_2O
b.	$Hg + O_2$	→	HgO
c.	$Ca + N_2$	→	Ca_3N2
d.	$Fe + O_2$	→	Fe_2O_3
e.	$Fe + CuSO_4$	→	$FeSO_4 + Cu$
f.	$HCl + NaOH$	→	$NaCl + H2O$
g.	$HCl + KOH$	→	$KCl + H2O$
h.	$HNO_3 + Ca(OH)_2$	→	$Ca(NO_3)2 + H_2O$

6. Complete the following formula and balance them.

a.	$Fe + HCl$	→	………………… $+ H_2$
b.	$HCl +$ ………..	→	$NaCl + H_2O$
c.	$H_2SO_4 + NaOH$	→	……… $+ H_2O$
d.	$Na +$………..	→	Na_2O
e.	$Ca + O_2$	→	……….
f.	……… $+ O_2$	→	HgO
g.	$Fe +$ ………	→	Fe_2O_3
h.	……… $+ Ca(OH)_2$	→	$Ca(NO3)_2 + H_2O$
i.	$Al + N_2$	→	…………………

16

Gas

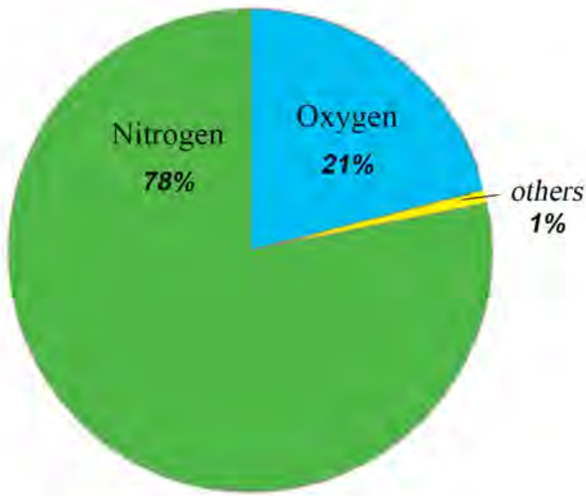


Figure: 16.1 gases in atmosphere.

Atmosphere is a layer which covers the earth around. There are various types of gases in the atmosphere. Look at the pie-chart given above and compare the volume of the various types of gases that are found in the atmosphere.

From the given pie-chart it is clear that about 99% of the atmosphere is occupied by nitrogen and oxygen. Except these gases, carbon dioxide, hydrogen, argon, ozone etc. gases are also present in the atmosphere.

Gases are present not only in the atmosphere but also in plants, animals, water, food, minerals etc. in the form of different types of compounds. These gases are used in respiration, photosynthesis and in the formation of various types of compounds. On the basis of weight, approximately 96% of the human body is made up of four elements oxygen, hydrogen, nitrogen,and carbon, out of them oxygen, hydrogen and nitrogen are gases. Therefore, gases are very important for us. The gases that we require are obtained from atmosphere or industrial manufacture. For the scientific studies gases are prepared in laboratories.

Hydrogen gas

The lightest gas found in the universe is hydrogen gas. Hydrogen gas is found in the form of different types of compounds like acid, base, hydrocarbon, carbohydrate, protein etc. Abundant amount of isotopes of hydrogen is found in stars including the sun.

The atoms of the elements which have the same atomic number but different in mass number are called isotopes. For example, $1H^1$, $1H^2$, $1H^3$

Chemist Henry Cavendish in 1893 had said that hydrogen is a combustible gas. Lavoiser named it as hydrogen since it gives water when it is combusted with oxygen. The meaning of hydrogen is water producer.

Some facts about hydrogen are given as follows:

Symbol	Atomic number	Atomic mass	Molecular formula	density
H	1	1	H_2	0.09 kgm^{-3}

laboratory preparation of hydrogen gas

Hydrogen gas is prepared by the displacement of hydrogen of acid by the active metals like zinc; magnesium etc. On the basis of this fact, hydrogen gas is prepared in the laboratory by reacting granulated zinc with dilute hydrochloric acid. The reaction is very slow with pure zinc. Therefore, impure zinc is used. The impurities present in impure zinc helps to catalyze the reaction to increase the rate.

$Zn\ (s) + \quad 2HCl\ (aq) \quad \rightarrow ZnCl_2\ (aq) \quad + \quad H_2\uparrow$

(zinc) (dil. hydrochloric acid) (zinc chloride) (hydrogen)

Method

Experimental activities: 1

Method of preparation of hydrogen gas

a. Put some pieces of granulated zinc in Woulff's bottle.

b. Connect a thistle funnel in at one opening and a delivery tube in another opening of Woulff's bottle by the help of cork as shown in the figure.

c. Close the cork making air tight.

d. Connect the delivery tube in the bee hive shelf in a water trough so that the opening of the tube sinks in water.

e. Invert a water full gas jar on a bee hive shelf.

f. Pour dilute hydrochloric acid through thistle funnel slowly.

Hydrogen gas starts to evolve immediately when zinc and acid are in contact. Thus produced gas is collected in a gas jar by the downward displacement of water since hydrogen is lighter than water.

Figure: 16.2 laboratory preparation of hydrogen gas

Test of hydrogen gas

To confirm the gas thus obtained is hydrogen, we need to test it. When a burning candle is taken to the jar with hydrogen gas, the burning candle extinguishes and a pop sound is heard with blue flame.

Precautions

1. All the apparatus should be washed well.
2. Impure zinc should be used.
3. It should be airtight when connecting apparatus.
4. Dil. acid should be used; concentrated acids do not give hydrogen.
5. Tip of the thistle funnel should be dipped but the tip of the delivery tube should not be dipped.
6. Gas jar should be completely filled with water.

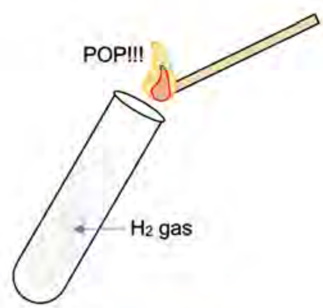


Figure: 16.3

Physical properties of hydrogen gas

1. Hydrogen is colorless, odorless and tasteless gas.
2. It is lighter than air.
3. It does not dissolve in water.
4. It does not respond to litmus paper, so it is neutral gas.
5. It liquefies at -253°C and solidifies at -259°C.

Chemical properties of hydrogen gas

1. Water is formed when hydrogen gas reacts with oxygen.

   $2H_2 + O_2 \rightarrow 2H_2O$

2. Hydrogen gas mostly reacts with non-metals at high temperatures.

   $C + 2H_2 \rightarrow CH_4$ (methane)

   $S + H_2 \rightarrow H_2S$ (Hydrogen sulfide)

3. Sodium, potassium, calcium etc. make unstable hydrides reacting with hydrogen gas.

   $2Na + H_2 \rightarrow 2NaH$ (Sodium hydride)

   $2K + H_2 \rightarrow 2KH$ (Potassium hydride)

   $Ca + H_2 \rightarrow CaH_2$ (Calcium hydride)

4. Hydrogen makes metal and water when treated with red hot oxides of less reactive metal. We follow this method to obtain metal from metal oxides. This process is called the reduction reaction. In this reaction, hydrogen reacts with oxygen of metallic oxide to form water and it makes metal free. Thus, the reaction is called a reduction reaction.

   Reduction reaction: The process of formation of a compound by the addition of hydrogen or formation of free metal by the removal of oxygen from metallic oxide is called reduction reaction.

   $2Fe_2O_3 + 6H_2 \rightarrow 4Fe + 6H_2O$

   $CuO + H_2 \rightarrow Cu + H_2O$

   $PbO + H_2 \rightarrow Pb + H_2O$

Uses of Hydrogen Gas)

1. Hydrogen is used to obtain metal from metallic oxide.
2. It is used to obtain ammonia gas by reacting with nitrogen by Haber's process.
3. It is used to convert vegetable oil into vegetable ghee. The process is called hydrogenation.
4. It is used as fuel in rockets. Enormous amount of energy is produced when hydrogen reacts with oxygen which helps to launch rockets.
5. When hydrogen is burnt in presence of oxygen it releases the temperature of about 3000°C. The flame thus obtained by the combustion of hydrogen is called oxy-hydrogen flame. It is used to cut and connect metals. This process is called welding.

Oxygen gas

Oxygen is required for living beings for respiration. Oxygen is about 21% in the atmosphere by volume. Oxygen is present in organic compounds like carbohydrate, protein, fat, wood etc. and inorganic compounds like calcium carbonate, silica, water etc.

British scientist Joseph Priestley had prepared oxygen for the first time by heating red oxide of mercury (HgO) in 1774 AD and Lavoisier had written the name oxygen.

Some facts about oxygen:

Symbol	Atomic number	Atomic mass	Molecular formula	Density
0	8	16	O_2	1.43 kgm^{-3}

Laboratory preparation of oxygen gas

A. By heating process

When oxide salt is heated, oxygen gas is produced. On the basis of this fact, oxygen gas is prepared by heating potassium chlorate ($KClO_3$) in the presence of catalyst manganese dioxide (MnO_2) in the laboratory.

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

Method

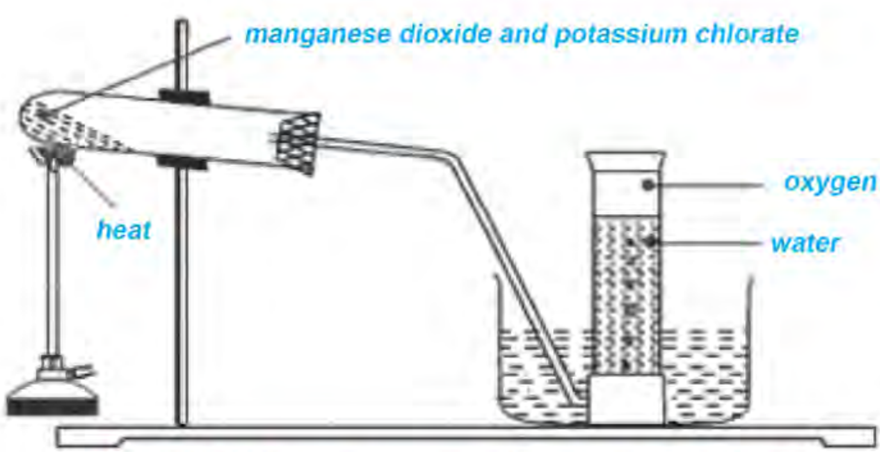


Figure: 16.4 Laboratory preparation of oxygen gas (by heating)

Experimental activity: 2

a. Put four parts of potassium chlorate and one part of manganese dioxide in a neat and clean hard glass test tube.

b. Connect a delivery tube as shown in the figure.

c. Close the cork air tight at the opening of the test tube.

d. Adjust the test tube on a stand slightly tilting opening downward.

e. Connect another end of the delivery tube to the beehive shelf so that the end sinks.

f. Fill a gas jar with water completely and invert it on a beehive shelf.

g. Heat the mixture of potassium chlorate and manganese dioxide by the help of Bunsen burner of spirit lamp.

Oxygen is produced by heating the mixture contained in the test tube. Thus obtained gas is collected in a gas jar by downward displacement of water. Oxygen gas is collected in a gas jar because it is lighter than water and partially soluble in water.

Precautions

1. Hard glass test tube should be connected at a tilting position as shown in the figure. It forbids the mixing of water obtained from the reaction with reactants.
2. It should be air tight when apparatus are connected.
3. Gas jar should be filled completely with water; it means there should not be air spaces.

B. Preparation of oxygen gas without heating

Oxygen gas is prepared in the laboratory by decomposition of hydrogen peroxide (H_2O_2) in presence of manganese dioxide (MnO_2).

$$2H_2O_2 \xrightarrow{MnO_2} 2H_2O + O_2$$

Procedure:

Experimental activities: 3

a. Keep manganese dioxide in a neat and clean conical flask.

b. Connect conical flask, thistle funnel, delivery tube etc. as shown in the figure.

c. Pour hydrogen peroxide into a conical flask by the help of thistle funnel so that the thistle funnel is dipped by hydrogen peroxide.

When hydrogen peroxide comes in contact with manganese dioxide, oxygen gas is obtained. Thus, obtained gas is collected in a gas jar by downward displacement of water.

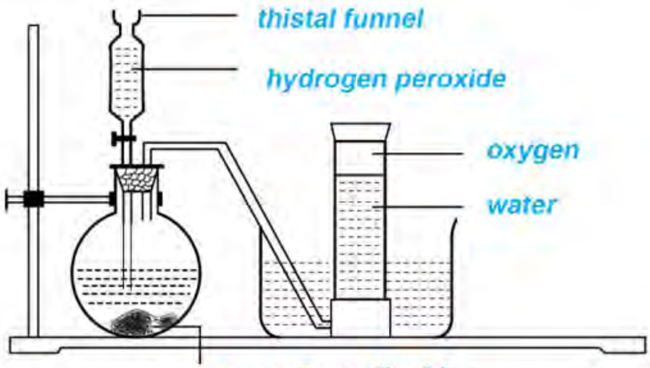


Figure: 16.5 Laboratory preparation of oxygen gas (without heating)

Precautions

1. While preparing the gas, all the apparatus should be connected by making air tight.
2. Hydrogen peroxide is kept in a conical flask till another end of the thistle funnels dips.
3. The manganese dioxide used should be pure.

Test of oxygen gas

Allow a burning candle to a jar containing oxygen gas to test whether the produced gas is oxygen or not. The candle burns more shining (larger flame). This proves that the produced gas is oxygen.

Fig 16.6

Properties of oxygen gas

Physical properties

1. Oxygen is colorless, odorless and tasteless gas.
2. It is slightly heavier than air.
3. It is partially soluble in water.
4. Oxygen gas is neutral in nature. So it does not respond with litmus paper.
5. It liquefies at -183°C and solidifies at -219°C.

Chemical properties

1. Oxygen makes metallic oxides when burned with metals.

Metal + Oxygen ⟶ Metal oxide

$4Na + O_2 \longrightarrow 2Na_2O$ (sodium oxide)

$4K + O_2 \longrightarrow K_2O$ (potassium oxide)

$2Mg + O_2 \longrightarrow 2MgO$ (magnesium oxide)

Activity:

Take a piece of magnesium ribbon. Observe an action in which ash of magnesium oxide is formed when magnesium ribbon is burnt.

2. Oxygen makes non-metallic oxide when it is burnt with non-metal.

Non-metal + oxygen ⟶ Oxide of non-metal.

$2H_2 + O_2 \longrightarrow 2H_2O$ (Water)

$C + O_2 \longrightarrow CO_2$ (Carbon dioxide)

$S + O_2 \longrightarrow SO_2$ (Sulphur dioxide)

$4P + 5O_2 \longrightarrow 2P_2O_5$ (Phosphorous pentoxide)

3. When hydrocarbons are burnt in presence of oxygen, they give carbon dioxide, water and energy.

Hydrocarbon + oxygen ⟶ Carbon dioxide + water + energy

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + energy
(Methane)

$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$ + energy
(Ethene)

4. When glucose is reacted with oxygen, it gives carbon dioxide, water, and energy. In the respiration process in living beings, this type of reaction occurs.

   $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O +$ energy

   (Glucose)

5. Alcohol gives carbon dioxide, water and energy when burned with oxygen.

   $C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O +$ energy

   Ethyal alcohol

Uses of oxygen gas

1. Living beings use oxygen gas to produce energy through the respiration process.
2. Oxygen is used to cut or connect metals by welding process. For this, oxy-acetylene flame or oxy-hydrogen flame is used.
3. It is used in artificial respiration for the patient who is suffering from difficulty in breathing.
4. Cylinder oxygen is used in the places where there is no abundant oxygen like mines, mountaineering, space journey, mariners etc.
5. Oxygen is used in the manufacture of steel.

Ozone

Ozone is a triatomic compound (composed up of three atoms) of oxygen with blue color. But in liquid state it looks dense blue. Ultraviolet rays coming from the sun destroys ozone into atomic (nascent oxygen) oxygen. Molecule of ozone is formed by the combination of a molecule and an atom of oxygen (nascent oxygen).

$O_2 \xrightarrow{uv\text{-}rays} O + O$ (nascent oxygen)

$O_2 + O \xrightarrow{uv\text{-}rays} O_3$ (ozone)

Thus, obtained ozone makes a thick layer at the stratosphere of the atmosphere. This layer formed in the stratosphere is called the ozone layer. It extends from 25 km to 40 km from the surface of the earth.

Importance of ozone layer

The ozone layer present in the atmosphere absorbs ultraviolet rays coming from the sun. Due to this, the harmful rays cannot reach the surface of the earth. Therefore, this layer of atmosphere is called the protective layer.

a. Ozone layer helps to balance climate and temperature of earth.

b. It helps to prevent aquatic and terrestrial ecosystems present in the earth.

c. It helps to prevent the destruction of ecosystems and to keep them in balanced form.

d. It absorbs the harmful rays that come from the sun and prevents living beings of earth from suffering from the disease that can cause from radiation.

Depletion of ozone layer

The process of becoming an ozone layer thinner present in the stratosphere is called ozone layer depletion. The chief chemical that depletes the ozone layer is chlorofluoro carbon (CFCs). In addition to this, methyl chloroform, carbon tetrachloride, methyl bromide, oxides of nitrogen etc. are causative chemicals that depletes the ozone layer. The chemicals that are used in modern devices are mixed in the stratosphere and they are broken in presence of ultraviolet rays to atoms of bromine, chlorine. These atoms break the ozone into oxygen molecules and the ozone layer is depleted. Continuous depletion of the ozone layer makes a hole in it.

The process of depletion of ozone layer by chlorofluoro carbon is given the following example.

$$CFCl_2 \xrightarrow{\text{UV rays}} CFCl + Cl$$

$$ClO + O_3 \longrightarrow ClO + 2O_2$$

$$2ClO \longrightarrow 2Cl + O_2$$

Effects of ozone layer depletion

Due to ozone layer depletion, uv-rays coming from the sun reach to the surface of the earth. It causes the following effects in biotic and physical aspects.

a. Effects in human health: Ultraviolet radiation causes burning of eyes, itching of eyes, cataract. It causes burning of bodies, itching of skin, rupture of skin etc. Human beings may suffer from skin cancer due to the effects of it. The immune system of human beings becomes weaker and reproductive ability of the organism decreases.

b. Effects in plants: Growth of the plant stops due to ultraviolet radiation. It also decreases the rate of photosynthesis in plants. Due to which agricultural products are decreased.

c. Temperature of the earth is increased Due to depletion of the ozone layer, energetic radiations like ultraviolet radiations come from the sun reaching the earth. It results in an increase in the temperature of the earth.

d. Effects in ecosystem Due to ozone layer depletion, elements of the ecosystem are affected. So, the ecosystem is imbalanced.

Let's discuss:

Why do the problems given below occur? Discuss with your opinion.

a. The extent of snow on the mountain is decreasing and the snowing mountain is being converted into black hill, why?

b. The diseases like cataracts, hereditary variation etc. are being increased, why?

Ways to protect ozone layer

a. The use of the device and the machine, which produces chlorofluoro carbon should be minimized because it is the gas which depletes the ozone layer.

b. The use of hydrofluoric carbon instead of chlorofluoro carbon should be encouraged.

c. The use of nitrogenous fertilizer should be minimized because it produces oxides of nitrogen.

d. The use of vehicles that are conducted by petroleum should be minimized and the use of electric vehicles should be increased.

Nitrogen Gas

Activity

Based on volume, which of the gas is found in the largest amount? What is the significance of the gas? Search on the internet and in other resources.

Daniel Rutherford discovered an inert gas in 1772 AD and Jean Antoine Chaptal named the gas as nitrogen in 1790 AD. In comparison with other gases, nitrogen is more inert gas. It does not react with other elements or compounds in normal condition. It is found in plants and protein, enzymes, RNA, DNA etc. found in animals. Nitrogen gas is also found in some stones and minerals in the form of various compounds.

Laboratory Preparation of Nitrogen Gas

Nitrogen gas is prepared in the laboratory by heating the mixture (solution) of sodium nitrite ($NaNO_2$) and amonium chloride (NH_4Cl).

$$NaNO_2 + NH_4\,Cl \xrightarrow{\text{heat}} N_2\uparrow + NaCl + 2H_2O$$

Procedure

About 5 g of sodium nitrite and 4 g of ammonium chloride is kept in a clean round bottomed flask. About 50 ml of water is kept in the flask and a solution is prepared. Apparatus are fitted as shown in the figure. Now, the solution is heated gently. Nitrogen gas is produced after the mixture is heated. Thus produced nitrogen gas is collected in a gas jar by downward displacement of water by the help of a delivery tube.

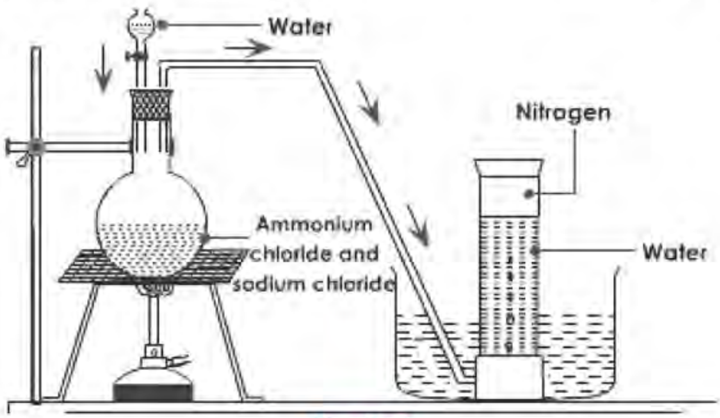


Fig: 16.7

Precautions

1. Apparatus should be fitted air tight and the mixture is heated gently.
2. Solution of the mixture needs to be prepared before heating since ammonium chloride turns into gas at solid state (undergoes sublimation)

Test of the gas

A burning magnesium ribbon continues burning when it is inserted into the jar containing nitrogen gas and finally turns into yellow powder. If the smell of ammonia is felt when some drops of water are kept in the powder, we can conclude the presence of nitrogen in the gas jar.

Physical properties of nitrogen gas

1. Nitrogen is colourless, odourless and tasteless gas.
2. It is lighter than air.
3. It is sparingly soluble in water.
4. Nitrogen gas is neutral in nature. So, it does not affect litmus paper.
5. It is neither combustible nor a supporter of burning.
6. It liquefies at about -196°C and solidifies at -210°C.

Chemical properties of nitrogen gas

Nitrogen gas is inert gas in comparison with other gases. It does not react easily with other elements in normal conditions. In some special conditions, it reacts with various substances.

1. Nitrogen reacts with hydrogen at about 450°C temperature and 500 atm pressure along with presence of Fe/Mo promotor and forms ammonia.

   $$N_2 + 3H_2 \xrightarrow{450°C \text{ and } 500 \text{ atm}} 2NH_3 \text{ (ammonia gas)}$$

2. Nitrogen forms nitric oxide reacting with oxygen at 2000°C to 3000°C temperature and electric arc.

   $$N_2 + O_2 \xrightarrow{\text{electric arc}} 2NO \text{ (Nitric oxide)}$$

3. When burning magnesium, calcium, aluminium is inserted into a gas jar containing nitrogen gas they continue burning and forms metallic nitride.

   $$3Mg + N_2 \xrightarrow{\text{heat}} Mg_3N_2 \text{ (Magnesium nitride)}$$

   $$3Ca + N_2 \xrightarrow{\text{heat}} Ca_3N_2 \text{ (Calcium nitride)}$$

Uses of Nitrogen gas

1. Nitrogen gas is used to prepare ammonia, nitric acid etc. that are used to manufacture nitrogenous chemical fertilizer.
2. It is used to fill in the packets containing food materials to prevent spoiling.
3. It is used to fill in bulbs to prevent tungsten filament from burning.
4. It liquefies at -196.5°C so it is used to cool the refrigerator.

Project work:

Ozone layer is considered as the protective layer which stops the ultraviolet rays coming from the sun. What is the reason behind this? There are many effects of ozone layer depletion. So, it is of utmost importance to preserve the ozone layer. How can we prevent the ozone layer? Prepare a report by using the internet, magazine and other different types of resources.

Exercise

1. Choose the correct answer.

a. Which one of the following compound is heated to obtain oxygen gas in the

i. $KClO_3$ ii. $CaCO_3$

iii. H_2O_2 iv. Fe_2O_3

b. Which of the following compounds is formed when magnesium is burnt with oxygen?

i. Magnesium nitrate ii. Magnesium nitrite

iii. Magnesium oxide iv. Magnesium nitride

c. Metal and water is formed when dry hydrogen is passed into hot metallic oxide. What is this process called?

i. Hydrogenation ii. Reduction

iii. Oxidation iv. Carbonation

d. Which is the main gas that depletes the ozone layer?

i. Chlorofluoro carbon ii. Methane

iii. Carbon dioxide iv. Sulphurdioxide

e. Which compound is suitable to fill in the following blank?

$C_6H_{12}O_6 + O_2$ ……... + H_2O + energy.

i. CO ii. CO_2

iii. CaO iv. $CaCO_3$

2. Give a reason.

a. Ozone layer is called protective layer.

b. Hydrogen and oxygen gas is collected by water displacement method.

c. The rate of melting ice in mountains is increasing.

3. Answer the following questions.

a. Write the chemical equation which is used in laboratory preparation of hydrogen gas.

b. Draw a diagram of laboratory preparation of hydrogen gas and write the procedure stepwise.

c. Write any four physical properties and any four uses of hydrogen.

d. How do you identify the hydrogen gas contained in a gas jar? Write.

e. Which compounds are formed when the following substances react with hydrogen? Write with a balanced chemical equation.

   i. Sodium   ii. Oxygen   iii. Calcium   iv. Ferric oxide

f. Explain the method of preparation of oxygen without heating in the laboratory with a diagram.

g. Explain the method of preparation of oxygen by heating in the laboratory with a diagram.

h. Write any four physical properties and four uses of oxygen.

i. How do you identify the oxygen gas contained in a gas jar? Write.

j. Which compounds are formed when the following substances are reacted with oxygen? Write with a balanced chemical equation.

   i. Magnesium   ii. Carbon   iii. Methane   iv. Glucose

k. What is the ozone layer? How does its formation and depletion occur? Write with an equation.

l. Write the role of the ozone layer to protect living beings on the earth.

m. Man is responsible mainly for the increase in the radiation in the earth. Justify the statement with an example.

n. In any place of the earth, increased radiation from the sun is measured. Write its causes and effects.

4. Complete the following chemical equations.

(i) $2H_2 + \ldots\ldots\ldots\ldots \longrightarrow 2H_2O$

(ii) $Na + H_2 \longrightarrow \ldots\ldots\ldots\ldots\ldots\ldots$

(iii) $\ldots\ldots\ldots\ldots \longrightarrow KCl + 3O_2\uparrow$

(iv) $\ldots\ldots\ldots + O_2 \longrightarrow CO_2 + 2H_2O + \text{energy}$

(v) $C_6H_{12}O_6 + O_2 \longrightarrow \ldots\ldots\ldots\ldots + \ldots\ldots\ldots + \text{energy}$

(vi) $3Mg + O_2 \longrightarrow \ldots\ldots\ldots\ldots\ldots\ldots$

(vii) $4P + 5O_2 \longrightarrow \ldots\ldots\ldots\ldots\ldots\ldots$

(viii) $Zn + \ldots\ldots\ldots\ldots \longrightarrow ZnSO_4 + H_2$

17

Metals and Non-metals

Various types of matter are found around us. Out of these matters some are elements. Elements have been divided into three parts i.e. metal, metalloids and non-metal. We are using metals, metalloids and non-metal. Metal is used extensively among them. Metal is used to make utensils, vehicles, and electric devices etc. which are used in our daily life. Metals are found in free state (pure state) or in the form of ore (impure state). Iron (metal) is present in our blood, metals are found in the form of chlorophyll in plants as well. Therefore, the study of metal is important.

Activity: 17.1

Observe the following figures and answer the following questions

Figure: 17.1

1. From which metals are the objects shown above prepared? Identify them and say their name.

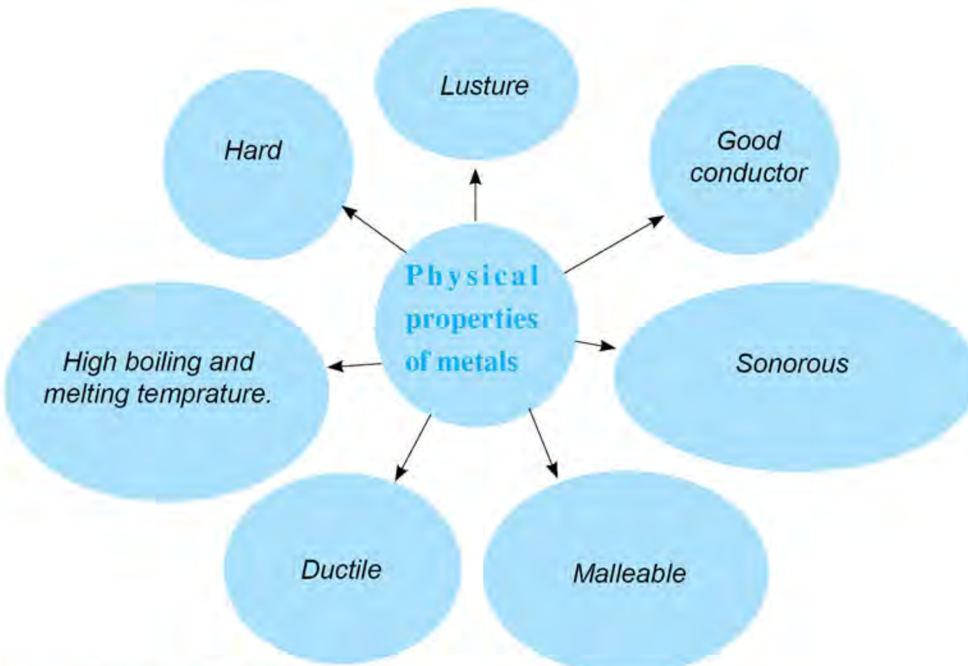
2. Write the name of metals that you see and mention their uses.

General properties of metals

The properties of metals have been divided into two parts: physical and chemical properties.

A. Physical properties of metals

Some physical properties of metals have been given in the figure below.



1. Metals are malleable.

Activity 17.2

Collect pieces of wood, iron nail or wire, pieces of copper, coins, pieces of aluminium, Sulphur, coal etc. which are found in your surroundings. Hit these substances by keeping one above another on the supervision of your guardian or teacher by the help of a hammer. Which of these objects got broken and which of them turned into flats? Observe them and fill in the table below.

The malleable objects	The brittle objects(turns into pieces)

From the above activity, we can know that metals like iron, copper, aluminium, silver, tin, gold etc. turn into flat foil when hammered but non-metals like Sulphur, carbon etc. get broken down into pieces. The property of metals which turns into flat foil when hammered is called malleability. The main reason for malleability is due to metallic bond which does not break but transfers from one atom to another.

2. Metals are ductile.

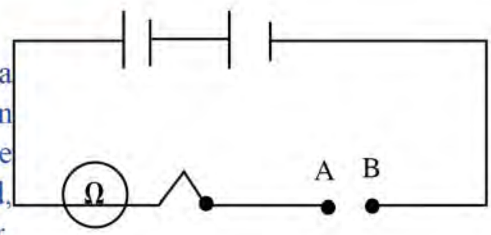
Activity 17.3

Wires of which metals have you seen? Observe and prepare a list

You may have seen long wires of iron, copper aluminium etc. All of these wires are obtained by stretching metals. The properties of metals do not change if we do so. We can make wire by stretching metals. The property of metal is called ductility. The main reason for malleability is due to metallic bond which does not break but transfers from one atom to another.

3. Metals are good conductor of electricity.

Activity 17.4



Take a dry cell, pieces of wire and a bulb. Connect all these objects as shown in the figure. Complete the circuit by the help of aluminium wire, piece of wood, a piece of paper, a piece of Sulphur, copper wire, iron nail etc. turn by turn in the space between A and B. At which conditions does the bulb glow? Observe. When the bulb glows connecting by the objects; the object is metal if it does not glow the object is non-metal.

Bulb glows when aluminium wire, copper wire, iron wire, coin, zinc etc. are connected, but when pieces of Sulphur, coal etc. are used to connect the circuit, the bulb does not glow. It proves that metals are good conductors of electricity but non-metals are not.

4. Metals are good conductors of heat.

Activity 17.5

Collect some objects like iron nails, steel spoon, aluminium foil, pencil, piece of wood etc. Heat these objects from one end in fire on the supervision of your parents or your teacher. Have you felt the other end of the objects that you touch heated?

The heat transfers from one terminal to another in metals but does not transfer in non-metals. Therefore, metals are called good conductors of heat but non-metals are bad conductors (insulator). The electrons present in atoms of metal are free. Metals are good conductors of heat.

5. Metal produces a sonorous sound when beated.

Activity 17.6

produced. Compare the sound produced in this activity with the sound produced during ringing of bell at temple and discuss in your classroom.

Sonorous sound is produced when the substances made up of metals are hammered. This property of metal is called sonorous.

6. Most of the metals are hard.

Activity 17.7

Collect a foil of iron, a foil of aluminium, copper utensil, coal, Sulphur etc. Examine the hardness of these substances by touching, cutting or scratching with an iron nail. Try to break these substances again. What types of results did you get? Prepare a table and present in your class.

It is clear from the activities above that most of the metals are hard. We cannot cut, scratch, and break these substances easily. Non-metals are soft, and can cut, scratch and break into pieces easily.

Note: All metals are not hard. For example: sodium, potassium. These metals are soft and can be cut easily by the help of a knife. Diamond is non-metal but it is the hardest substance known.

7. Most of the metals have high melting and boiling point.

There is a strong attraction force between atoms of metal. Therefore, most of the metals are strong and hard. Melting point and boiling point of these metals is high. Most of the non-metals have low melting and boiling point

Chemical properties of metals

1. Most of the metals make basic oxides reacting with air (oxygen).

Activity 17.8

Burn a piece of magnesium metal by the help of a fire tong. Collect the ash formed by this process in a test tube. Observe the color and odor of the ash and shake the test tube adding little water in it. Test the acidic or basic nature of the solution thus obtained and discuss in the classroom.

Metals make metallic oxide reacting with metal. These oxides are basic in nature.

Metal + oxygen $\longrightarrow$ Metallic oxide

$4Na + O_2 \longrightarrow 2Na_2O$ (sodium oxide)

$2Mg + O_2 \longrightarrow 2MgO$ (Magnesium oxide)

$4Al + 3O_2 \longrightarrow 2Al_2O_3$ (Aluminium oxide)

$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$ (Ferric oxide)

$2Cu + O_2 \longrightarrow 2CuO$ (Cupric oxide)

2. Reactive metals react with dilute acid and produce salt of metal and hydrogen gas.

Activity 17.9

Take dilute hydrochloric acid in a test tube. Put a piece of magnesium ribbon into it. After some time, hydrogen gas is evolved outside from the test tube and salt of magnesium chloride is obtained at the bottom of the test tube. Observe the same activities done with aluminium, iron. Test the hydrogen gas produced by these reactions.

Metal + dil. acid $\longrightarrow$ salt of metal + hydrogen gas

$Mg + \text{dil.}2HCl \longrightarrow MgCl_2 + H_2$

$2Al + \text{dil.}6HCl \longrightarrow 2AlCl_3 + 3H_2$

$2Fe + \text{dil. }6HCl \longrightarrow 2FeCl_3 + 3H_2$

$Zn + \text{dil. }H_2SO_4 \longrightarrow ZnSO_4 + H_2$

$Mg + \text{dil. }2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$

3. Reactive metals react with water and form metallic hydroxide (alkali) and hydrogen gas.

Activity 17.10

Take some water in a test tube. Put a small piece of sodium, potassium or calcium into the water. After sometime, hydrogen gas is evolved leaving metallic hydroxide at the test tube. Reactive metals like potassium and calcium should not be touched by our bare hands. Test the hydroxide of metal and hydrogen gas obtained from the reaction.

Precautions: Sodium is a very reactive metal, so it may explode when dissolved in water.

The metals like lithium, sodium, potassium, calcium displace hydrogen from water and forms metallic hydroxide.

Reactive metal + water $\longrightarrow$ hydroxide of metal + hydrogen gas

$$2Li + 2H_2O \longrightarrow 2LiOH + H_2$$

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

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

$$2K + 2H_2O \longrightarrow 2KOH + H_2$$

Differences between metals and non-metals

The differences between metals and non-metals can be studied in points as follows:

SN	Properties	Metal	Non-metal
1.	Malleability	Malleable	Not malleable
2.	Ductility	Ductile	Not ductile
3.	Conductivity	Good conductor	Bad conductor
4.	Conduction	Can transfer heat	Cannot transfer heat
5.	Melting point and boiling point	M.P. and B.P. higher	M.P. and B.P. lower
6.	Hardness	Mostly hard and cannot be broken	Mostly soft and can be broken

Activity 17.11

On the basis of text studied above, fill the following table.

Matter	Physical properties	Chemical properties		
		Reaction with oxygen	Reaction with H2O	Reaction with acid
Metal				
Non-metal				

Some metals required for human body

Some metals are essential to conduct metabolic activities regularly in our body. For example: sodium, potassium, magnesium, calcium, iron, etc. These metals reach our body through various foods. Due to lack of these metals, metabolic activities of our body get affected. For example, anemia occurs due to lack of iron in blood. The heartbeat becomes irregular due to lack of sodium and potassium in our body. We need to know the sources that supply essential metals in our body through food materials. In this lesson, we know the sources, advantages, and effects due to lack of sodium, potassium, magnesium, calcium, and iron.

Name of metal	Sources	Advantages to the human body	Effects due to lack of it in human body
Zinc	1. Seeds of plants like pumpkin, seed of aalas, seed of sunflower, cereals, mushroom, almond, cashew nut etc. 2.Materials prepared from milk, meat, fish, egg etc.	1. It enhances immune power in human body. 2. It enhances ability to fight against bacteria and viruses. 3. It forms protein, DNA, hereditary materials in human cells. 4. It helps to develop embryos in pregnancy.	1. Hair fall 2. Decrease in odor and in taste 3. Feeling laziness 4. Loss of weight and suffered from diarrhea. 5. It takes longer time to cure wounds and injuries.

Iron	1. Spinach, cereals, broccoli, seeds of plant etc. are the sources of iron. 2. Iron can be obtained from fish and meat.	1. Blood consists of iron which transfers oxygen in the body. 2. Iron forms DNA in body 3. It helps in respiration. 4. It maintains immune power of body and helps in the production of energy.	1. Persons suffer from the disease like anemia due to lack of iron. 2. Due to lack of it, people feel tired, and feel difficulties in breathing.
Sodium	1. Table salt is the main source which supplies sodium in the human body. 2. In addition to this meat, egg etc. are the sources which supply sodium.	1. Sodium balances water and salt inside and outside of the cell of human body. 2. It helps to continue work efficiency of nerves and muscles	1. Due to lack of sodium, people may suffer from diseases like hyponatremia. 2. Due to lack of sodium, muscle spasm occurs. 3. It can cause vomiting, loss of sense, fainting or can die due to lack of sodium.
Potassium	1. We can get the potassium that our body gets from fruits, soyabean, vegetables, and from dairy products. 2. Potassium can also be obtained from banana, avocado, bamboo buds (tama), milk, curd, etc.	1. Potassium controls the liquid materials, muscles and efficiency of the nervous system. 2. It controls the weakening of bone, being stone in kidney.	1. Due to lack of potassium the disease like hypokalemia can be caused. 2. Blood pressure gets increased due to lack of it. People suffer from constipation, the body feels weakness, and muscles become weak.

Activity 17.12

On the basis of the lesson studied above, fill the following table.

Essential minerals for human health	Iron	Zinc	Sodium	Potassium
Sources				
Advantages for human body				
Effect due to lack of minerals				

Harmful effect of mercury and lead

Activity 17.13

Prepare a list of things that have the use of lead and mercury. What types of effect can be seen in our body if these metals enter into our body? Investigate the effects and prepare a list. Present the prepared list in your class and discuss.

Lead

Lead is used in batteries of vehicles, color, petroleum, lead crystal glass, radiation security foil etc. It has many other negative effects on our body. Lead harms almost all parts of the body.

The effects in children are more than other age groups. Due to lead, one can suffer from headache, stomachache, changes in attitude, anemia, retardation of the development of the brain etc. If the lead deposits are maximum in bone, formation of blood cells and absorption of calcium is stopped. Lead weakens the bone.

Mercury

Mercury is used in thermometer, barometer, tubelight etc. There are many negative effects of mercury in our body. The harmful effects of mercury are called hydrargyria or mercurialism.

1. A drop of mercury blocks the blood vessels and it can cause death.
2. Compounds of mercury harm (loses) the brain badly.
3. It harms the kidneys and lungs.
4. Mercury harms the babies in the womb because mercury can enter into the placenta easily and stops the development of babies in womb.
5. Compounds of mercury have negative effects in the mental development of the child.

Exercise

1. Choose the correct answer.

i. Which of the following is an example of non-metal?

a. Mercury b. Bromine

c. Iron d. Copper

ii. Which of the following is the characteristic of non-metal?

a. Conductor of heat b. Brittle

c. Ductile d. Malleable

iii. Which of the following metals is harmful to our body?

a. Fe b. Ca

c. Zn d. Pb

iv. What is the harmful effect of mercury called?

a. Hydrargyriasis b. Anemia

c. Hemophilia d. Scurvy

v. Metal can conduct current. Which of the following is the reason behind this?

a. Metal contains free electron.

b. Metal has tendency to gain electron.

c. The outermost shell of the atom of metal is completely filled.

d. Atom of metal is in motion.

2. Differentiate between:

a. Metal and non-metal on the basis of physical properties

b. Malleability and ductility

3. Give reasons:

a. Metals can be turned into flat foil by beating and turn into wire by stretching.

b. Melting point and boiling point of metals is high.

c. The mercury thermometer should not be given to children to take it in their mouth.

4. Answer the following questions.

a. Make a list of physical properties of metal.

b. 'Metals are good conductors of electricity'. How do you prove? Clarify.

c. Write any three chemical properties of metals with chemical equations.

d. Write any two negative effects of mercury and lead of each in the human body.

e. Make a list of sources of metals that are required for the human body.

Metal	Iron(Fe)	Zinc(Zn)	Sodium(Na)	Potassium (K)
Source				

18 Carbon and its Compounds

Introduction to Carbon

Have you seen coal, charcoal, sooty etc.? Have you seen the color of these substances? By which materials are they formed? Discuss.

The color of coal, charcoal and sooty is black. They are formed from carbon. The word 'carbon' has come from Latin, the meaning of this word is charcoal. Generally, the color of carbon is black and burns in air easily. Burning of carbon gives black dense smoke along with heat and light. If a substance burns and gives black dense smoke as well as the remaining substance after burning is black, it confirms the presence of carbon in the substance. Nowadays, people are extensively using various things like diamond, graphite etc. made up of carbon. The study of carbon is highly increased because carbon is the chief element of organic compounds. Carbon is a non-metal with atomic number 6 and atomic mass 12 and has abnormal color.

Activity 18.1

Collect coal, sooty, charcoal, lead of pencil, black rod present in dry cells etc. and study the color and other properties of carbon.

Sources of Carbon

Think for some time in the examples given below:

When firewood is burnt, black smoke is obtained. Similarly, burning of candles also gives black smoke. Burning of sugar forms sugar charcoal. Are smoke, charcoal, and sooty etc. sources of carbon? On the basis of these examples, discuss the sources of carbon.

Carbon is found in all living beings in different forms. So, carbon is considered as a fundamental component of the structure of living beings. Compounds of carbon are present in food, clothes, table, pen, pencil etc. Some of the sources of carbon are given in the following table.

In the form of carbon element	Carbon; in the form of compound	
	Inorganic compounds	Organic compounds
Coal Sooty Charcoal Diamond Graphite Graphene	Carbonates, bicarbonates, carbides (eg. CaC_2, SiC) Minerals, stones, gases, CO2, CO etc.	Carbohydrates, protein, fat, petrol, urea, vitamins, medicine, silk, paper, soap etc. Hydrocarbon gases, like methane, ethane, LPG etc.

Activity 18.2

Prove that wood and sugar consist of carbon.

Burn a piece of wood and observe. Did you get black colored charcoal? Take sugar in a spoon and observe while heating. Observe the changes in color and odor of heating sugar. What is the color of the sugar when it gives a pleasant odor? The stage of sugar which gives a pleasant smell is called caramel. The black and unpleasant substance obtained when sugar is heated is called charcoal. Thus it proves that sugar and wood consist of carbon.

Nature of carbon

Carbon is a special type of abnormal non-metal. Out of six electrons present in it, four electrons remain in the valence shell. To gain octet state, all four electrons present in the valence shell of carbon are shared and it forms four covalent bonds. Therefore, carbon has valency four. It forms covalent compounds combining with hydrogen, other carbon atoms, oxygen and other elements. Due to this nature of carbon millions of organic compounds are discovered.

a. Catenation

Most of the elements do not share electrons with many atoms of similar types of elements. But carbon has a tendency to make long chains by forming covalent bonds, this property is called catenation. By this property, carbon compounds like butane, pentane, polythene, polyvinyl chloride etc. are formed.

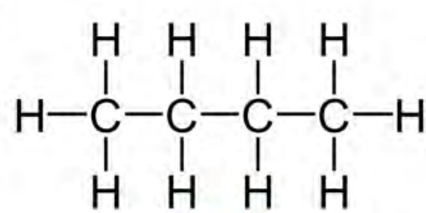
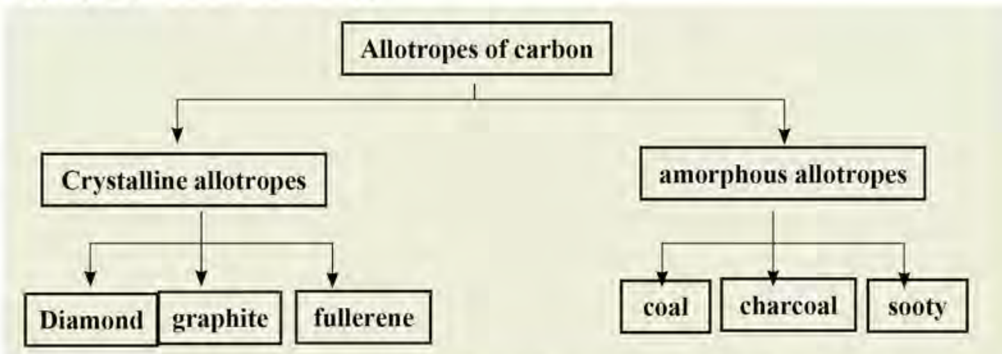


Fig 18.1

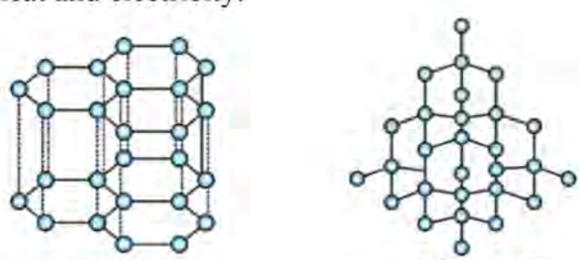
Due to the catenation property of carbon, many compounds of carbon are discovered. In chemistry, there is an individual branch to study the compounds of carbon which is called organic chemistry.

b. Allotropes and allotropy

In the sources of carbon, we saw matters with carbon elements only. For example, coal, charcoal, sooty, graphene, diamond, graphite, etc. All these compounds are different forms of carbon. It is called allotropes. The elements which have the same chemical formula but have different physical properties are called allotropes and this property is called allotropy.



In graphite, three valence electrons of a carbon atom make a bond and one electron remains free. But in diamond, all (four) valence electrons of a carbon atom make a bond, so no free electron is present in the valence shell. Therefore, one free electron present in the valence shell of a carbon atom in graphite helps in conduction of heat and electricity. So, graphite is a good conductor of heat and electricity. In diamond, no free electron is present in the valence shell of the carbon atom. Thus, diamond is a bad conductor of heat and electricity.



graphite   diamond

Physical properties of carbon

1. Carbon is found in solid state. Diamond, graphite and Buckminster fullerene are crystalline allotropes of carbon and coal, charcoal, sooty etc. are amorphous allotropes of carbon.

2. Carbon does not dissolve in water.
3. When carbon is heated at high temperature, it directly turns into a gaseous state.
4. Carbon is black in color but diamond is colorless and transparent.
5. Carbon does not have a shining property but diamond shines.
6. Carbon is a bad conductor of heat and electricity but graphite is a good conductor.
7. The density of carbon varies from 1.5 g/cm3 to 3.5 g/cm3 according to allotropes.

Chemical properties of carbon

1. Combustion

Carbon gives carbon dioxide when combusted with excess oxygen but with a low extent of oxygen carbon gives carbon monoxide.

Excess extent $C + O_2 \longrightarrow CO_2 + \text{heat}$

low extent $2C + O_2 \longrightarrow 2CO + \text{heat}$

2. Reaction with metal

Reactive metal + carbon $\longrightarrow$ metallic carbide

$4Al + 3C \xrightarrow{\text{heat}} Al_4C_3$ (aluminium carbide)

$3Fe + C \xrightarrow{\text{heat}} Fe_2C$ (Ferrous carbide)

$2Li + 2C \xrightarrow{\text{heat}} Li_2C_2$ (Lithium carbide)

$Ca + 2C \xrightarrow{\text{heat}} CaC_2$ (calcium carbide)

3. Reducing property)

The process of removal of oxygen from oxides of metal is called reduction.

a. Carbon helps to remove oxygen from metallic oxides of less reactive metals.

Metallic oxides + carbon $\longrightarrow$ metal + carbon monoxide

$Fe_2O_3 + 3C \xrightarrow{\text{heat}} 2Fe + 3CO$

$ZnO + C \xrightarrow{\text{heat}} Zn + CO$

$PbO + C \xrightarrow{\text{heat}} Pb + CO$

b. Carbon makes carbides reacting with oxides of non-metal.

Oxides of non-metal + carbon $\longrightarrow$ carbide + carbon monoxide

$SiO_2 + 3C \xrightarrow{heat} SiC + 2CO$

Silicon carbide

$CaO + 6C \xrightarrow{heat} 2CaC_2 + 2CO$

4. Reaction with steam

If steam is passed into carbon heated to 1000 0C, it forms carbon monoxide and hydrogen gas. The mixture is called water gas.

$C + H_2O \longrightarrow CO + H_2$

Organic and inorganic compounds

Various types of compounds are found around us. Out of them, some contain carbon but some compounds carbon does not contain. On the basis of the presence of carbon, compounds are divided into two groups.

Organic compounds

Methane, ethane, methanol, urea, insulin, protein, carbohydrate, oil etc. are the examples of organic compounds. Hydrocarbons and the compounds formed by it are called organic compounds. Generally, in organic compounds, a carbon atom is present and within the atoms present in the compound covalent bond is formed. In organic compounds, carbon makes covalent bonds with other carbon atoms, hydrogen as well as with oxygen, nitrogen, halogen, Sulphur, phosphorous etc. It forms covalent bonds. In some organic compounds metals are also bonded. Even carbon dioxide, carbon monoxide, carbonate, bicarbonate, carbides contain carbon but they are inorganic compounds.

Most of the organic compounds do not dissolve in water because they cannot make hydrogen bond with water. For example, ghee, wax, petrol, kerosene etc. The organic compound which makes hydrogen bond can dissolve in water. For example: sugar, alcohol. Organic compounds dissolve in organic solvents. Ether, carbon tetra chloride, benzene etc. are organic solvents.

Inorganic compounds

The compounds in which hydrogen is not bonded with carbon are called inorganic compounds or the compounds except organic compounds are called inorganic compounds. Carbon is not an essential element in inorganic compounds. Inorganic compounds are formed by combining various types of elements. Electrovalent bond is formed in inorganic compounds mainly but in some cases it forms covalent bond or both. Inorganic acid, base and salt are inorganic compounds. In addition to this, oxides of carbon, carbonate, bicarbonate and carbides are also inorganic compounds.

Most of the inorganic compounds dissolve in water because these compounds get dissociated into ions in water. For example: sodium chloride ($NaCl$), hydrochloric acid (HCl), magnesium hydroxide [$Mg(OH)_2$] etc. Those inorganic compounds which can dissociate into ions in water do not dissolve in water i.e. silver chloride($AgCl$), barium sulphate ($BaSO_4$), Calcium carbonate ($CaCO_3$) etc.

Activity 18.3

Collect organic and inorganic compounds found in your house and school and present in your class.

Difference between organic and inorganic compounds

Activity 18.4

Some organic compounds are ghee, oil, sugar, urea etc. and some inorganic compounds are acid, base, salt, carbonate, bicarbonate etc. Do you get differences in terms of color, odor, physical state, solubility, combustibility in these organic and inorganic compounds? Observe.

SN	Basis of differences	Organic compound	Inorganic compound
1.	Physical state	Found in solid, liquid and gas state	Most of the compounds are found in solid state, some are in liquid state (water, hydrochloric acid etc.) and some are found in gaseous state (CO2, H2S etc.).
2.	Chemical bond	Covalent bonds are found in organic compounds	Mostly electrovalent bond is formed but sometimes covalent bond is also formed in inorganic compounds.
3.	Ionization	They do not ionize	They ionize.
4.	Solubility	Most of the organic compounds do not dissolve in water but dissolve in organic solvents.	Most of the inorganic compounds dissolve in water but do not dissolve in organic solvents.

5.	Melting point and boiling point	The melting and boiling point of organic compound is low.	The melting and boiling point of inorganic compounds is high.
6.	Combustibility	Organic compounds burn easily. For eg. ghee, oil, petrol, LPG etc.	Generally, inorganic compounds do not burn. For eg. salt, limestone etc.

Uses of organic compounds in our daily life

Activity 18.5

Collect the organic compounds used in our daily life and prepare a list. For what purposes are these organic compounds used? Share in your class.

We are using various types of organic compounds in our daily life. Some of them are given below.

1. Food: We have daal, rice, vegetables, fish, meat, milk, curd, fruits as food in our daily life. Organic compounds like carbohydrate, protein, vitamin etc.are found in these food materials.
2. Clothes: The clothes that we use to wear are made up of various types of substances (cotton, silk, jute). These substances are made up of various types of organic compounds.
3. Medicine: Most of the medicines that we use during sickness are made up of organic compounds.
4. Energy: Petrol, diesel, kerosene, spirit etc. are made up of organic compounds. These matters are used in vehicles and are used as fuel.
5. Agricultural products and food materials used in agriculture: Various types of agricultural products (eg. daal, rice, vegetables, fruits etc.) consist of carbohydrates, protein, vitamins etc. They are organic compounds. The materials used in agriculture like food material; insecticides, vitamins etc. also consist of organic compounds.
6. Cosmetic products: Most of the cosmetic products consist of organic compounds.

Exercise

1. Choose the correct answer.

i. Which of the following is the characteristic of carbon?

a. Found in solid, liquid and gaseous state

b. Soluble in water

c. Turns solid into gas at high temperature

d. Has lustrous property

ii. If we prepare polythene by the use of carbonic compounds, which of the following is related to the property of carbon?

a. Allotropy b. Catenation

c. Reducing property d. Combustibility

iii. Which of the following is a group of organic compounds?

a. protein, carbohydrate, ammonia, methane

b. glycerine, phenol, alcohol, carbon dioxide

c. methane, methanol, chloroform, urea

d. ether, ammonia, methane, insulin

iv. The outer surface of the utensil that is used to cook food by the use of firewood is black (sooty). What does it prove?

a. Burning of utensil b. Firewood consists carbon

c. Firewood is wet d. Pollution is caused while burning firewood

2. Differentiate between:

a. Graphite and diamond

b. Organic compound and inorganic compound

3. Give reasons:

a. In the winter season, we should not burn coal/ firewood closing windows and doors.

b. Powder of graphite can be used in the form of dry lubricants.

c. Graphite and diamond are both allotropes of carbon. Graphite can conduct electricity but diamond cannot.

d. The melting and boiling point of inorganic compounds is higher than that of organic compounds.

e. While burning firewood in an anvil, sometimes black smoke comes but sometimes does not by burning properly.

4. Answer the following questions.

a. Define catenation and allotropy of carbon with examples.

b. When we heat sugar continuously it gives a black mass. What can we infer from this?

c. Give any two examples of crystalline and amorphous allotropes of carbon of each.

d. Write the condition of formation of carbon monoxide and carbon dioxide when carbon is burnt, and write chemical reactions.

e. What is water gas?

f. What happens when carbon is reacted with steam? Write a chemical reaction of this process. mother advised him to use petrol on part of the clothes where grease has fallen. Will the problem of Rohan be solved? Explain the cause of Rohan's problem and ways of solution on the basis of scientific facts.

h. Write any four examples of organic compounds which are used in your daily life.

19 Materials used in Agriculture

Most of the food materials that we eat come from plants. Plants get nutrients from soil. If continuous farming is done without using fertilizer, the soil becomes infertile. Plants may suffer from various types of diseases according to season. Ultimately, the fertility of soil decreases. To enhance fertility and to remedy various types of diseases, we use different types of chemicals. For the growth of plants, we use chemical fertilizer, and insecticides are used to cure diseases as well as for their safety. Eventhough these chemicals are useful, they have harmful effects too.

Experience of Harka bahadur in farming

High quality maize seed planted in Harka bahadur's field did not germinate for a long time. The seeds germinated after a long time and the plants thus developed had variation in stem, leaf and size of flower according to the farm. Some plants had problems like standing erect due to weak roots, falling leaves, and turning yellow and drying up leaves. According to the advice given by his neighbor, he used urea in his field. After some time, some plants grew excessively after using urea. All the problems seen in plants could not be solved. There was no uniformity in the size of seed and in the comb. Then, according to advice given by an expert of the agricultural office, he tested the soil of various parts of the farm. From the test of soil, it is found to have deficiency of various elements and have variation in acidity of the soil.

In the second time, Harkabahadur sowed seeds using various types of chemical fertilizer (urea, ammonium phosphate and in some places potassium sulphate). In some places, he used lime and in some places calcium chloride. At this time, all the plants grew well but insects troubled him. Then he used insecticides according to the advice of an agricultural expert.

- Why did the plants not become well even though he used high quality seeds?
- Urea helped to grow plants in some parts of the field. Why did the plants not grow well in other places?
- What is the reason behind the use of urea, ammonium phosphate and potassium sulphate in various parts of the field?
- What is the reason that Harkabahadur used lime and calcium chloride?

Necessary nutrients for plants

Seeds of plants grow in soil. New plants grow into adult plants. In that plant, seed is grown by the development of flowers into fruit. In this way the life cycle of plants continuously go on. Many elements are necessary to complete the life cycle of plants. Plants get necessary elements for the life process from soil.

17 essential elements for plants:

Carbon (C), Hydrogen (H), Oxygen (O), Nitrogen(N), Phosphorous(P) , Potassium(K), Sulphur(S), Calcium(Ca), Magnesium(Mg), Boron(B), Chlorine(Cl), Copper (Cu), Iron(Fe), Manganese(Mn), Molybdenum(Mo), Nickel(Ni), and Zinc(Zn)

The nutrients that require for the plants are divided into two groups; primary nutrients and secondary nutrients

a. Primary nutrients M

Nitrogen (N), Phosphorous (P) and Potassium (K) are the primary nutrients because plants need these elements to a large extent. For the proper growth of plants, proper management of these elements needs to be done.

b. Secondary nutrients M

The nutrients which are required in fewer amounts for the plants are called secondary nutrients. Calcium, magnesium, Sulphur, boron, iron, zinc etc. are secondary nutrients. Growth and development of plants and their production is retarded due to scarcity of these nutrients.

Essential nutrients in the soil are formed naturally by decaying organic compounds. The shortage of nutrients in the soil due to continuous farming is compensated through fertilizer.

Fertilizer

Plants absorb essential nutrients from the soil. The compound which supplies essential nutrients to the plants is called fertilizer. We use fertilizer artificially to fulfill scarcity of essential nutrients. Fertility of soil can be increased by the use of fertilizer. Fertilizer helps in growth and development of plants and saves from diseases.

Types of fertilizers

There are two types of fertilizer. They are organic fertilizer and inorganic fertilizer.

a. Organic fertilizer

The fertilizer which is formed by decaying dead bodies and excreta of living beings is called organic fertilizer. Compost manure, green fertilizer, powder of mustard cake (Pina), and bone powder are included in it.

Compost manure: The manure which is formed by decaying leaves of plants, dead bodies, straw, grasses, fodder, excreta of animals etc. is called compost manure. Cow dung, buffalo dung, etc. are also examples of compost (organic) manure.

Green manure: We used to grow fast decaying plants in the field before farming of main grains. Decaying of these plants buried in soil forms manure. If the plants of cereals decay in soil, it provides essential nitrate to the soil. Likewise, manure is made by decaying parts of plants. Thus, decaying of green plants directly to make manure is called green manure. Adhatoda, mugwort (pati), khirro, marijuana (ganja), etc. are examples of green manure.

Figure: 19.1 Daichi farming for green fertilizer

Advantages of organic fertilizers

Organic fertilizer enhances fertility of soil. There are no negative effects on soil for a long time if we use organic fertilizer. It controls environmental pollution too. Vegetables and fruits become tasty, nutritive, and hygienic by the use of organic fertilizer. There are no negative effects on human health if we eat vegetables and fruits grown in such fertilizer.

b. Inorganic fertilizer

Fertility of the soil is decreased if there are no nutrients that require plants to grow. For this, nutrient chemicals are used in soil. The inorganic chemical which supplies nitrogen, phosphorous and potassium that are required to the plants are called inorganic fertilizer. These fertilizers are manufactured by the reaction of minerals. For example, urea can be manufactured by the reaction between ammonia (NH_3) and carbon dioxide (CO_2). Inorganic fertilizers are also called chemical fertilizer.

Chemical fertilizers are easily soluble in water. So, the effect of use of it is seen in plants fast. In chemical fertilizer the amount of particular nutrients is contained to a large extent. On the basis of essential main nutrients, inorganic fertilizer is classified into three groups i.e. nitrogenous fertilizer, phosphorous fertilizer and potassium fertilizer.

Nitrogenous fertilizer

The inorganic compounds which are used as a source of nitrogen and essential for plants are called nitrogenous fertilizer. Ammonium sulphate [NH4(SO4)2], ammonium nitrate [NH4NO3], urea [NH2CONH2] etc. are examples of nitrogenous fertilizer.

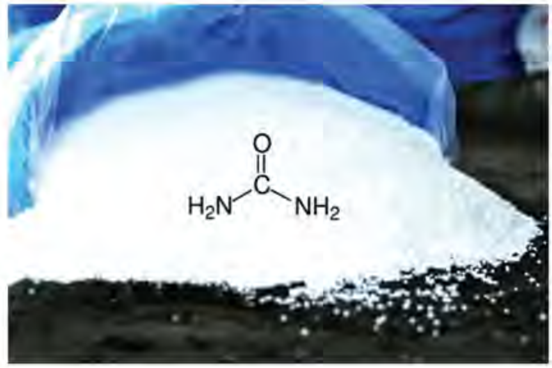


Figure 19.2 urea fertilizer

Importance of nitrogen fertilizer

Nitrogen helps in rapid growth and high yielding of crops. It enhances the rate of photosynthesis and in formation of protein and protoplasm.

Effects of deficiency of nitrogen in plants

Due to lack of nitrogen, the growth of plants stops and decreases the crop production. The leaves of plants become yellow, and the size of flower, fruit and seed becomes small.

Phosphatic fertilizers

The inorganic salts/compounds which are used as sources of phosphorous and essential for plants are called phosphorous fertilizer. Ammonium phosphate [(NH4)3PO4], calcium super phosphate [Ca(H2PO4)2CaSO4], triple superphosphate [3Ca(H2PO4)2], and ammonium metaphosphate [NH4(H2PO4)2] are the examples of phosphorous fertilizer.

Figure 19.3 triple superphosphate fertilizer

Importance of phosphatic fertilizer

Phosphorous helps in the growth and development of roots. It helps to maintain maturity in plants and seeds. It saves plants being infected from disease.

Effects of deficiency of phosphorus in plants

Roots of the plants do not grow properly if they lack of phosphorous. Cell division in plants becomes slow and plants become thinner and lean due to deficiency of phosphorous. Due to lack of phosphorous, maturity in plants and seeds slows and seeds become wrinkled. If deficiency of phosphorous continues, immune system of plant becomes weak.

Potassium fertilizer

The inorganic chemicals used as a source of potassium and essential for plants are called potassium fertilizer. Potassium chloride (KCl), potassium sulphate (K2SO4), potassium nitrate (KNO3) and potassium carbonate (K2CO3) are examples of potassium fertilizer.

Figure 19.4 potassium chloride fertilizer

Importance of potassium fertilizer

Potassium is found in ash. Potassium helps to strengthen the stem and root of plants and enhances immune power. It helps in the growth and development of flowers. It helps in the formation of protein, starch including other matter in plants.

Effects of deficiency of potassium in plants

Deficiency of potassium in plants decreases the formation of protein, starch and other matters, and the rate of cell division also decreases. Thus, growth and development of plants become weaker. Due to deficiency of potassium leaves become smaller and fade fast. There is a high possibility of drying and dying of plants due to lack of it.

Activity 19.1

Study the symptoms of plants that do not grow well in your surroundings. Identify the symptoms which have occurred due to lack of nitrogen, phosphorous or potassium.

Advantages of chemical fertilizers

a. Chemical fertilizer contains the nutrients that are required for the plants. So, it enhances the fertility of soil.

b. Chemical fertilizers are easily soluble in water. Therefore, plants absorb the nutrients from the soil easily.

c. It is easy to use, transport, and manufacture.

Activity 19.2

Observe solubility collecting various types of chemical fertilizer.

Disadvantages of chemical fertilizers

Even chemical fertilizer is useful but it has many banes due to excessive use of it. Some disadvantages of it are given below.

a. Chemical fertilizers are not biodegradable, so they pollute the environment.

b. Chemical fertilizer increases the acidity or basicity of the soil.

c. If chemical fertilizer is used once, it needs to be used regularly. Otherwise, the soil becomes infertile and the rate of production decreases.

d. Taste and nutrients of vegetables and fruits decrease due to use of chemical fertilizer.

Project Work

Study the symptoms that are seen due to deficiency of nutrients in plants. Collect photos of some models. Prepare a report according to the table given below and present in your class.

Nutrients	**Fertilizer which consists nutrients**	**Deficiency in soil**	
		Symptoms	**Paste the photo that you have collected**
Nitrogen	Ammonium sulphate, ammonium nitrate, urea	Leaves become yellow, size of flower, fruit and seed is small	
Phosphorous	....	....	....
Potassium	....	....	....

Insecticides

The production of crops decreased due to various harmful insects. Various types of insecticides are used to kill or control such harmful insects,. The chemicals that kill or control harmful insects which harm the crop are called insecticides. Insecticides can be used in the form of powder or can be sprayed in liquid form. We can control and kill the insects that harm vegetables, fruits, etc. by using malathion.

Activity 19.3

What kinds of insecticides are used to kill or control the harmful insects in the farm of your surroundings? Observe, investigate and discuss it.

a. What are the advantages of use of insecticides?

b. What domestic measures are applied to control harmful insects?

c. Does the use of insecticides have negative effects?

Types of insecticides

Insecticides are divided into two types. They are bio-insecticides and chemical insecticides.

Bio-insecticides

insects. Jholmol is an example of bio-insecticide. The ash which is used by farmers in rural areas is an example of bio-insecticide. Use of adhatoda (asuro) before potato farming, use of neem (nim) leaves to store grains, use of mugwort (titepati) and juice of neem (nim) to kill bedbugs are the examples of use of bio-insecticides.

The insensible use of chemical insecticides pollutes the physical and biological environment. Instead of chemical insecticides, we can use bio-insecticides. Bio-insecticides help to propel and save from various diseases. The use of bio-insecticides does not harm soil as well as other organisms. It does not harm human health too.

Activity 19.4

How can we prepare bio-insecticides at the local level?

a. Mix the pieces of the parts of plants available in local level, leaves of sisno, nim, zanthoxylum, bakaino, adhatoda, dhatura, ketuki, titepati, ocimum, babari, ginger, garlic, onion and peel of orange fruit.

b. In the above mixture, mix cow dung and cow urine about half of the mixture. Leave the final mixture for about 15 days making air tight. We can use bacteria and yeast to make the mixture fast biodegradable.

c. The bio-insecticide thus formed can be used by adding 3 to 5 parts of water in a part it.

b. Chemical insecticides

Chemical insecticides are the compounds prepared on an industrial scale. DDT (dichloro diphenyl trichloroethane), BHC (benzene hexa chloride) methoxy chloride, Aldrin, dialdrin, etc. are examples of chemical insecticides.

Advantages of insecticides

Insecticides destroy the insects that harm crops and help in high yielding of crops. Although, insecticides save crops but create many negative effects in the environment. Use of chemical insecticide is not the interest but is compulsion of the farmer. Such types of chemicals are a kind of poison. They should be stored safely.

Disadvantages of insecticides

If we swallow the remains of insecticides, it has a direct effect on human health. For example, use of dichlorodiphenyl trichloroethane (DDT) causes respiratory diseases. If we are in contact with chemical insecticides, it affects the nervous system and glandular system. By the use of chemical insecticide, air, water and soil are polluted. Use of insecticide affects the ecosystem. Chemical insecticide kills not only harmful insects but also useful insects. For example, when DDT is mixed, it pollutes water and air. In polluted water, aquatic creatures cannot survive. The reproductive power of the surviving ones is also decreased. The reproductive power and growth of birds and fishes also decrease.

Precautions to be taken while using chemical insecticides

We should study about using manuals of insecticides before using. The person who sprays insecticide should use suitable clothes. The chemical insecticide should not come in contact with the eye and mouth. While spraying insecticide, it should be sprayed in the direction of air. Chemical insecticide, which is left after spraying, should be stored properly. The equipment, which is used in spraying chemical insecticides, should not be washed near the source of water.

Conservation of soil quality

The quality of soil should be maintained to get a proper production of crops. The excessive use of chemicals to increase the production of crops possibly decreases the quality of soil. To conserve quality of soil, we can follow the following ways.

a. Test of soil quality: Frequent test of quality of soil helps to know the necessity of nutrients in the soil. In addition to this, we should know which farming is suitable in the farm according to the composition of the soil.

b. Use of suitable farming technology: Cyclic farming system, mixed farming system, use of agricultural lime, excessive use of compost manure, minimization of use of chemical fertilizer, suitable irrigation technology can be done to maintain the quality of soil.

c. Proper use of land: The fertility of soil goes decreasing if farms remain unploughed.

Burning of dried leaves and other materials on the land destroys useful microorganisms. All the manure of land flows away if we do farming in the steep land. Therefore, to maintain the quality of soil, farming should be done ploughing the field, dried leaves should not be burnt, and farming in steep land making lower part higher etc. should be done.

Exercise

1. Choose the correct answer.

i. Which of the following domestic substance fulfills the deficiency of phosphorous in soil?

a. Ash b. Powder of bone

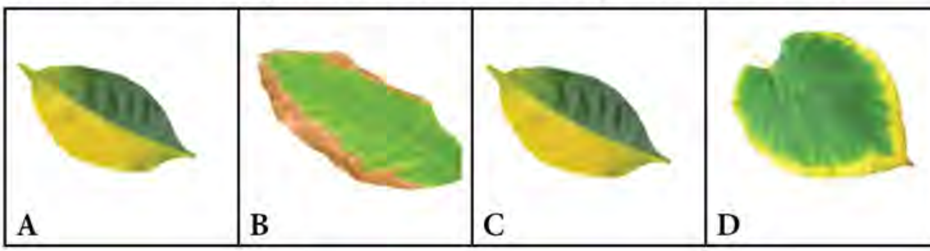
c. Peel of banana fruit d. Leguminous plant

ii. A growing maize plant on land is shown in the figure. Which nutrient is deficient in the land?

a. Nitrogen b. Phosphorous

c. Potassium d. Calcium

iii. Leaves of plants grown in various lands have shown in the following figure. Which of the following leaves indicate the lack of potassium in the soil?



(a) D (b) A (c) C (d) B

iv. Which of the following is a group of insecticide?

a. Potassium chloride, Aldrin, benzene hexachloride

b. DDT, sodium chloride, Aldrin

c. Dialdrin, DDT, methoxy chloride

d. Potassium chloride, Aldrin, malathion

2. Differentiate between:

a. Chemical fertilizer and organic fertilizer

b. Chemical insecticides and bio-insecticides

3. Give reasons:

a. Use of organic fertilizer is environmental friendly.

b. Ecosystem is imbalanced by the use of DDT powder.

4. Aanswer the following questions.

a. What is NPK fertilizer? Write its importance.

b. Give any two examples of nitrogenous, phosphatic and potassium fertilizer of each.

c. The plants shown in the figure are produced from a similar seed. Study the development of the plants comparatively and give the reason for differential growth. Also suggest the solution to the problem.

d. A farmer is in dilemma whether he uses chemical fertilizer or not to increase the production. What suggestions would you give to the farmer?

e. What could be alternatives to the farmers who do not want to use chemical fertilizer? Write advantages of that kind of fertilizer.

f. What is chemical insecticide? Write any two examples of it.

g. What is bio-insecticide? Write any two examples of it.

h. 'Use of chemical insecticides should be replaced by the use of bio-insecticides'. Justify this statement with two examples.

i. Write the importance of the use of chemical fertilizer and use of insecticides.

j. Nowadays, farmers are using excessive chemical fertilizer and chemical insecticide for profit. Use of these chemicals is affecting human health. Write any two slogans which helps in promoting public awareness.

k. Write any two effects of excessive use of chemical insecticides with examples.

l. Write two examples of alternatives to the chemical fertilizer and chemical insecticides used around you.