Science

Class VIII

Department of School Education
Ministry of Education and Skills Development
Thimphu

Published by
Department of School Education (DSE)
Ministry of Education and Skills Development (MoESD)
Thimphu

Provisional edition 2013
First edition 2017
Second edition 2020

Reprint 2024

Acknowledgments

The Royal Education Council would like to thank all the science faculty members of the Colleges of Education, Paro and Samtse and teachers from different schools for their valuable contributions towards the development of this book. Our sincere gratitude goes to Ministry of Education, Royal Society for Protection of Nature, Ministry of Agriculture, Ministry of Health, Ministry of Economic Affairs, and other relevant agencies for their unfailing support, starting from the development of the Science Curriculum Framework to the production of science textbooks and manuals.

The curriculum revision was possible with the generous financial and technical support rendered by relevant stake holders. The National Environment Commission in integration of Sustainable Waste Management from 'Ecology Note: Towards a Clean, Green, and Beautiful Bhutan'. The United Nations Population Fund (UNFPA) through Ministry of Education in inclusion of components of Comprehensive Sexuality Education in strengthening life skill education for children.

Our sincere courtesy to all the source of pictures that are used in this book.

Advisors
Sangay Zam, Secretary, Ministry of Education, Thimphu
Tshewang Tandin, Director General, Department of Adult and Higher Education, Ministry of Education, Thimphu
Kesang C Dorji, Director, Department of Curriculum and Research Division, Ministry of Education, Paro
Kinga Dakpa, Director General, Royal Education Council, Paro
Wangpo Tenzin, Dean, Royal Education Council, Paro

Coordination
Wangchuk, Royal Education Council, Paro
Proof Reading

Gopilal Acharya, Free Lance Editor, Thimphu
Amber Kumar Rai, Curriculum Officer, Royal Education Council, Paro
Sharda Rai, Subject Specialist, Bhutan Council for School Examination and Assessment, Thimphu
Art Work and Layout

Surjay Lepcha, Curriculum Officer, Royal Education Council, Paro
Sangay Tshering, Teacher, Drugyel HSS, Paro.

ISBN 978-99936-0-417-4

Foreword

Today, science is an indispensable discipline of learning that shapes the lives of humankind and their wellbeing. The enduring engagement of people in the scientific world of exploration, inquiry and investigation has culminated in the addition of an ever-growing repository of scientific knowledge and milestones. Through the time, how science works and affects the world has been influencing the way we view and deal with the subject.

Unfortunately, many a times, the subject is seen as very complex and difficult, hard to comprehend and demanding to learn, thereby posing challenges in our effort in instilling scientific beliefs and attitudes in young learners. Such generalisation has influenced the learners to shy away from the experiential learning and the scientific endeavour in favour of a discipline that is perceived to be easier. Therefore, it is time that concerted efforts are pursued in making learning of science a way of igniting the fire of curiosity and investigation in the minds of learners.

Towards making education meaningful and relevant for students, it is imperative to link the scientific concepts to the real world through rigorous engagement of learners in the scientific processes of observation, inquiry, investigation, experimentation and generalisation. The timely revision of science textbooks is an attempt to align learning outcomes with the emerging global view of science and educational philosophies, accentuate the development of scientific skills of doing science, and foster the scientific temper and literacy in young minds. However, the endeavour in science education in our context emanates from the national, social, cultural and religious belief system imperative to nurturing nationally rooted and globally competent citizens who can productively contribute to the nation building initiatives and development of a dynamic global society.

Therefore, it is our sincere hope that the science curriculum provides a limitless avenue for every learner as a young scientist to explore continuously and engage in doing science. The meaningful participation is crucial in the development of transversal competencies of critical thinking, creativity, communication and collaboration along with other essential life skills fundamental to succeed and excel in the 21st century world as productive and socially responsible individuals.

I would like to wish all our teachers and students, a fulfilling social and academic engagement and experiential experiences through enduring and enterprising learning and doing science as part of every learner's life.

Tashi Delek

Kinga Dakpa
Director General

Contents

Introduction

Science as a body of knowledge allows an individual to explore, create, and organize ideas in the form of testable explanations and predictions that ultimately enable the discovery of new knowledge. Science has thus far played an important role in helping humankind to best understand the universe, make the best use of natural resources, and advances accordingly.

The importance of Science has been revealed through the way science and scientific knowledge has shaped the lives of human since the time immemorial. The advancement of a human world was possible due to the influence of science as almost all the activities, from sowing a seed to building a rocket involves scientific knowledge. Thus, science has become an indispensable discipline for the survival and advancement of humankind. Being conscious of the role science has played in shaping the lives of humankind and the power it holds for further advancement, catching up with the new and possible discoveries in the field of science are very important and urgent to progress along with the world around us.

Nonetheless, the unfounded belief of viewing science as a subject for the elite learner has affected the way we view and deal with the subject. Many times, the subject is seen as very complex and difficult, tough to comprehend, and demanding to make sense out of associated concepts. Such generalization has influenced the learners to shy away from it in favour of a discipline that is perceived to be easier. This trend has challenged the effort of instilling scientific beliefs and attitudes in young learners.

It has, therefore, called for a concerted effort to make learning of science a way of igniting the fire of curiosity in the minds of learners. Such a move is possible only when all the players collaborate to provide and use the right tools, forum, opportunities and instructions supported by consistent follow-up and monitoring while teaching and learning science. In essence, dealing with science should foster seeing, using and doing the real things so as to give 'the feel of real science' to the learners. It is imperative to link the concept to the real world, for science encompasses the understanding of structure and behaviour of the physical and natural world that can be better understood only through the use of the scientific inquiry process.

Scientific Process

A scientific process is an inquiry approach that involves a systematic understanding of the natural and physical world. It forms the basis of experimentation for scientific knowledge. It is imperative to know the basic scientific process to derive predictions and confirmations from the ideas and information gathered through observation of different phenomena. Thus, it entails asking relevant questions related to observation, testing ideas, and communicating the findings. The scientific process includes:

1. **Observation**

   It is the fundamental skill that enables learners to view the world objectively and systematically by using all the senses. It consists of gathering information, evidences, and ideas about different phenomena. This facilitates learners to compare, contrast, and generalise ideas about the world around them. These experiences foster inquisitiveness in them.

2. **Questioning**

   The competency that involves creative and critical thinking which attempts to link the known with the unknown ideas. It enhances the ability of the learners to put their observations in the form of a question that is clear, concise, and testable.

3. **Hypothesis**

   It is an educated guess and possible explanation about the observation and question. Based on the limited evidence as a starting point, learners carry out further investigation. Therefore, the hypothesis is a specific and testable prediction about what may happen in a study.

4. **Background information**

   It is the collection of relevant and significant information regarding the topic in order to provide a comprehensive understanding of what has been said on the topic and by whom. Through this step, the learner build-up a story related to the question and hypothesis.

5. **Design**

   It is an experimental set-up that allows investigation of the relationship between variables. This allows learners to manipulate the variables and test whether their prediction is accurate.

6. **Data collection**

   It is the systematic observation, measurement, and recording of information about various phenomena happening in the experimental set-up. It allows learners to gather evidence to answer stated research questions, test hypotheses, and evaluate outcomes.

7. **Analysis**

   It is an interpretation of data through the use of analytical and logical reasoning to determine the patterns, relationships, and trends. The learner makes sense out of the information recorded to establish a relationship between variables, based on which results and conclusions are drawn.

8. **Conclusion**

   It is the step where the learner makes generalisation of the information based on the data analysis and interpretation. The generalisation may or may not support the hypothesis. This facilitates learners to develop the skills of articulating diverse information to draw a comprehensive conclusion about the phenomena.

9. **Sharing**

   This is the final step wherein the learner presents their findings in the form of a final report, display or presentation as asked by the subject teacher. The learners explore and learn to use different forms of communication such as graphic, audio-visual, etc. to share their ideas or findings.

Textbook Content

The content in this textbook covers topics on Biology, Chemistry, and Physics in equal proportion to promote the learning of concepts in all the three disciplines. The concepts under each topic are made learner-friendly by incorporating various kinds of activities that meaningfully engages both teacher and learners. Essentially, this textbook contains the following learning experience plan.

Learning objectives: The list of statements that define what learners are expected to know at the end of each topic or chapter.

Activity: This provides information on the aim, the materials required and steps to carry out the activity. It is intended to provide hands-on experience for the learners and test the learned theory or to draw generalization and build concepts.

Do you know? This is provided as additional information to add to general knowledge in science. This is not for testing.

Questions: Where appropriate, the questions are provided to immediately test the concepts learned. This will help learners to test their understanding.

Exercise: This is provided to check the understanding of the concepts learned in the chapter. It has different sets of questions to test learning in terms of scientific knowledge, skills, and values and attitudes.

Model Question Paper: This is provided at the end of the textbook to help learners familiarize with the type of questions that are expected in the terminal examinations. It provides cues of the range of cognitive level of learnings, skills, the values and attitudes that the science curriculum is expected to achieve.

The realization of the curriculum aspirations and intends is determined by the way the curriculum is implemented. So, the use of various strategies that allows learners to explore diverse strategies will help realize the curriculum's intent besides fostering scientific aptitude and attitude in the learners. The provision of avenues to arouse curiosity will go a long way in fostering intellectual development and enhancement of overall performance. If the right tools and strategies are being used, this science curriculum will provide a limitless avenue for the learners to explore continuously on and beyond the scientific concepts embedded in this book.

STEM Unit
Royal Education Council

Chapter 1
Cell

You have learnt that living things are made up of cells. The cell is the structural and functional unit of life. It contains special parts called cell organelles, which have definite structures and functions. A group of similar cells form a tissue; a group of tissues form an organ; and then the organs together form an organ system. The study of cell, tissue, organ, and organ system help us to understand the levels of organisation found in the multicellular organism.

1. The Parts of Cell and their Functions

Learning Objectives

On completion of this topic, you should be able to:

- identify the cell organelles of plant and animal cell.
- explain the functions of cell organelles.
- draw the labelled diagram of plant and animal cell.

A cell consists of cytoplasm, nucleus, and other living parts, which are collectively called **protoplasm** or **protoplast**. A number of specialised parts, called cell organelles, are present in the cytoplasm. The cell organelles have definite shape, size, and function.

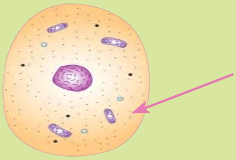
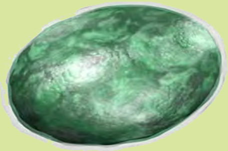
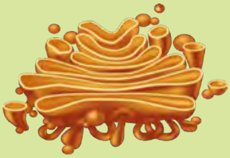
Activity 1.1. A journey inside the cell

Let us make a journey into the plant cell.

http://www.glencoe.com/sites/common_assets/science/virtual_labs/E08/E08.html

Reprint 2024

Table 1.1 *The Cell Oganelles and their Functions*

Sl No	Structure	Cell Organelle	Function
1		Endoplasmic reticulum	....
2		....	Synthesis of protein
3		Chloroplast	....
4		Golgi bodies	....
5		....	....

i. Copy and complete Table 1.1.

ii. Name and write the functions of cell organelles that you would come across if it was a journey inside an animal cell.

iii. List three cell organelles present in animal cell which are not present in Table 1.1.

Reprint 2024

Questions

1. Relate each cell organelle with one item listed in the box based on their function.

Brick wall, torch, generator, kitchen, computer, water tank, sieve, table

Example, Cell wall: Brick wall

i. Cell membrane: …………………………
ii. Mitochondria:…………………......…….
iii. Chloroplast:…………………………….....
iv. Nucleus:…………………………………...
v. Vacuoles:…………………………………..

2. Find the names of five cell organelles hidden in the word maze.

A	J	F	B	H	E	M	O	S	O	S	Y	L	A	I
H	V	V	A	C	U	O	L	E	T	Q	U	N	O	E
C	M	I	T	O	C	H	O	N	D	R	I	A	X	C
S	U	E	L	C	U	N	W	P	L	A	S	T	I	D

3. Write the function of the following cell organelles.

i. Leucoplast
ii. Vacuole
iii. Cell membrane

WEBLINK

http://www.biologyjunction.com/cell_functions.htm
http://www.carolguze.com/text/102-19-tissuesorgansystems.shtml
http://www.innerbody.com/

Reprint 2024

2. Levels of Organisation in Multi-cellular Organism

Learning Objectives

On completion of this topic, you should be able to:

- define tissue.
- classify plant tissues and animal tissues with examples.
- explain the structures of plant tissues and animal tissues.
- identify plant tissues using a compound microscope.
- describe organs, organ systems, and organism with examples.

Cell is the simplest unit of life. All living things have evolved from single-celled or unicellular forms.

Activity 1.2. From simple to complex

Using the pictures given in Figure 1.1, create a flowchart to show the levels of organisation in human body. Based on your arrangement, answer the questions.

(a) Organ system (b) Tissue (c) Organism (d) Organ (e) Cell

Figure 1.1. Levels of organisation in human body.

i. Which picture did you place in the beginning of your flowchart? Why?

ii. Which picture did you place at the end of your flowchart? Why?

a. Tissue

What is tissue? In a multicellular organism, a group of similar cells perform specific functions in the body. This group of similar cells that perform particular function is called tissue. Can we find tissue in unicellular organism?

Reprint 2024

Types of Tissue

Plants and animals are made up of different types of tissues. Different tissues perform different functions. These tissues can be categorised into many types.

Plant Tissue

Activity 1.3. Observing a plant tissue

Materials required

Permanent slide of dicot stem (TS) and a compound microscope.

Procedure

Step 1. Take a permanent slide of dicot stem (TS).

Step 2. Observe it under the microscope.

Step 3. Draw what you observe.

Precaution

Do not let the objective lens touch the glass slide.

Are the dicot cells similar in structure? Explain your observation.

Plant tissues are basically of two types: meristematic tissue and permanent tissue.

Meristematic tissue is found at all growing points of a plant, such as tips of roots, stems and branches. It is also present in between the bark and the wood of trees. It multiplies and brings about the growth of plants.

Permanent tissues are made up of either living or dead cells, which have lost their ability to multiply. They have permanent shapes and perform particular functions. Permanent tissues are of two types: simple permanent tissue and complex permanent tissue.

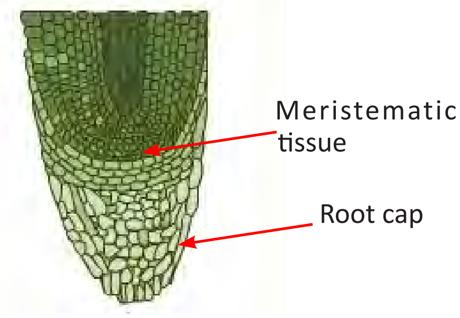


Figure 1.2. Longitudinal section (LS) of root tip.

Reprint 2024

i. **Simple permanent tissues** are of the following types:

Parenchyma consists of oval, spherical, or polygonal cells as shown in Figure 1.3. The cell wall is thin, and there are spaces between the cells.

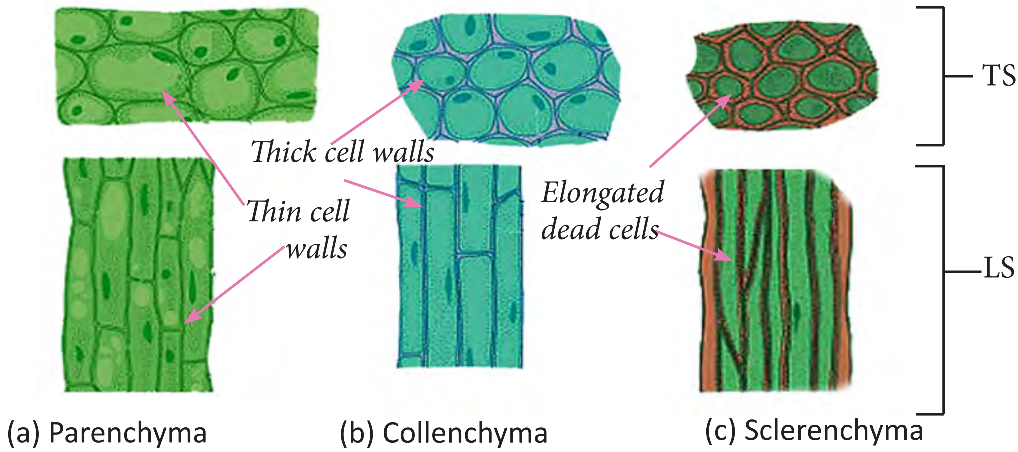


Figure 1.3. Simple permanent tissues.

They are found in soft parts of plants such as in the central part of roots and stems. The functions of these tissues are to store food and water, and also provide temporary support to the plant.

Collenchyma are living cells with thick cell walls without spaces between them. They may be circular, oval or polygonal in shape as shown in Figure 1.3. Collenchyma is mostly found in non-woody plants, leaf stalks, and veins of leaves. It provides support and flexibility to the plant.

Sclerenchyma are dead cells with thick cell walls that are closely packed. The cells of this tissue are elongated and have pointed ends or polygonal in shape as shown in Figure 1.3. It is found in stems and veins of leaves. It provides strength and protection to the plant.

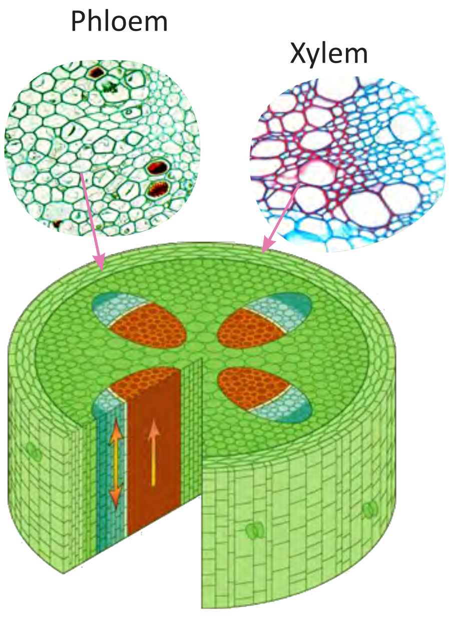


Figure 1.4. Complex permanent tissues.

ii. **Complex permanent tissues** consist of two conducting tissues: xylem and phloem, which together form the vascular bundle.

Xylem transports water and dissolved minerals from the roots to the other parts of the plant.
Phloem transports food from the leaves to different parts of the plant.

Animal Tissue

Activity 1.4. Observing an animal tissue

Precaution

Do not let the objective lens touch the glass slide.

Materials required

Permanent slide of muscle and a compound microscope.

Procedure

Step 1. Take a permanent slide of muscle.
Step 2. Observe it under the microscope.
Step 3. Draw what you observe.

Are the muscle cells similar or different in structure? Explain your observation?

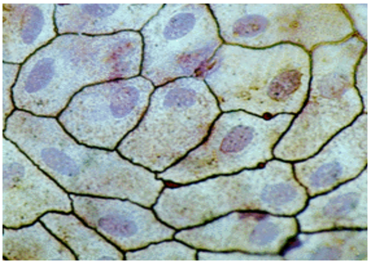
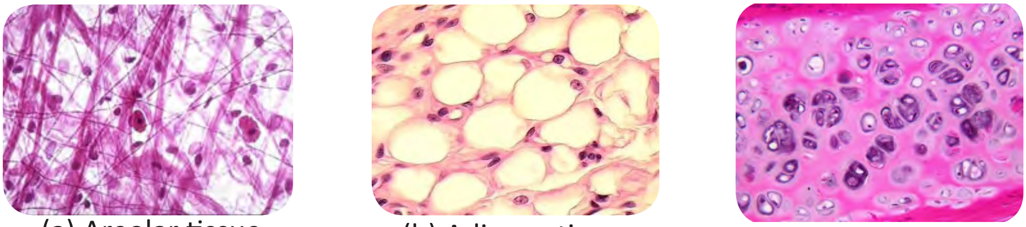


Figure 1.5. Epithelial tissue.

Like plants, animals are also made up of different kinds of tissues. Based on the locations and functions, tissues can be classified into four categories: epithelial tissue, connective tissue, muscular tissue and nervous tissue.

Epithelial Tissue covers the surface of the body (skin) and lines the internal organs and cavities of the body such as mouth, nose, stomach, lungs, blood vessels, etc. Epithelial cells may be flat, cuboidal, or columnar in shape. The tissue is mainly responsible for protection against injury and germs, and helps in absorption, secretion, and sensation.



(a) Areolar tissue (b) Adipose tissue (c) Cartilage

Figure 1.6. Connective tissues.

Reprint 2024

Connective Tissue is also known as supportive tissue. It binds one tissue to another, and connects various organs. Examples of connective tissue are blood, bone, cartilage, ligament and tendons. This tissue also provides protection to various parts of the animal body. Some connective tissues are shown in figure 1.6.

Muscle Tissue forms the muscles of the body. It consists of a special type of cells, which has the ability to contract and relax. Thus, it helps the body in its movement. Muscle tissues are of three types: cardiac, striated, and non-striated.

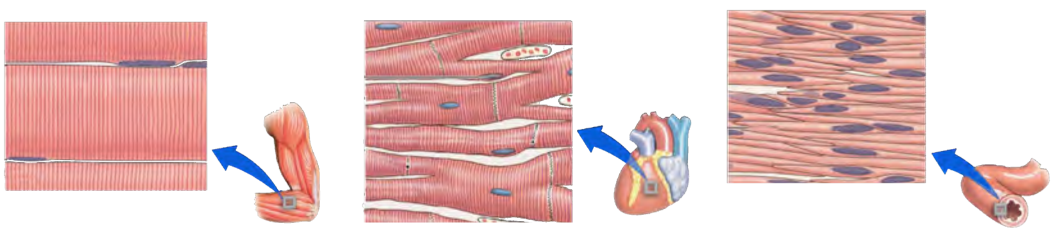


Figure 1.7. Muscle tissues.

Nervous Tissue is made up of highly specialized cells called **neurones**. They transmit messages from all parts of the body to the brain and the spinal cord, and vice versa. The part of neuron containing nucleus is called cell body. Many long cytoplasmic projections called **dendrites** arise from the cell body. One of the dendrites is long and is called **axon**. The dendrites carry messages towards the cell body, and the axon carries messages away from the cell body.

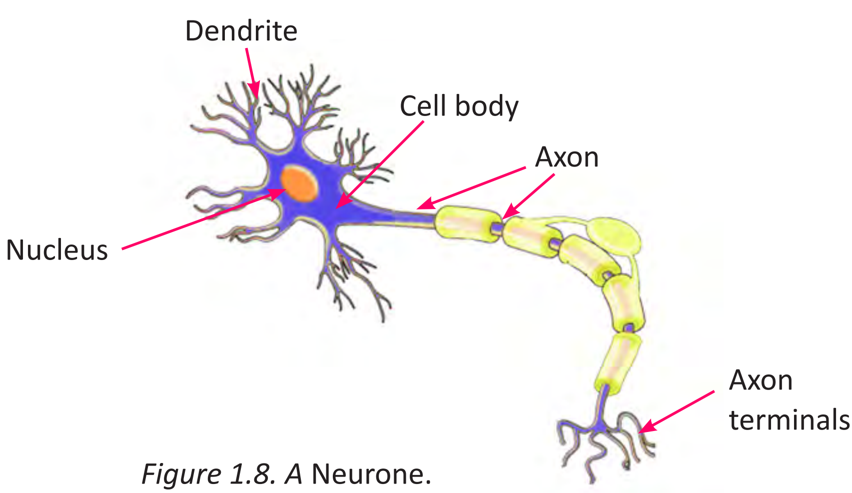


Figure 1.8. A Neurone.

b. Organ

What is organ? An organ is a group of tissues working together to perform a common function. For example, heart is an organ, which has lining of epithelial tissue, muscular tissue, nerve tissue and connective tissue. All these tissues work together to pump the blood. Other examples of organs are lungs, kidneys, skin, etc.

c. Organ System

An organ system is a group of organs which work together to carry out a specific function. The human body is made up of different organ systems as shown in Figure 1.9.

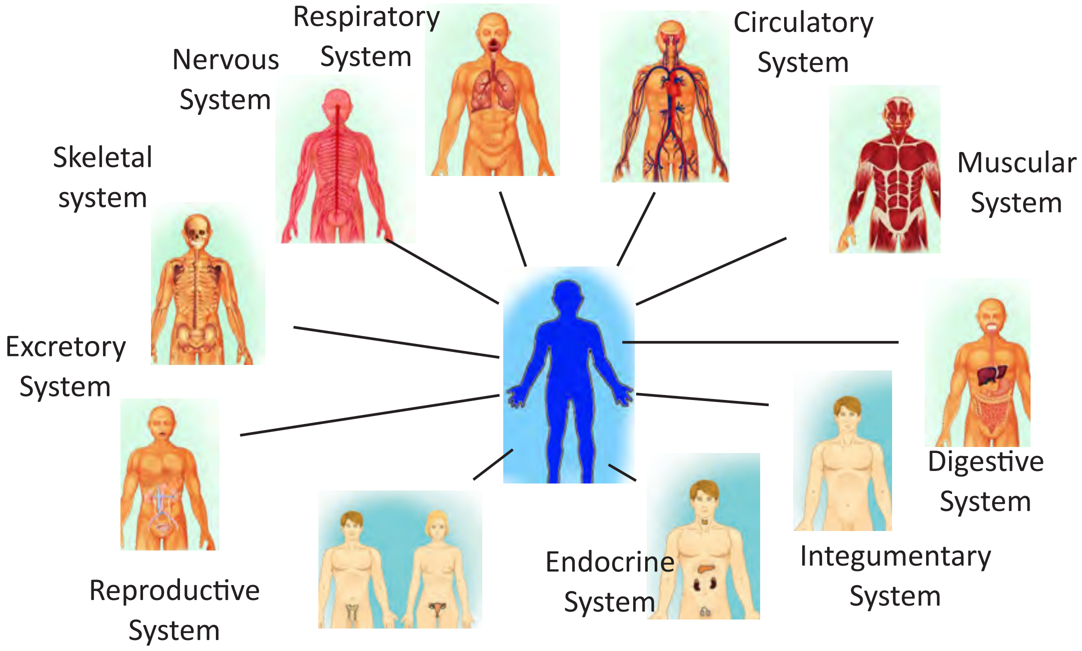


Figure 1.9. Human organ system.

d. Organism

An individual, such as an animal, a plant, or even a microorganism that reproduce, grow, respire, etc. is known as organism.. Unlike unicellular organisms, multicellular organisms have organs and organ systems. Each organ system coordinates with other organ systems to perform life processes such as digestion, respiration, excretion, etc.

Reprint 2024

Questions

1. Differentiate the following pairs:

   a. Cell and tissue. b. Organ and organ system. c. Xylem and phloem.

2. Classify the following structures into cell, tissue, organ, organ system, and organism. Structures: neuron, blood, egg, leaf, bone, flower, bacteria, mushroom, bear, eye, human skeleton, and parenchyma.

Reprint 2024

Exercise

Multiple Choice Question

1. A cell has mitochondria, centrosome, nucleus, and other cell organelles. Based on this information, it could be the cell of

   A. an apple.
   B. a yeast.
   C. a cat.
   D. a flower.

2. TWhich of the following tissue would be present in the animal tissue shown in Figure 1.10?

Figure 1.10.

   A. Epithelial tissue and nervous tissue.
   B. Muscle tissue and connective tissue.
   C. Nervous tissue and muscle tissue.
   D. Connective tissue and epithelial tissue.

3. Study the Figure 1.11.

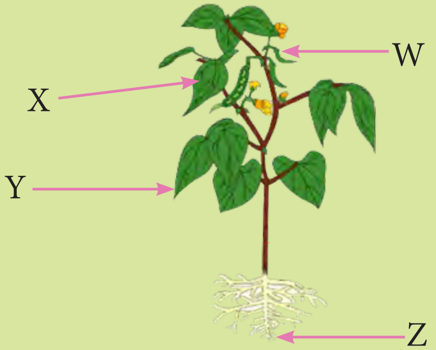


Figure 1.11

The letters that represent the presence of meristimatic tissue in Figure 1.11 are

A. w and y
B. y and z
C. x and y
D. x and z

4. Most organelles in the cell are suspended in the

A. cell membrane.
B. mitochondrion.
C. endoplasmic reticulum.
D. cytoplasm.

5. The Figure 1.12 shows four living organisms.

Figure 1.12.

Which statement about the organisms shown in Figure 1.12 is true?

A. They are all single celled and have similar organs.
B. They are all single celled and have identical organs.
C. They are all multicellular and have similar organs.
D. They are all multicellular and have identical organs.

6. What would happen to the cell if lysosomes are damaged?

A. The cell would produce more proteins than it needs.
B. The cell would have chloroplasts that appear yellow rather than green.
C. The cell would be less able to break down the dead and injured cell organelles in its cytoplasm.
D. The cell would be less able to regulate the amount of fluid in its cytoplasm.

Reprint 2024

7. The nose, trachea, and lungs function together during respiration. Thus, they form an

   A. organism.

   B. organ system.

   C. organelle.

   D. organ.

8. A student touches a hot object and then quickly pulls the hand away. Which body tissues are mostly involved in the student's reaction?

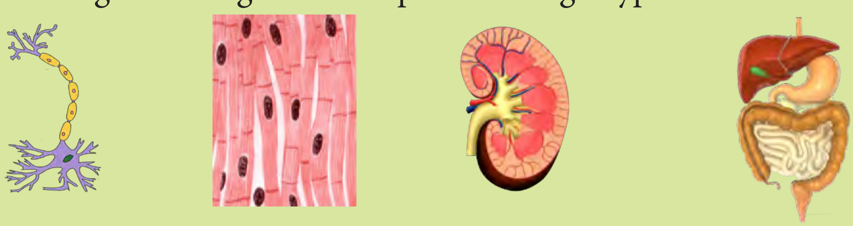
   A. Epithelial tissue and muscular tissue.

   B. Nervous tissue and muscular tissue.

   C. Connective tissue and muscular tissue.

   D. Muscular tissue and connective tissue.

9. Which diagram in Figure 1.19 represents single type of a human tissue?



(1) Neuron (2) Muscle (3) Kidney (4) Digestive System

Figure 1.13.

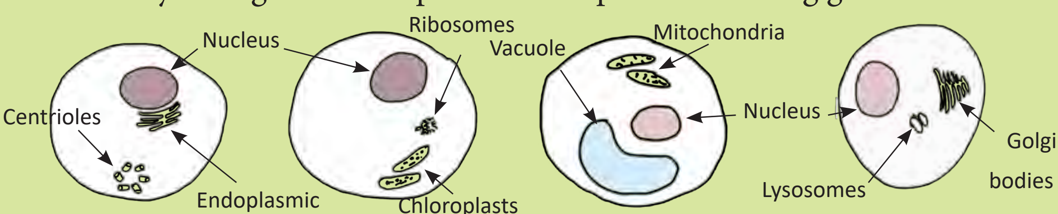
   A. (1).

   B. (2).

   C. (3).

   D. (4).

10. Identify the figure that depicts a cell capable of making glucose.



Cell A Cell B Cell C Cell D

Figure 1.14.

Reprint 2024

A. Cell A.
B. Cell B.
C. Cell C.
D. Cell D.

Fill in the blanks.

1. Note the relationship between the first two words and write a suitable word(s) in the blanks.
   i. Xylem: water; phloem:___________.
   ii. Epithelial tissue: lining of stomach; connective tissue:__________.
   iii. Cardiac muscle: muscle tissue; ligament:___________.
   iv. Parenchyma: storage of food; sclerenchyma:___________.
   v. Man: organism; lungs:_______________.

Check whether the following statements are True or False. Correct the false statements.

1. A heart is an organ system.
2. Meristematic tissue is only found in growing regions of plants.
3. Hand lens is used to observe cells.
4. Protoplasm includes cytoplasm, cell organelles, and vacuoles.
5. Collenchyma is for strength and support.

Match the following.

Column A	Column B
Absorption, secretion, and sensation	Centrosome
Carries impulse	Cell wall
Shape and rigidity to the cell	Chromoplast
Colour of flowers and fruits	Neuron
Cell division	Epithelial tissue

Reprint 2024

Answer the following questions.

1. It is the part of a cell that acts as a check post with fine pores present in it.
   i. Name the part of a cell.
   ii. Compare this part with the cell wall.
2. Figure 1.15 shows the classification of plant tissues.
   Copy and complete the flow chart labelled from 1 to 6.

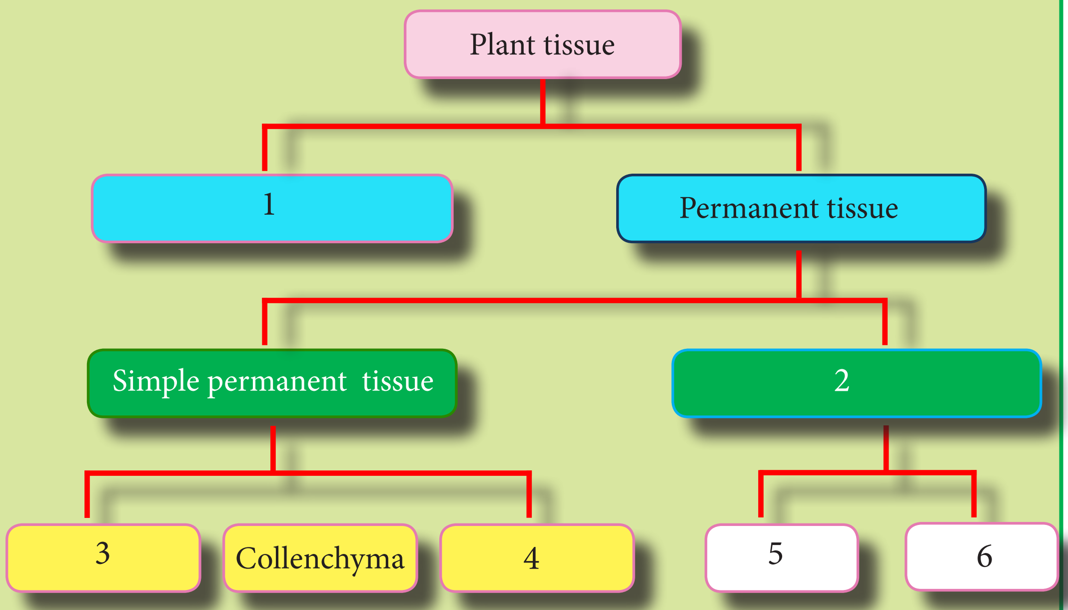


Figure 1.15.

Reprint 2024

Chapter 2
Human as Organism

You have learnt in earlier chapter that the human body is made up of different organ systems. Each organ system is specialised to carry out a specific function. For example, the digestive system converts larger molecules of food substances to simpler forms, while reproductive system helps to maintain the continuity of life.

Proper functioning of organ systems is essential to lead a healthy life. The health of an individual is generally affected by several factors, such as environment and changing lifestyles.

In this chapter, you will learn about some of the important human organ systems.

1. Human Digestive System

Learning Objectives

On completion of this topic, you should be able to:

- name the parts of the human system.
- explain the function of each part of digestive system.
- explain the process of digestion.

Humans need nutrients to grow and remain healthy. These nutrients are obtained from the food that we eat. Most of the food is in complex insoluble form (starch), which has to be changed into simpler soluble form (glucose). The conversion of food from complex to simpler soluble form is known as **digestion**. The process of digestion takes place in the digestive system. This system consists alimentary canal and the digestive glands.

Reprint 2024

Parts of digestive system and their functions

The alimentary canal is a muscular tube, which consists of mouth, oesophagus (food pipe), stomach, small intestine, large intestine and anus. The digestive glands, which are part of the digestive system secrete specific substances that help in the process of digestion of food. Figure 2.1 explains the process of digestion.

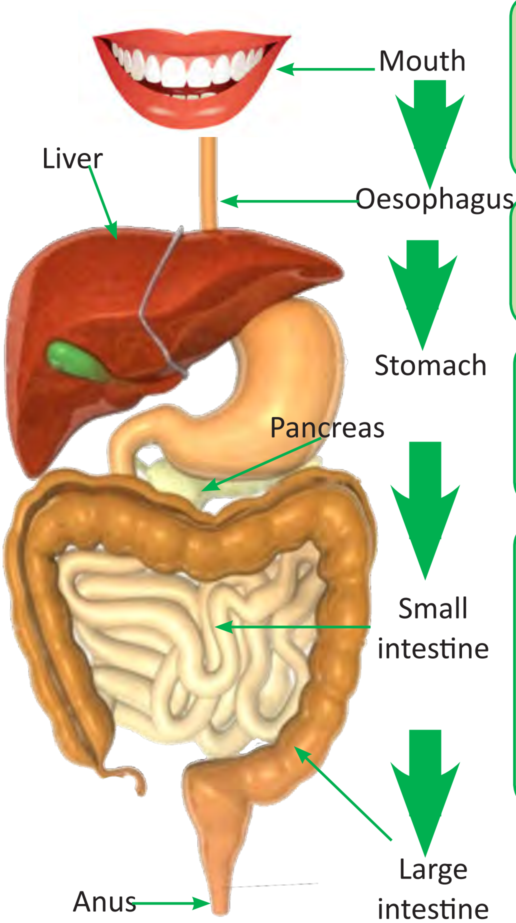


Figure 2.1. Human digestive system.

Mouth is the opening of the alimentary canal, where the food is chewed and mixed with saliva. The tongue helps in mixing the food with saliva. Saliva is a watery liquid containing an enzyme called salivary amylase, which is secreted by salivary glands. This enzyme helps to break down starch into simpler form, for example, maltose.

Oesophagus is a straight, narrow and thick-walled muscular tube. In esophagus, peristalsis makes the food move towards the stomach. The wave-like contraction and relaxation of muscular walls of the alimentary canal is called peristalsis.

Stomach is a large pouch with muscular wall, which stores, stirs and mixes the swallowed food with gastric juice and hydrochloric acid. These juices are secreted by the wall of the stomach containing gastric glands. The gastric juices further break down the large insoluble molecules of food into soluble ones.

Small intestine consists of three segments: duodenum, jejunum and ileum. Small intestine continues the process of breaking down the food with the help of enzymes from various glands. Liver is the largest gland of the body that secretes bile. Pancreas secretes pancreatic juice. There are other numerous smaller intestinal glands in the walls of the small intestine that secrete intestinal juice. The inner wall of the small intestine has millions of finger shaped folds called villi, which absorb digested food and water.

Large intestine absorbs water and stores faeces. The large intestine leads to rectum that opens at the anus through which the faeces is removed (defecation).

Do You Know?

In humans, the total internal surface area of villi is about 30 square metres or slightly larger than the size of a tennis court.

Reprint 2024

Activity 2.1. What happens to the food we eat?

Watch the video using the link given below and answer the questions that follows:

https://www.youtube.com/watch?v=zr4onA2k_LY

The digestion of food begins in ……1…… The …...2…… is partly broken down by chewing and by the action of salivary amylase. The chewed food reaches ……3…... through oesophagus. With the help of hydrochloric acid and ……4……juice, the food is then converted into a semi-solid state called chyme, which passes into the small intestine. In small intestine, the chyme is completely digested by the action of intestinal juice, bile, and …...5…… juice. The soluble food is then absorbed in the small intestine through ……6…. The absorbed food molecules enter the blood stream through the blood capillaries present in the villi. The blood then ……7…… the absorbed food molecules to all the …...8….. of the body, where it is used for producing ……9…... The undigested food in the small intestine passes into the ...…10…... intestine. This undigested food is passed out of the body through the …...11…... in a semi-solid form called ...…12…...

i. Why is energy not released soon after eating food?
ii. How is small intestine adapted to absorb digested food?

WEBLINK

http://www.enchantedlearning.com/subjects/anatomy/digestive/
http://www.innerbody.com/image/digeov.html
http://www.britannica.com/EBchecked/topic/1081754/human-digestive-system

Reprint 2024

Exercise

Answer the following questions.

1. Why is chewing of food important part of digestive process?
2. Use Figure 2.2 to answer the questions that follows.

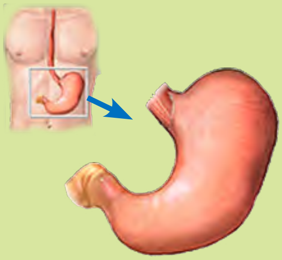


Figure 2.2.

   i. Identify the alimentary organ.
   ii. How does it help in the process of digestion?
   iii. Name the gland present in this organ.
   iv. Name the substance secreted by the gland.

2. Muscles, Joints, and Movement

Learning Objectives

On completion of this topic, you should be able to:

- identify different types of muscles with examples.
- describe different types of joints and their functions.
- explain the working principle of antagonistic muscles.

Movement in human being is produced by combined action of the skeleton and muscles. The skeleton is formed by a framework of bones. Bones are living tissues made up of calcium and phosphorus. How many bones are found in the adult human body? The bones are held together by tendons, ligaments, and cartilages.

Reprint 2024

Tendons are tough fibrous connective tissues that connect muscles to the bones, while ligaments are elastic and fibrous connective tissues, which connect two or more bones at the joints. **Cartilages** are also connective tissues, found between two or more bones. They prevent bones from rubbing against each other.

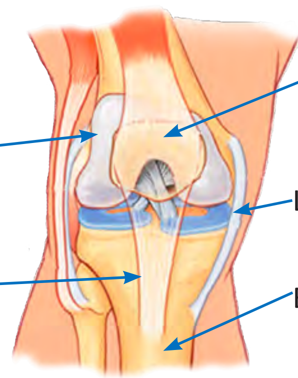


Figure 2.3. Joint.

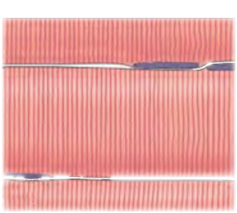
a. Muscle

Muscle is composed of bundles of cells, capable of contracting and relaxing to produce movement. There are three types of muscles in our body. They are:

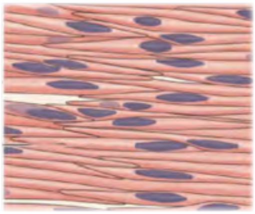
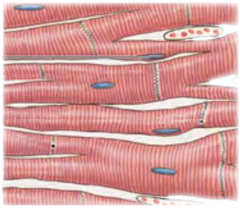
i. striated muscle.
ii. non-striated muscle.
iii. cardiac muscle.

The various kinds of muscle tissues, their locations, and functions are given in the Table 2.1.

Table 2.1 *Types of Muscles*

Muscle Tissue	Characteristic	Function
Striated muscle 	It is long and cylindrical, non-tapering and unbranched. It is attached to the skeleton and is voluntary in nature (individual can control it). There are stripes on it; therefore, it is called **striated muscle**. It is also known as skeletal muscle or voluntary muscle. For example, muscles of arms, anus, legs and shoulder.	Helps in voluntary movement of the body.

Reprint 2024

Non-striated muscle 	It is spindle shaped and there are no stripes on it. It is involuntary in nature (individual cannot control). It is found in the internal organs such as intestine, stomach, blood vessels, reproductive system and bronchioles. It is also known as smooth muscle or involuntary muscle.	Causes the movement of internal organs.
Cardiac muscle 	It is striated, cylindrical and branched, present only in the heart. It is involuntary in nature and it works non-stop.	Helps in the continuous pumping of the blood.

Antagonistic Muscle

Examine Figure 2.4 and its working mechanism.

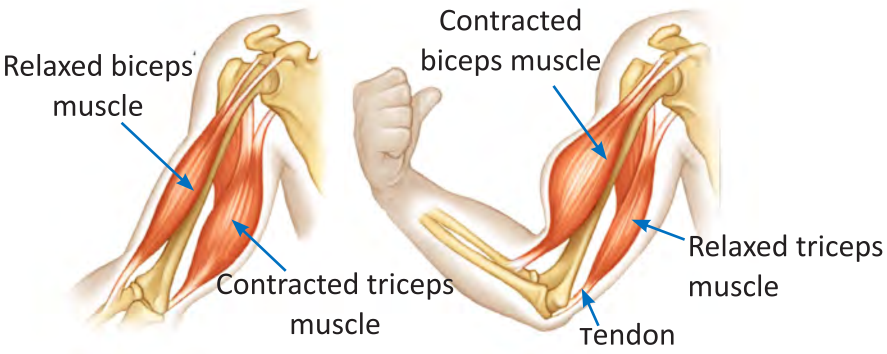


Figure 2.4. Working of antagonistic muscle.

From the above two diagrams, we can see that for the arm to move up, the bicep muscle has to contract and the tricep muscle has to relax. To lower the arm, the tricep muscle has to contract and bicep muscle has to relax. Therefore, biceps and triceps in the arms are antagonistic pair of skeletal muscles. **Antagonistic muscles** are those skeletal muscles that oppose the action of another muscle.

Reprint 2024

b. Joint

The point where two ends of bones meet in the body is termed as a **joint**.

Activity 2.2. Know your joint

Study Figure 2.5 and answer questions that follows.

Skull

Hip

Back bone

Figure 2.5. Different types of joint.

Identify the part which has:

i. immovable joint.
ii. slightly movable joint.
iii. movable joint.

Types of joint

On the basis of movements, joints are of three types:

i. Immovable joints

Immovable joints are those which do not permit any movement of the bones. For example, joints in skull.

ii. Slightly movable joint

Slightly movable joints are those which allow slight movement of the bones. For example, joints in the vertebral column.

iii. Movable joint

Movable joints are capable of free movement. In this type of joint, there is a cavity (space) present in between the ends of two bones. This space is called **synovial cavity**. It is filled with a lubricating fluid called **synovial fluid** that prevents friction and acts as a lubricant. For example, joints in the knee and elbow.

Reprint 2024

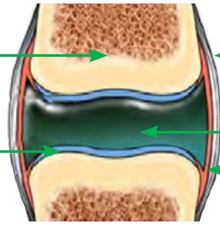
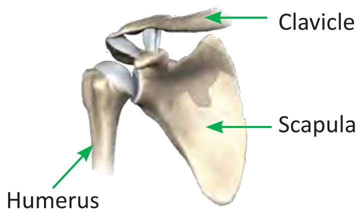
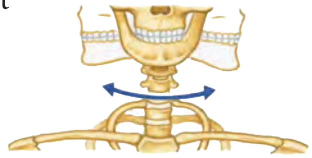
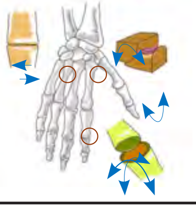


Figure 2.6. Synovial joint.

There are four major types of movable joints

Table 2.2 *Types of Movable Joint*

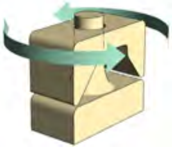
Movable Joint	Characteristic	Example
Ball and socket joint 	In this type of joint, one end of the bone is round and ball-like, which fits into the hollow cup shaped socket of another bone. Here, the bones can move in all directions.	Hip joints and the shoulder joints.
Hinge joint 	This type of joint allows movement in one direction. It moves like a hinge of a door.	Elbow joints and knee joints.
Pivot joint 	In such type of joint, the pointed part of one bone fits into the cavity of another bone.	The joint between the first and the second vertebrae of the backbone.
Gliding joint 	In this type of joint, one bone slides over the other.	In this type of joint, one bone slides over the other.

Reprint 2024

Questions

1. Study Table 2.3 and identify the type of joints.

Table 2.3

Sl. No	Model	Type of Joint
1		
2		
3		
4		

2. A researcher made an interesting observation about the working condition of thigh muscles during a marathon run. He found out that pairs of thigh muscles helped runners in their leg movement. What type of skeletal muscle did he discover?
3. 'Muscles of our limbs are voluntary'. Explain in your own words.
4. Name the fluid present in the movable joints. Write down its function.

WEBLINK
http://kidshealth.org/parent/general/body_basics/bones_muscles_joints.html

Reprint 2024

3. The Human Respiratory System

Learning Objectives

On completion of this topic, you should be able to:

- explain the role of lungs.
- compare anaerobic respiration in plants with that of animals.
- explain the effects of smoking on the respiratory system.

The digested food after reaching the cells is oxidised to release energy, carbon dioxide, and water. The oxidation of food in cells occurs in presence of oxygen. The oxygen reaches the cells through the process of gaseous exchange in the lungs.

a. Gaseous exchange

Lungs are main organs in the respiratory process. Lungs contain bronchioles which end in large number of alveoli (singular: alveolus). The alveoli are surrounded by network of capillaries. When we breathe in, the inhaled air rich in oxygen reaches the alveoli. The oxygen diffuses into the blood in the capillaries from alveoli as shown in Figure 2.7.

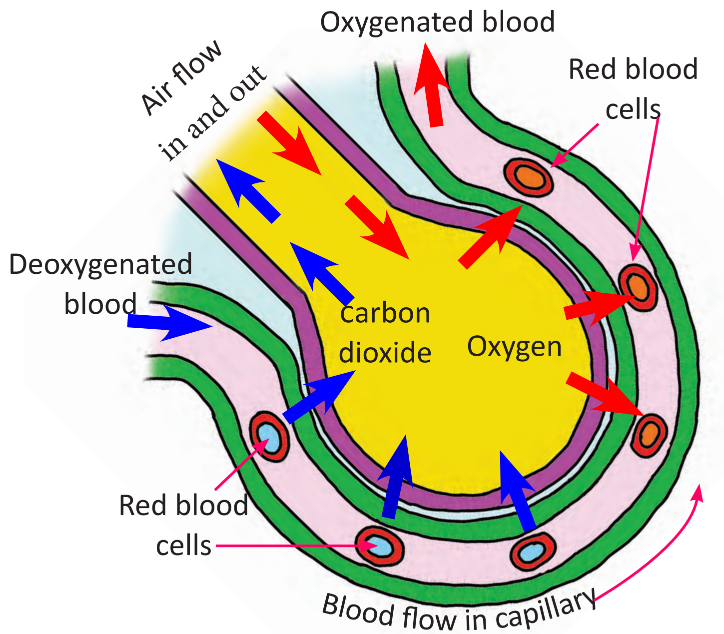


Figure 2.7. Gaseous exchange in alveolus.

The oxygenated blood from the lungs is carried to the heart and pumped to different parts of the body. The oxygen in the blood then diffuses into the cells.

Do You Know?

A resting human breathes out about 500 litres of carbon dioxide every 24 hours.

Reprint 2024

The diffused oxygen is used in the cells to oxidise the food (glucose) to release energy, carbon dioxide, and water.

The carbon dioxide released during respiration in the cells diffuses into the blood. Next, the heart pumps deoxygenated blood from various parts of the body into the lungs. The carbon dioxide then diffuses into the alveoli and is removed during exhalation. The diffusion of oxygen from alveoli in the blood, and carbon dioxide from the blood in the alveoli takes place at the same time.

b. Effect of smoking on lungs

Smoking and chewing tobacco have become common habits among people despite their harmful effects on the person's health, family and economy. Smoking and chewing tobacco severely affect the gaseous exchange in the respiratory system in the individual.

The tobacco in the cigarette contains nicotine, tar and many other harmful substances. The tar present in tobacco is one of the main causes of emphysema, a condition in which the alveoli ruptures and cause breathing difficulty. Continued deposits of tar along the lining of the lungs also leads to cell degeneration. Most of the chemicals present in the tar are toxic. The accumulation of toxic chemicals stimulates the body to form a tumour (uncontrolled growth of cells) around the affected area, leading to cancer.

Globally, millions of people die every year because of smoking. It is considered as one of the leading causes of human death. Tobacco consumption in our country is increasing among all population groups, especially youth.

Activity 2.3 Facts and myths about smoking

Work in groups

Prepare a presentation slide to advocate on the effects of smoking and tobacco use. Your slides must also help in clarifying myths related to smoking and tobacco use.

c. Respiration in human

Respiration is important for all organisms for the oxidation of food. There are two types of respiration:

i) aerobic respiration

ii) anaerobic respiration.

Reprint 2024

Aerobic respiration in animals is similar to that of plants. Aerobic respiration takes place in presence of oxygen. The overall process of aerobic respiration is represented by the following equation:

$$\text{Glucose} + \text{Oxygen} \longrightarrow \text{Carbon dioxide} + \text{Water} + \text{Energy}$$

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + 38ATP$$

However, anaerobic respiration in animal is different from plants in some aspects. Anaerobic respiration is a type of respiration that does not use oxygen. The anaerobic respiration in human occurs in the skeletal muscle cells when they work rapidly with insufficient oxygen. The lactic acid produced during anaerobic respiration cause pain in the muscle or muscle fatigue.

Anaerobic respiration in animals is represented by:

$$\text{Glucose} \longrightarrow \text{Lactic acid} + \text{energy}$$

$$C_6H_{12}O_6 \longrightarrow 2CH_3CH(OH)COOH + 2ATP$$

Differences between anaerobic respiration in plant and animal

Table 2.4 *Comparison of Anerobic Respiration in Plants and Animals*

Anaerobic Respiration in Plant	Anaerobic Respiration in Animal
1. End products are ethanol and carbon dioxide.	1. End product is lactic acid.
2. The energy released is more.	2. The energy released is less.

Questions

1. Figure 2.8 contains jumble of sentences related to gaseous exchange. Read the sentences carefully and put them in a proper sequence to build up the concept of gaseous exchange.

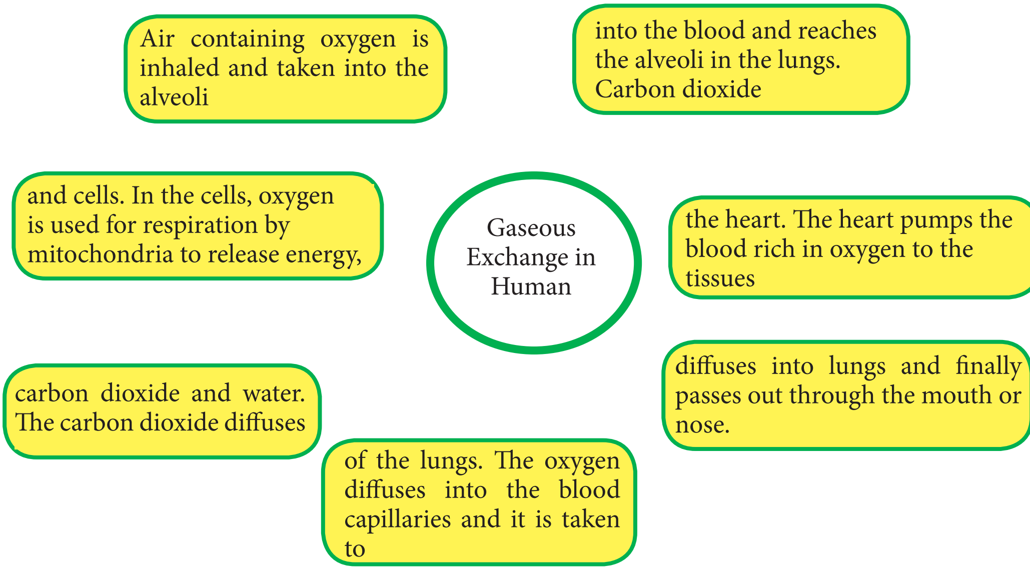


Figure 2.8.

Reprint 2024

2. Our lungs contain billions of alveoli. Figure 2.9 represents gaseous exchange occuring in the alveolus. Copy and complete the figure.

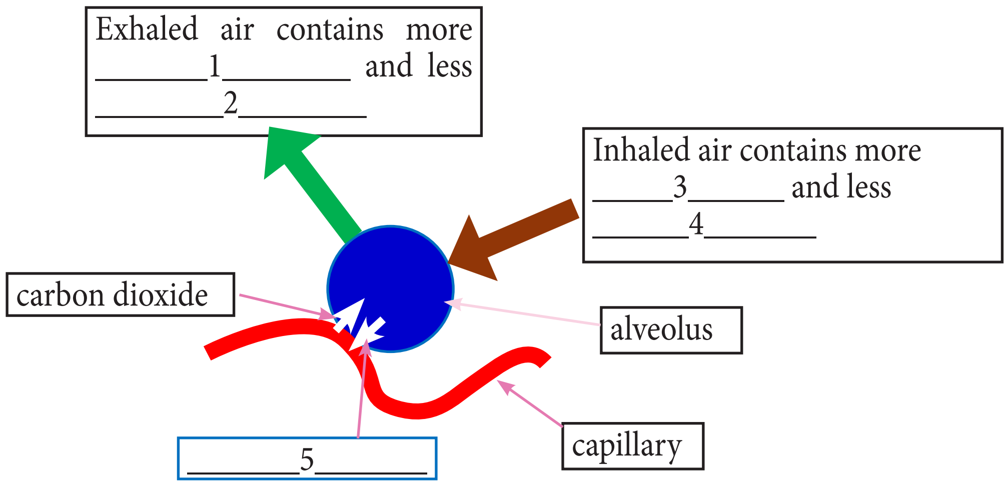


Figure 2.9.

3. Which respiration is more efficient in human, aerobic or anaerobic? Why?
4. We often see soccer players suffering from muscle cramp during the game. As a science student, how would you explain this process to your friends?
5. What is wrong with the statement, we breathe in only oxygen and breathe out only carbon dioxide?

WEBLINK

http://www.excellup.com/InterBiology/plantrespiration.aspx
ences/biology/plant-biology/respiration/respiration-energy-for-plant-metabolism
http://www.oum.ox.ac.uk/thezone/animals/life/respire.htm
http://www.dummies.com/how-to/content/animal-respiration.html

4. Fertilisation and Development of Foetus

Learning Objectives

On completion of this topic, you should be able to:

- explain the process of fertilisation.
- describe the development of foetus.
- explain the function of placenta.
- Outline the ways to avoid early sex and teenage pregnancy.

Human beings reproduce sexually. It starts with the production of gametes in the reproductive organs followed by fertilisation and the development of foetus in the womb.

a. Fertilisation and Implantation

Did you know that our life begins from a single cell structure called zygote? The reproduction in human being begins with the production of male gamete (sperm) and the female gamete (ovum). After the puberty, a single ovum is released in female by two ovaries alternatively every month.. Sperms are produced inside the testes of male. During sexual relation, millions of sperms are deposited into the vagina. The sperms travel up the vagina and uterus and reach the fallopian tube where fertilisation occurs. Only one sperm fuses with the ovum. This fusion of sperm and ovum is called **fertilisation**. It results in the formation of a single-celled structure called **zygote**.

The zygote divides and forms a cluster of cells called **blastula**. It travels down to the uterus and fixes itself to the wall of the uterus. The fixing of a blastula to the wall of uterus is called **implantation**. The blastula develops into an **embryo**. The walls of uterus become thick with increased blood supply to nourish the growing embryo.

Within the uterus, the embryo is surrounded by a protective sac called **amnion** or **amniotic** sac. The amniotic sac contains a fluid called **amniotic fluid**. This fluid acts as shock absorber and protects the embryo from damage. After six weeks, the embryo is called a **foetus**. The foetus is attached to the uterus by an organ called **placenta**.

Reprint 2024

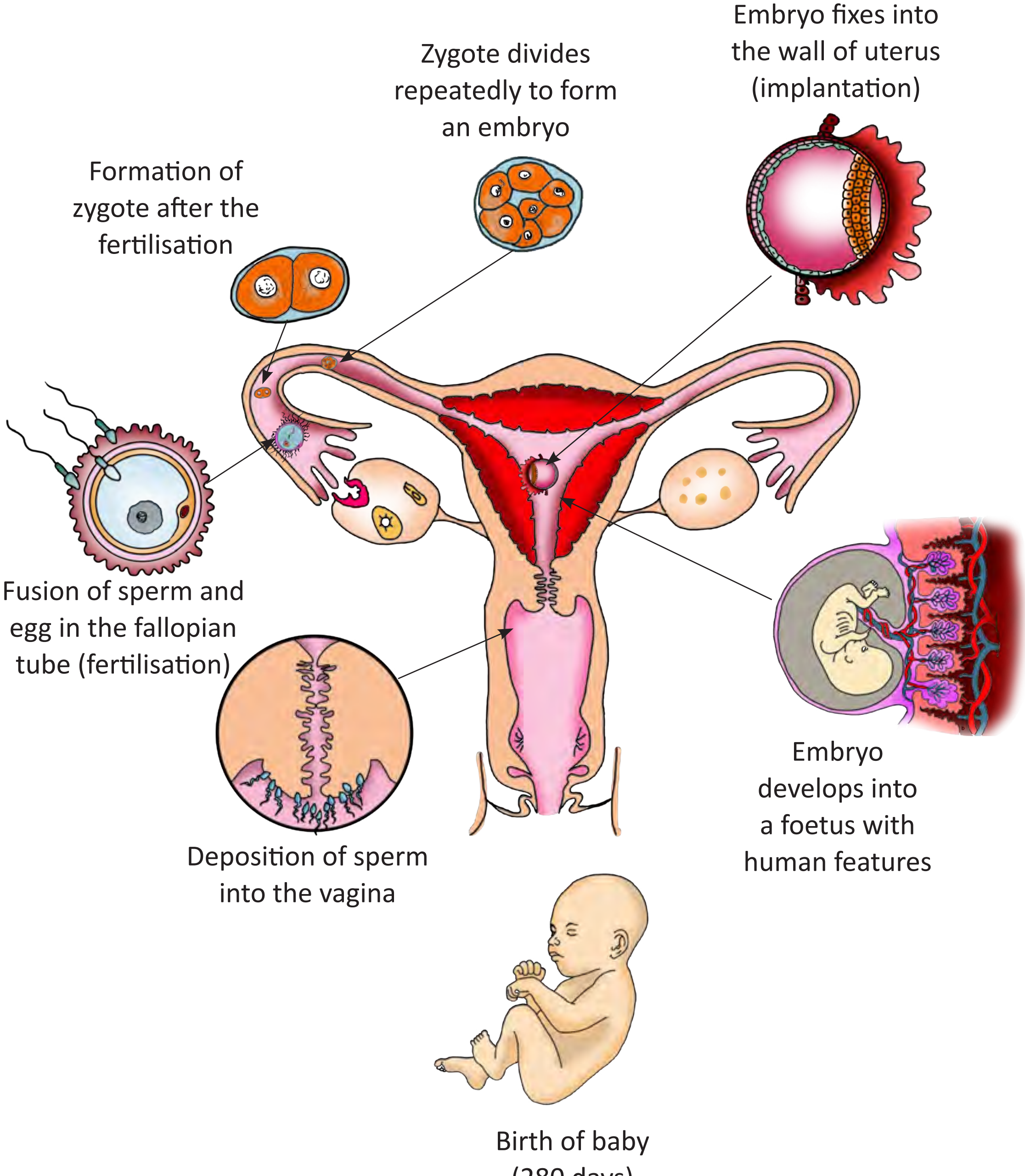


Figure 2.10. Stages of foetal development.

Activity 2.4. Use Edraw Max or any other drawing tools to create the flowchart that explains the foetus development.

Reprint 2024

Placenta

Placenta is an organ attached to the wall of the uterus. A cord containing blood vessels connects the placenta with the foetus. This cord is called **umbilical cord**. Nutrients, oxygen and other substances pass from the mother's blood into the foetus through the placenta. It also carries carbon dioxide and waste materials from the foetus to the mother's blood.

Gestation period and birth

The period between the formation of zygote and the birth of baby is called **gestation period**. It is about 280 days in humans. The state of carrying foetus in the uterus of a woman is called **pregnancy**.

The emergence of a baby from the body of mother is called **birth**. At the time of birth, the muscles of uterus contract to push the baby out through the vagina.

Questions

1. Study Figure 2.11 and fill up the missing terms in the boxes numbered 1 to 4 in your note book.

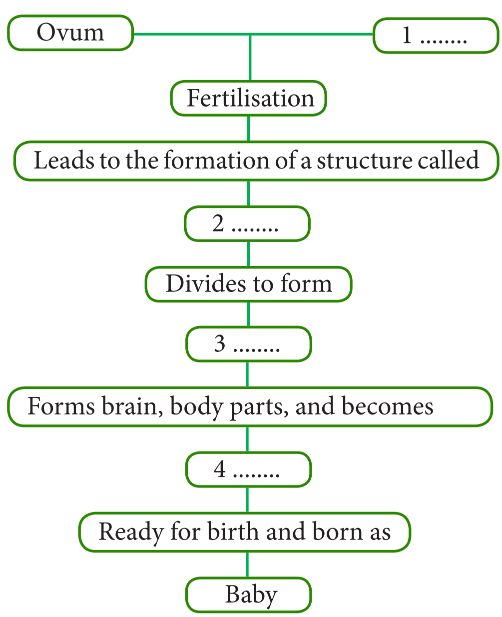


Figure 2.11.

Work in groups:

Read the following passage and answer the questions that follow:

The Woes of Yongmin

Yongmin was an only child born in a broken family. Her parents divorced when she was 5 years old and she lived with her maternal grandparents. Her mother owned an entertainment center in a town and hardly spent time with Yongmin. She never saw her father after her parents got divorced. However, her grandparents never let Yongmin miss her parents. She was blessed with their love and care.

Yongmin completed her class ten with distinction and enrolled in a Higher Secondary School. Her grandparents were proud of her and gifted a smartphone on her achievement. She was found using her phone till late at night. Complaints started to come from the school regarding her academic performance.However, grandparents did not take it into account as they feared losing Yongmin.

One late evening, Yongmin's grandmother found her with a boy below the house exchanging unhealthy touches. She became suspicious and asked Yongmin about the incident in which she replied rudely. Her grandmother was shocked and slapped her for acting rude. She packed her things, called the boy and asked him to take her with him. Her grandmother pleaded her to rethink but in vain. She was resolved to marry him when she was just 16. She turned deaf ear to her grandparents and walked out with that boy.

After six months, her grandfather found Yongmin in the street carrying a child and begging for food. As soon as she saw her grandfather, she broke into tears. She apologized for failing to obey her elders. The grandfather lodged a complaint to the police against that boy. It was found that the boy had such relations with a lot of teenage girls and had played with them. He was punished with accordance to the law of the country.

1. Why didn't Youngmin listen to the requests of her grandparents?
2. State the problems she encountered after leaving her house.
3. Although, at the age of 16, Youngmin's body is ready to reproduce; is she ready to start a family? Support your answer with a brief explanation.

Reprint 2024

4. Assume that you are Yongmin in the story and answer the following questions;
   i. How would you have resolved the problem of "family instability" appropriately and differently?
   ii. List down as many alternatives as possible that would have helped you to make informed decision on getting married.
   iii. Write down all the disadvantages of early marriage.

Do You Know?

Identical twins: *These twins are identical in looks and of the same sex. They develop from a single zygote.*

Fraternal twins: *These twins look different and may be of same sex or different sexes. They develop from two separate zygotes.*

WEBLINK

http://www.s-cool.co.uk/a-level/biology/reproduction/revise-it/sexual-reproduction-in-humans-the-first-stages

Reprint 2024

5. Sense Organs

Learning Objectives

On completion of this topic, you should be able to:

- describe the structure of an eye and their functions.
- describe the structure of an ear and their functions.
- identify the types of taste receptors and their functions.
- explain nose as a sense organ for smell.
- describe the structure of a skin and their functions.

All living organisms respond to physical and chemical occurring after changes in the environment. Our body has specialised cells called **receptors**, which receive stimuli from the environment. Any change in the environment (external or internal) that affects the organism or excites the receptors is called **stimulus**. Some of the receptors are present in the sense organs. Eyes, ears, tongue, skin, and nose allow us to enjoy the world around us, the beauty of a sunrise; the sound of music; the taste of food; the softness of a fur; the fragrance of a rose, etc. Each of these sense organs is connected to the brain by nerves.

Activity 2.4. Discover your senses

Your teacher will take you for a short nature walk. List down all the things that you see, hear, smell, taste, and feel during the walk. Stop at various points along the way, and ask your friends to share what they sense. Draw attention on some of the interesting sights, smells, and sounds during the walk.

At the end of the walk, form pairs and share what you have experienced during the walk.

a. The eye and its structure

The eyes are located within the eye sockets. Each eye is in the form of a ball called eyeball, which measures about 2.5 cm in diameter. They are protected by eyebrows and eyelids. The eyebrows protect the eyeballs from perspiration and rain drops getting into them. Eyelids protect the outer surface of the eyes and also shut out light. Each eyelid carries eyelashes, which prevent falling of dust

Reprint 2024

particles into the eye. Tear glands or lacrimal glands are situated at the upper side of each eyelid. They produce tears which help to flush out foreign particles and prevent infection.

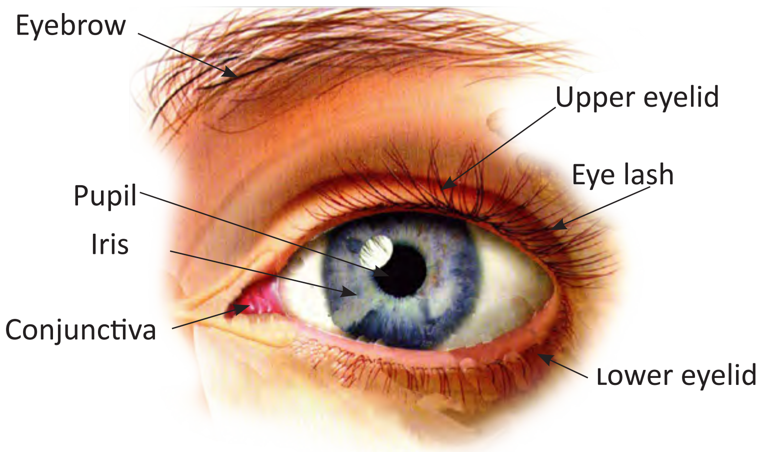
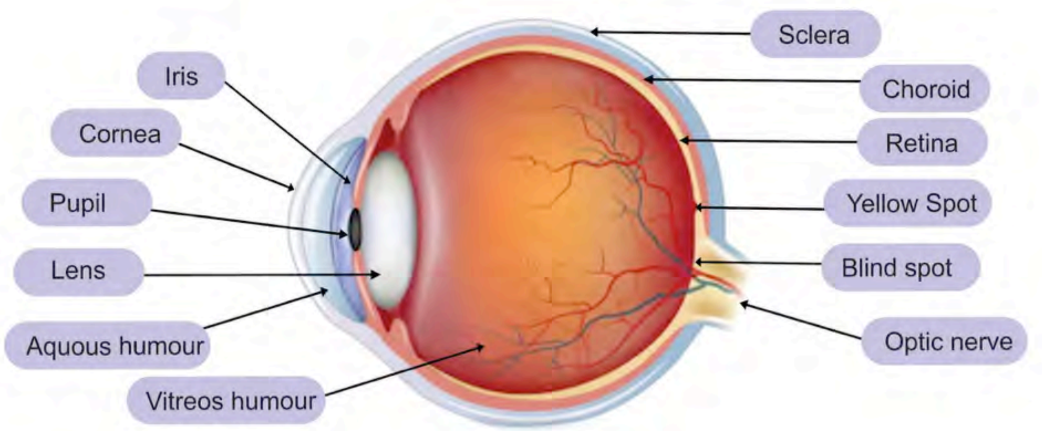


Figure 2.12. External structure of an eye.

Reprint 2024

Structure of Eyeball Showing Its Parts and Function



Iris- End of the choroid layer around the pupil.
-Regulate the size of the pupil.

Cornea- Front transparent part of the eye which reflects the light entering the eye.

Pupil- Opening in the cetre of choroid layer.
- regulates the amount of light entering the eye

Lens- It is transparent and focuses the light on the retina.

Cornea- Fluid that fill the space between the lens and cornea.
- Gives the shape to eye ball.

Vitreous humour- Gel like fluid which fills the space between the lens and retina.
- It gives shape to the eye.

Sclera- Outmost layer, thick, tough and opaque.
- maintains the shape of the eyeball and protects the delicate parts inside

Choroid- Black Middle layer
- Prevents the internal reflection of light

Retina- Inner most layer with many receptor called rods and cones.
- place of formation of image of an object

Yellow Spot- spot on retina with maximum rods and cones.
- Place of best vision

Blind spot- Spot on retina where the rods and cones are absent.
- Place of no vision

Optic nerve- transmits visual information from the retina to the brain.

Figure 2.13. Structure of an eye.

Reprint 2024

Activity 2.5 Observing the contraction and dilation of pupil

Precaution

Do not look at the Sun or very bright objects directly.

Work in pairs

Procedure

Case-I

1. Look into your friend's pupil and observe its size. This must happen inside the class.
2. Let your friend do the same.
3. Draw the size of the pupil in your exercise book.

Case-II

1. Go outside the class.
2. Look at the bright objects for a while.
3. Observe your friend's pupil again.
4. Let your friend do the same.
5. Draw the size of the pupil in your exercise book.

i. Compare the size of the pupil in case-i and case-ii.

ii. Name the muscle responsible in changing the size of the pupil.

iii. Why does the size of the pupil change?

Activity 2.6. How do we see ?

Copy and complete the following text.

Light enters your eye through a clear portion of the sclera called the **…1…** It is curved, so the light rays slightly bend as they pass through it. Light then passes through **…2…** humour and then through the pupil. The**…3…** adjusts the size of the pupil. It is the coloured part of the eye. In dim light, the iris **…4…** and the pupil gets bigger; in bright light, the iris expands and the pupil gets smaller. **…5…** is located behind the iris. It is the structure that can change shape in order to focus light onto the retina, so that we can see the objects clearly. The ciliary muscles, around the lens control the shape of the lens. Behind the lens is a clear gel-like substance called the **…6…** humour. The light passes through this and strikes the **…7…** which is the inner most layer of the eye. It contains two types of cells: rods and cones. Rods are sensitive to **…8…** light, while the cones are sensitive to bright light and colour. The rods and cones send messages through the **…9…** nerve, which carries the information to the **…10…** The brain interprets the image of the object.

Reprint 2024

b. The ear and its structure

The ear consists of three parts namely external ear, middle ear, and the inner ear. The external ear consists of pinna, auditory canal, and the eardrum. The middle ear is a small chamber with three small bones called **ear ossicles**. These bones are malleus, incus, and stapes that fits on the oval window. Stapes is the smallest bone in the human body. The middle ear is connected to throat by eustachian tube which balances air pressure on either side of the ear drum.

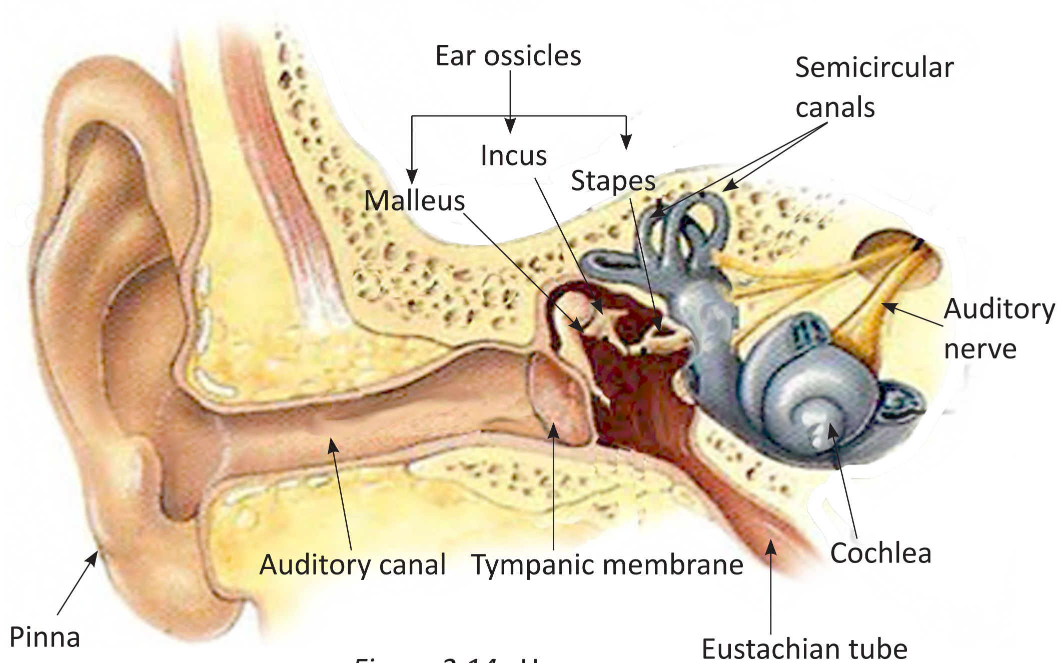


Figure 2.14. Human ear.

The inner ear has two main parts, the cochlea and the semi-circular canal. The cochlea looks like a snail's shell and is filled with fluid and sensory cells. There are three semi-circular canals arranged in right angles to each other, which are filled with fluids and sensory hairs.

When the body is losing its equilibrium, the fluid in the semi-circular canals washes over the sensory hairs and stimulates them. The impulse is sent to brain. The brain perceives that the body is losing its equilibrium, and will signal some muscles to contract and others to relax until balance is maintained. Thus, the ear helps in hearing and body balance.

How do we hear sound?

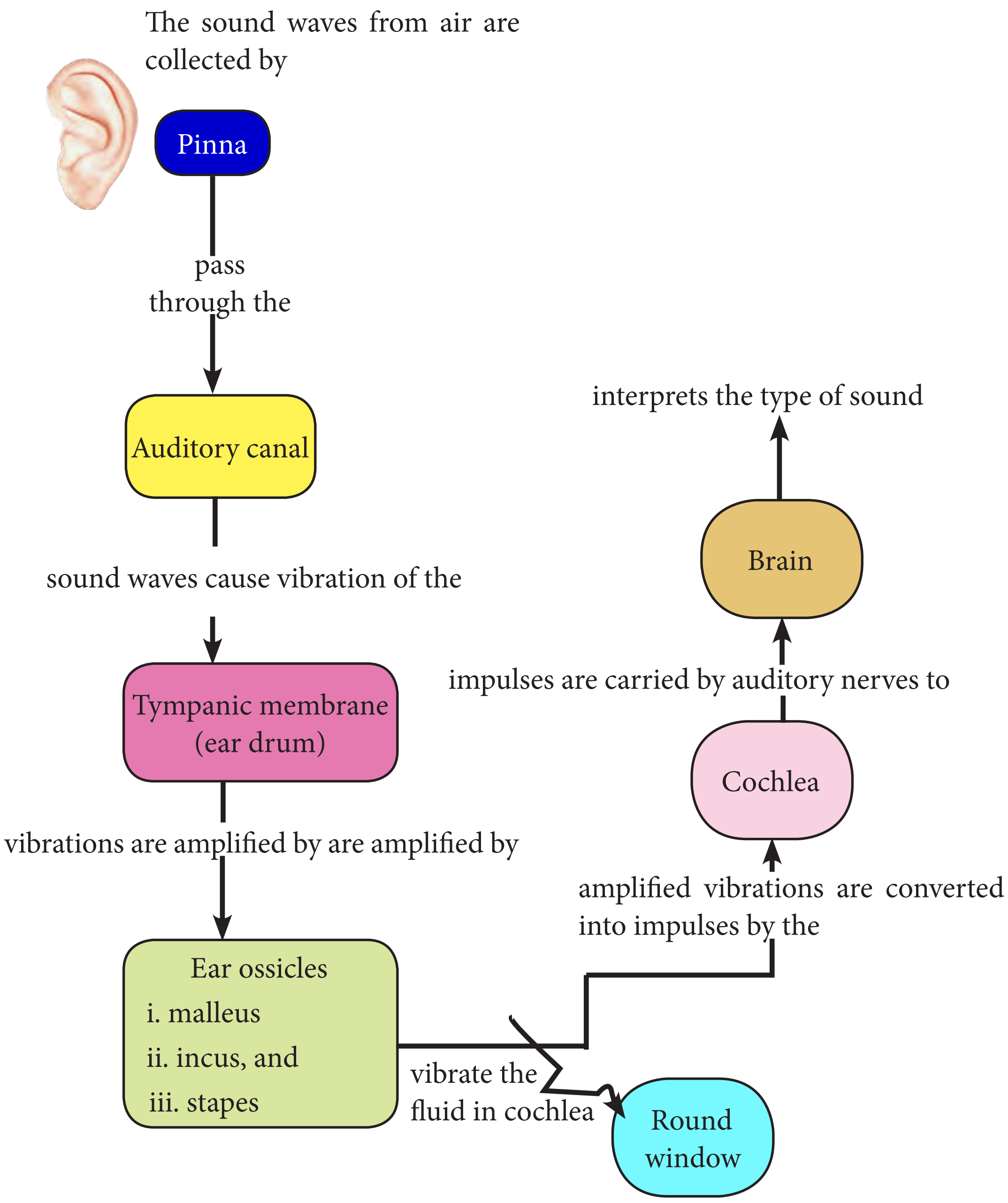


Figure 2.15. Process of hearing.

c. The tongue

Tongue is a muscular organ in our mouth. It is used for tasting food substances. The taste of food is detected by the taste buds in the papillae of the tongue. The taste buds are oval bodies consisting of sensory cells. These sensory cells end in hair-like processes, which project out of the taste pores. When substances in solution enter the pores, the sensory hairs are stimulated. The nerve fibres extending from the bases of sensory cells carry the impulses to the brain where the taste is identified.

There are mainly four taste sensations located on specific areas of the tongue. The posterior part of the tongue is sensitive to bitter taste; the tip is sensitive to sweet and salty; and the sides are sensitive to sour taste. Besides tasting the food, the tongue is also used for licking, swallowing, and articulating speech.

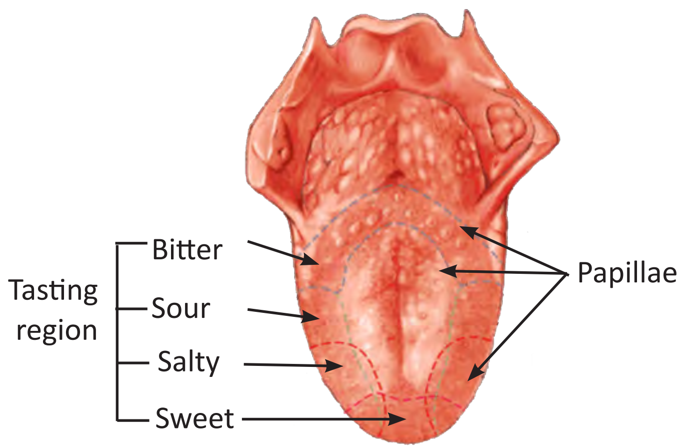


Figure 2.16. Taste receptors.

d. Nose

Nose is used for breathing and smelling. The nose contains two nostrils that lead to the nasal cavity. This cavity contains sensory cells called **olfactory cells**. These cells contain hair-like fine projections that help to receive the stimuli of the odour. The impulse generated by the stimuli is transmitted to the brain through the olfactory nerves. The brain then interprets the nature of the smell.

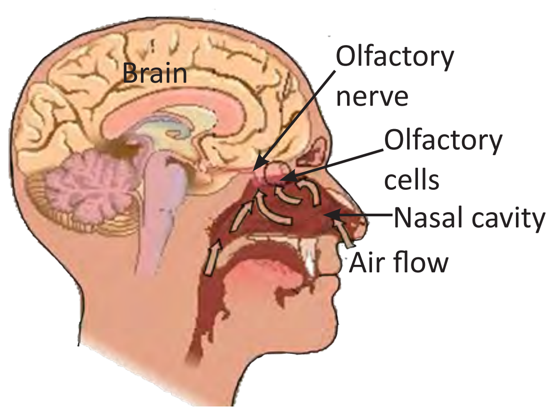


Figure 2.17 . Internal structure of a nose.

e. Skin

The outermost part of our body is called **skin**. It is composed of two layers, the epidermis and dermis. The skin contains a variety of specialized structures,

Reprint 2024

including hair, nail, sweat gland, and oil gland. It is supplied with nerves and blood vessels. It is the largest sense organ containing receptors that are sensitive to pain, temperature, and pressure. It removes metabolic waste and regulates body temperature through sweating, protects from germs and injuries, and synthesises vitamin D.

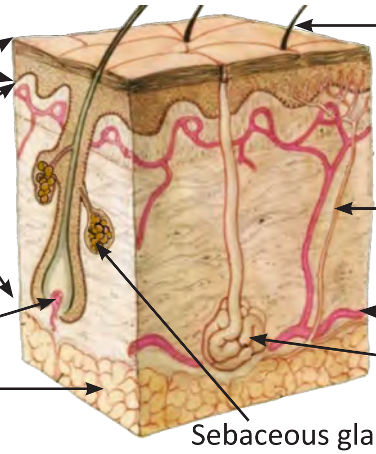


Figure 2.18. Structure of skin.

Activity 2.7. Care for sense organs

Sense organs in our body are important because they perform vital functions. First column in Table 2.6 shows the ways of taking care of our sense organs. Tick (✓) the correct sense organ in relation to the statement given, and give reason in the column provided.

Table 2.6 *Caring sense organ*

Ways of taking care	Eye	Ear	Nose	Tongue	Skin	Reason
Do not write or read under dim light	✓					It will stress and strain the eyes and affect the vision in long run
Do not watch television for long duration						
Take bath regularly						

Avoid listening to loud music						
Avoid too much of sunlight						
Rinse your mouth after every meal						
Avoid using tongue scraper						
Use handkerchief to avoid dust particles						
Do not scream close to your friends						
Avoid plucking hairs in the nostrils						
Do not sneeze with your mouth closed						
Do not wear other's clothes						
Do not use earphones for prolonged duration						

Questions

6. Why is 'yellow spot' called the area of best vision?
7. What would happen if eardrum is damaged?
8. Why is it advisable to breathe through nose than mouth?
9. A researcher asked ten students to taste mango pickle. Seven students found the pickle taste sour, while three students found it tasteless.
   i. What could be the possible hypothesis of the study?
   ii. What can you conclude from the above study?
5. A person standing in the sun feels hot. Name the sense organ involved in the detection of heat

6. Environment, Lifestyle, and Health

Activity 2.8. Identifying sources of pollution

Learning Objectives

On completion of this topic, you should be able to:

- explain how various environmental factors affect our health.
- explain the importance of healthy lifestyle in maintaining a good health.
- mention the importance of maintaining good eating habits.

Our health is affected by many factors such as personal, environmental, and hereditary factors. For a healthy life, we must include balanced diet, regular exercise, clean personal habits, and sufficient rest. Environmental factors such as pollution, urbanization, and climate change affects our health. Some of us may also inherit diseases from our parents. This type of disease is called **hereditary disease**.

In this topic, you will study how environmental factors, unhealthy habits, and lifestyles affect our health.

a. Environmental Factors and Health

All the natural and man-made conditions around us are called **environment**. The condition of the environment constantly changes and affects our health and well-being. Some environmental factors include air, food and water supply, climate change, urbanisation, chemicals, and genetically modified organisms (GMOs).

Air pollution

The contamination of air with dust, smoke, and harmful gases is called **air pollution**. It is mainly caused by the smoke emitted from industries, vehicles, and domestic use of fuels such as wood and kerosene. This smoke generally contains harmful gases such as carbon monoxide, carbon dioxide, nitrogen dioxide, sulphur dioxide, and other harmful chemicals.

Polluted air causes dizziness, headache, eye irritation, lung cancer, sore throat, chest pain, and allergies. Gas like carbon monoxide reduces the oxygen carrying capacity of the blood. It causes suffocation and may even cause death. Sulphur dioxide, carbon dioxide, and nitrogen dioxide gases cause acid rain, which affects the entire ecosystem including our health.

Water pollution

Any chemical, physical or biological change in the quality of water which has a harmful effect on any living thing is called **water pollution**. The main causes of water pollution are industrial, agricultural and domestic wastes. The polluted water contains large numbers of pathogens, which cause diseases such as cholera, dysentery, typhoid, and other skin diseases. The toxic or poisonous chemicals like mercury and lead from industrial wastes can enter our body through food and water and affect our health. Water polluted with nitrates from fertilisers may cause cancer, birth defects and genetic disorder.

Land pollution

Land gets polluted due to contamination from agriculture, industrial waste, mining activities, and solid waste dumping. Excessive use of chemicals in agriculture leads to soil pollution. Industries produce huge amount of chemical wastes, that cause land pollution. Mining is another source of land pollution which spreads metals in the soil. These metals get accumulated in plants, which makes it unsafe for consumptions by human and animal. Another major pollutant is garbage. In urban areas most of the pollution is caused by human sewage and household garbage.

Activity 2.8. Identifying sources of pollution

Work in groups

Pollution is a pressing issue nowadays. It is important to examine the different sources that can pollute our environment.

i. Identify the potential sources of land, water, and air pollution in your locality.

ii. As a responsible citizen, frame a policy to reduce pollution.

b. Life styles and health

Your lifestyle plays an important role in your health. Lifestyle includes the behaviour and activities that make up your daily life. This includes the work you do, your leisure activities, the food you eat, your interaction with family, friends, and others.

Reprint 2024

People develop different lifestyles according to their beliefs, attitudes, and values. Our life experiences and interactions with others also shape our thoughts and actions. Personal behaviour is affected by the information you learn at home and school, and from the internet, mobile, radio, newspapers, television, etc..

Activity 2.9. Know your lifestyle

Copy and complete Table 2.7 and answer the questions that follows.

Table 2.7. Knowing Your Lifestyle

Lifestyle	Activity
How do you spend your leisure time?	1…………………………………… 2…………………………………… 3……………………………………..
What are your favourite dishes?	1…………………………………… 2…………………………………… 3……………………………………..

i. How would you describe your lifestyle?

ii. Compare your lifestyle with lifestyle of your friend.

i. Work and leisure activities

The kind of work that we do affects our health. Some work requires prolonged exposure to dust, sound, heat, radiations, and toxic chemicals, and continuous use of computer. These may lead to cancer, respiratory problems, deafness, blindness, and other health issues. Leisure activities such as watching television, playing video games and mobiles for extended period of time may lead to obesity, muscular or skeletal problems, strained vision, and other health problems.

ii. Unhealthy habits

Certain unhealthy habits can lead to poor health. Habits like drinking alcohol, smoking, chewing tobacco and abusing drugs are harmful to health. All these substances lead to addiction, which means it becomes very difficult to stop as the body becomes dependent on them. Some common substances and their health effects are given below.

Tobacco contains an addictive chemical substance called nicotine. Smoking cigarettes and chewing tobacco can cause heart attack, chronic lung diseases

Reprint 2024

and cancers of mouth, throat, lungs and oesophagus. It can harm the development of foetus in a pregnant woman.

'Doma' chewing is a common habit among the Bhutanese. '**Doma**' is a combination of betel nut (Areca nut), betel pepper ('**pani**') and lime. The raw betel nut contains arecholic acid, which is an irritant. It acts on the nervous system causing stimulation of the body and dilation of blood vessels, that is why, when people eat '**doma**' they feel warm. Continuous chewing and swallowing of '**doma**' increases the risk of mouth, throat and stomach ulcer. It also damages the enamel of the teeth due to rubbing and grinding.

Alcoholism refers to uncontrolled consumption of alcoholic beverages like beer, locally brewed alcohol, whisky, etc. Alcohol can damage liver, heart, brain, and also greatly increases the risk of other diseases. Excessive drinking of alcohol over an extended time can cause liver **cirrhosis**. Cirrhosis is the scaring of the liver tissue that changes the structure of the liver and blocks blood flow, affecting normal liver functions. This may gradually lead to liver cancer.

Large amounts of alcohol in the body can turn to fat, causing weight gain and clogged arteries. Therefore, alcoholics are at high risk of stroke, or developing congestive heart failure. Alcohol can cause brain damage, and affect memory, speech, body balance and other brain functions. For women who are pregnant, their baby may develop mental and physical defects.

A **drug** is a substance, which alters the functioning of mind and body of a person. Drugs can cure diseases when taken in right quantities under the supervision of a physician. However, some drugs are consumed by people for pleasure. Such use of drug is called **drug abuse**. Drug abuse can cause serious damage to the nervous system. Once a person becomes addicted to drugs, it becomes very difficult to stop.

Activity 2.10. Carry out research in your community

Work in groups

Carry out the research using the steps featured below.. Seek help from your teacher and work in collaboration with your friends.

Step 1. **Identification of problem**: Identify the types of substances abused in your community (like unhealthy substances- '**doma**', alcohol, tobacco, etc.).

Reprint 2024

Step 2. Framing research question: "What unhealthy substances ('**doma**', alcohol and tobacco) are consumed the most in my community?"

Step 3. Making a hypothesis: Guess the answer for your research question.

Step 4. Data collection: You can collect data by randomly interviewing minimum of 15 people using the survey questionnaire provided. Be polite while interviewing people.

Step 5. Data analysis: Record your data using Table 2.8. Plot a suitable bar graph(s) to represent the number of people consuming different unhealthy substances. Look for patterns and relationships. Write your findings.

Step 6. Drawing conclusion: Compare your findings with your hypothesis. What is your conclusion?

Step 7. Report writing : Share your research works in the class, or during parent teacher meeting.

Survey Questionnaire

Gender: Male ☐ **Female** ☐

Put tick, if 'Yes' and cross if " No'

1. Do you eat *Doma*? ☐
   If yes, why do you take?
   a) Peer pressure ☐
   b) Culture and tradition ☐
   c) Availability ☐
   d) Others ☐
2. Do you drink alcohol? ☐
   If yes, why do you take?
   a) Peer pressure ☐
   b) Culture and tradition ☐
   c) Availability ☐
   d) Others ☐
3. Do you chew tobacco? ☐
   If yes, why do you take?
   a) Peer pressure ☐
   b) Culture and tradition ☐
   c) Availability ☐
   d) Others ☐
4. Do you smoke? ☐
   If yes, why do you take?
   a) Peer pressure ☐
   b) Culture and tradition ☐
   c) Availability ☐
   d) Others ☐

Thank You.

Reprint 2024

Table 2.8 *Data Tabulation*

Item	Doma		Reason	Alcohol		Reason	Tobacco		Reason	Smoke		Reason
	Yes	No		Yes	No		Yes	No		Yes	No	
			a. b. c. d.			a. b. c. d.			a. b. c. d.			a. b. c. d.
Total												

iii. Food habits

The foods that we eat also affect our health. Many studies show that poor nutrition increases the risk of many diseases. Addiction to fast foods such as pizza, burgers, potato chips, and noodles can lead to digestive problems, obesity and malnutrition.

iv. Personal habits

Good personal habits such as bathing, brushing teeth, washing hands before and after meals, wearing clean clothes, doing regular physical exercise, meditating, etc. are important for healthy living.

Activity 2.11. Understanding about food (Go-Slow-Whoa).

Materials required:

- Food cards
- Go-Slow-Whoa chart

Use the food cards provided by your teacher (a card with the names of food) in group.

Your teacher will paste the Go-Slow-Whoa chart on the board/ wall.

Discuss about the food cards in your group.

Take turns to place the food cards on the Go-Slow-Whoa chart and justify the reason for their choice.

Reprint 2024

What are the good eating habits?

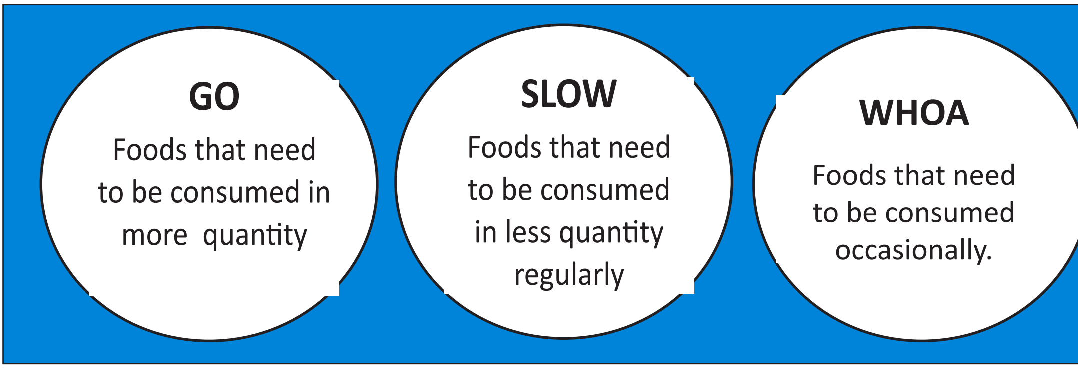


Figure 2.19. Quantity of food consumed.

Questions

1. Identify the environmental factor in Figure 2.19, and explain its health effects.

Figure 2.20.

2. Geyphel likes to eat biscuits for his breakfast, noodles for his lunch, and cakes for his dinner. Most of the time he plays games on his computer or his mobile phone. He hardly goes for outdoor activities. What are the diseases that you foresee in his life?
3. List some of the unhealthy habits that you see in your community.

Reprint 2024

Exercise

Multiple Choice Questions

1. Which of the following organ is involved in the absorption of digested food ?
   A. Mouth.
   B. Stomach.
   C. Small intestine.
   D. Large intestine.

2. Food in the alimentary canal travels through
   A. mouth- oesophagus-stomach-large intestine-small intestine-rectum.
   B. mouth- oesophagus-stomach-small intestine-large intestine-rectum.
   C. mouth- stomach -oesophagus- large intestine-small intestine-rectum.
   D. rectum-large intestine-small intestine-stomach-oesophagus-mouth.

3. Which is NOT true about smoking?
   A. It affects most of the organs of our body.
   B. It is a leading cause of cancer.
   C. It affects only the smoker.
   D. It affects the growing foetus in the pregnant mother.

4. Which of the following tissue connects muscle to bone?
   A. Tendon.
   B. Ligament.
   C. Cartilage.
   D. Nerve.

Reprint 2024

5. When do organs and organ systems begin to develop in humans?
   A. In the sperm cell before fertilisation.
   B. Before fertilisation and after birth.
   C. In the egg cell after fertilisation.
   D. After fertilisation and before birth.
6. All are the effects of alcohol EXCEPT
   A. bleeding gums.
   B. brain and liver damage.
   C. loss of speech and memory.
   D. obesity.
7. Use of vehicles, rise in industries, and burning fossil fuel contribute to
   A. soil pollution.
   B. noise pollution.
   C. water pollution.
   D. air pollution.
8. While drinking tea, the least likely sense organ used is
   A. eye.
   B. nose.
   C. tongue.
   D. ear.
9. The knee and elbow are examples of
   A. pivot joint.
   B. ball and socket joint.
   C. gliding joint.
   D. hinge joint.
10. Which of the following processes happen in the female reproductive system?
    A. Fertilisation and reproduction .

B. Fertilisation and implantation.
C. Digestion and gestation.
D. Reproduction and digestion.

Fill in the blanks.

1. Rods and cones are found in the .... of the eye.
2. The posterior part of the tongue is receptive to .... taste.
3. The muscle that pumps blood throughout the life is .... muscle.
4. Digested food is absorbed by .... of the small intestine.
5. One of the end products of anaerobic respiration in animal is .... acid.
6. The foetus and mother's womb are connected by ....
7. Gaseous exchange takes place in alveoli by the process of ....
8. .... is the part of female reproductive system where implantation of the embryo takes place.
9. The addictive substance present in the tobacco is ....
10. Substances which are harmful to our environment are called ....

Check whether the following statements are True or False. Correct the false statement.

1. Digested food is ultimately used by the cells.
2. The liver secretes gastric juice.
3. The skull has no joint.
4. The space between two bones at a joint is called synovial cavity.
5. The semicircular canal is responsible for hearing.
6. Fertilisation in human occurs in the uterus.
7. There are a few alveoli in our lungs.
8. Pivot joint is present in our neck.
9. Energy released by aerobic and anaerobic respiration in animal is same.
10. Main cause of pollution is due to human activities.

Match the following

Column A	Column B
1. Cones	a. Peristalsis
2. Placenta	b. Smell
3. Oesophagus	c. Heart disease
4. Obesity	d. Colour
5. Olfactory cells	e. Nutrition
	f. Taste

Answer the following questions.

1. Figure 2.20 represents sexual reproduction in humans. Each diagram in the figure is represented by letter A, B, C, and D.

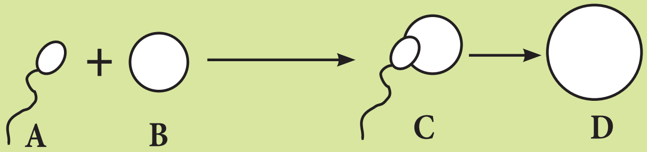


Figure 2.21.

a. Which diagram represents a female sex cell?
b. Name the process occurring at C?
c. Define the structure D.
d. The figure represents the process of sexual reproduction. How?

2. Figure 2.20 is a movable joint. Study the figure carefully and answer the questions that follows..

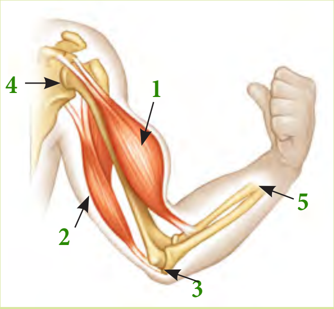


Figure 2.22.

i. Label the parts numbered 1-5.
ii. How is part 1 and 2 related in function?
iii. What kind of movable joint is represented by part 3?
iv. Identify the type of movable joint present in part 4 and 5?

3. Given below is an overall chemical reaction of a certain process.

Glucose ⟶ Lactic acid + 2ATP

a. Name the process.
b. Is this reaction applicable to only animal, only to plant, or both? Why?
c. Name one tissue where such kind of reaction occur in animals.

4. Explain the mechanism of hearing in your own words.

5. Study Figure 2.22 carefully and answer questions that follows.
i. Identify the type of pollution?
ii. List three possible health effects of this type of pollution.
iii. Suggest three ways to control this type of pollution.

Figure 2.23.

6. Study Figure 2.23 and answer question i to iii.
i. Identify the parts A and B.
ii. State the function of part B.
iii. What will happen to the foetus if part A does not function?

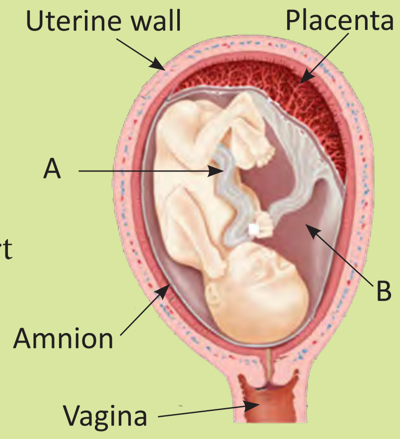


Figure 2.24.

Reprint 2024

4. Define
   i. Digestion
   ii. Blind spot
   iii. Embryo
   iv. Air pollution

8. Study Figure 2.24 and answer the questions that follows.

Figure 2.25.

   i. List down four sources of noise pollution.
   ii. Identify three harmful effects of noise pollution.
   iii. Write two ways to mitigate noise pollution.

9. The Figure 2.25 shows the digestive system of an earthworm.

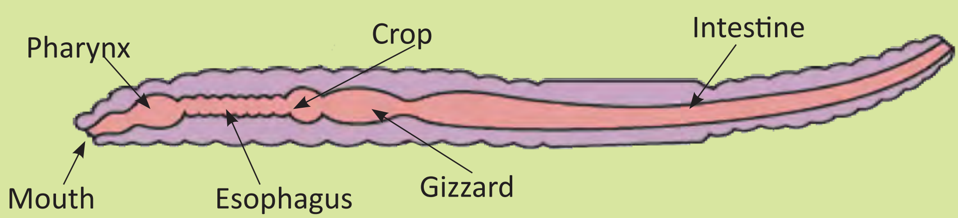


Figure 2.26.

i. Identify three digestive organs of the earthworm found in the human digestive system.

ii. Describe the function of each organ you identified in question i.

10. The Figure 2.26 show smooth muscle cell and a skeletal muscle cell.

Figure 2.27.

i. Identify one location where smooth muscle is found in the human body.

ii. Identify one location where striated muscle is found in the human body.

iii. How is cardiac muscle similar to striated muscle? Explain.

Reprint 2024

Chapter 3
Green Plant

Plants need different types of nutrients for their normal growth and reproduction. The roots absorb dissolved nutrients from the soil, which are transported to different parts of the plants through xylem. These nutrients in the soil are replenished naturally, or by adding manure, or chemical fertilisers.

Plants reproduce both sexually and asexually. Sexual reproduction in plants take place by the fusion of gametes in the flowers. Whereas, in asexual method, plants reproduce without the fusion of gametes.

Asexual reproduction in plantmay also occur through vegetative parts such as stems, roots ,and leaves which develop into new plants.

1. Absorption by Roots

Learning Objectives

On completion of this topic, you should be able to:

- identify different parts of a root.
- explain the absorption of water and minerals by root hairs.
- carry out an experiment to demonstrate osmosis.

A plant consists of a shoot system and a root system. In general, the parts of plants that remain under the ground form the root system, and the parts above the ground form the shoot system. However, in some plants, roots are exposed in the air, while in others, a part of the shoot remains buried in the soil.

Root System

Root is typically the non-green underground part of the plant. It does not possess nodes, leaves and buds, but is highly branched. There are two main types of root

Reprint 2024

systems: tap root system and fibrous root system.

The tap root system has only one main long root leading to the stem.The smaller roots that grow from the main root are called lateral roots.The lateral roots branch out to form the tertiary roots, which bear a number of fine out growths called root hairs.Tap root grows vertically deep into the soil.A single plant has only one tap root. This type of root system is found in apple tree, chilli plant, rose plant, etc.

Fibrous roots does not have a main root. They are short and most of them grow horizontally in the soil. A single plant can have hundreds of fibrous roots.This type of root system is found in grass, maize plant, banana tree,etc.

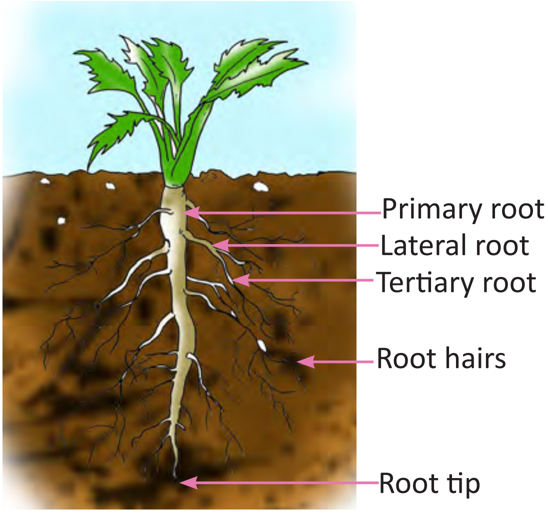


Figure 3.1. Tap root.

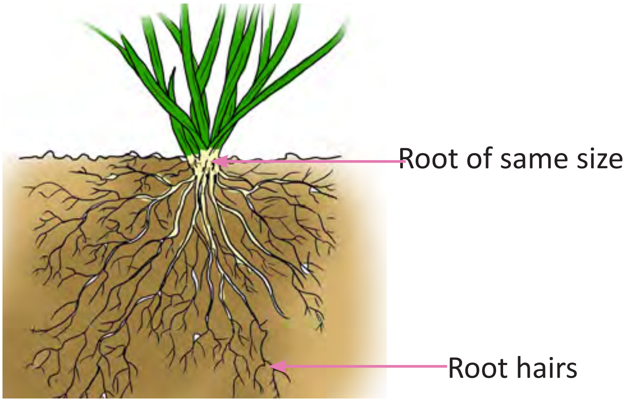


Figure 3.2. Fibrous root.

Reprint 2024

Absorption of Water by Roots

Root absorbs water from the soil through root hairs. Root hair is single celled structure. The root hairs have large vacuoles containing cell sap, which is an aqueous solution of mineral salts and sugar. The solutions of cell sap and the surrounding soil are separated by a semi-permeable membrane. The concentration of solution in the root hair is higher than in the soil. Therefore, water passes from the soil into the cell sap through cell membranes. The movement of water molecules from the region of its higher concentration to the region of its lower concentration through semi-permeable membrane is called **osmosis.** Through osmosis, water passes to the xylem in the root, which then carries it to all parts of the plant.

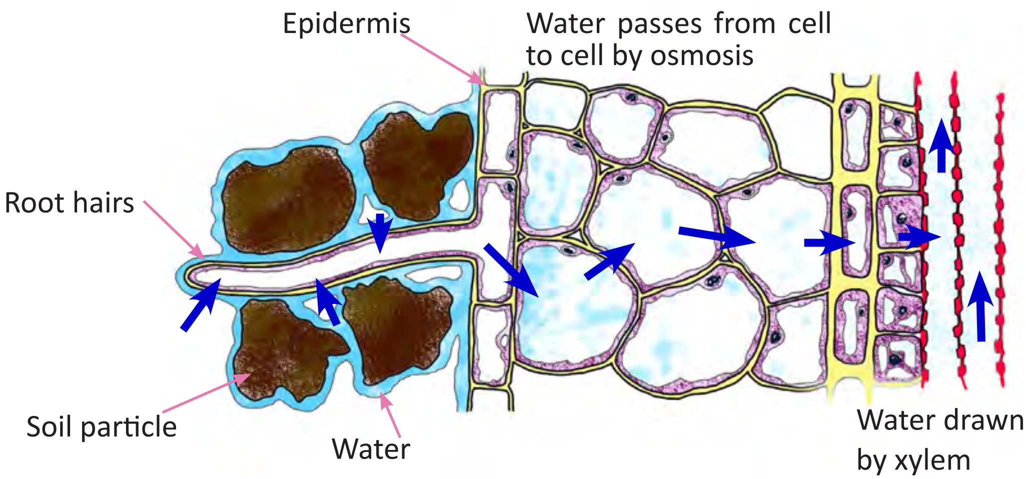


Figure 3.3. Absorption of water by root hair.

Activity 3.1. How do roots absorb water ?

Materials required

Potato, knife, water, pins, beaker, sugar solution and marker pen.

Carry out the following activity and answer the following questions.

Procedure

Step 1. Peel the potato with the help of the knife.

Step 2. Cut the potato into a square block as shown in the Figure 3.4.

Step 3. Scoop out the central portion to form a cup.

Step 4. Half fill the potato cup with the concentrated sugar solution, and mark the level of the solution by inserting a pin.

Step 5. Place the potato cup in the beaker. Now, pour water carefully from the side of the beaker in such a way that the water level is just below the mouth of the potato cup.

Step 6. Mark the level of the water in the beaker using the marker pen. Leave the set-up undisturbed for an hour.

Step 7. Observe the set-up carefully.

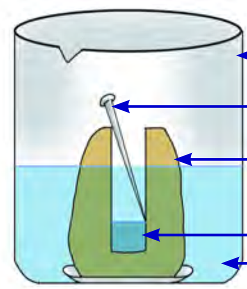


Figure 3.4. The experimental set up for osmosis.

i. What happens to the level of water in the beaker?

ii. What happens to the level of solution in the potato cup?

iii. Copy the Table 3.1 and relate the parts of the experiment with absorption of water by roots.

Table 3.1 *Observing Osmosis*

Experiment	Absorption of Water by Root
Water in beaker	
Potato cup	
Sugar solution	

iv. Explain the process observed in the experiment.

Absorption of Minerals by Roots

Root hairs not only absorb water from the soil, they also absorb mineral nutrients such as nitrogen, phosphorus, potassium, etc. which are dissolved in the soil water. The roots absorb minerals from the soil either through diffusion or active transport, depending on the concentration of minerals in the soil.

When the concentration of mineral ions in the soil is higher than in the root hair, the mineral ions will move from their region of higher concentration (soil) to their region of lower concentration (root hair cell). This movement of mineral ions from the region of higher concentration to the region of lower concentration is called **diffusion**. It is a passive process in which energy is not used by the root hair cells.

The other process of absorption of minerals by roots is **active transport**. It is the process in which the mineral ions move from a region of lower concentration

Reprint 2024

(soil) to a region of higher concentration (root hair cell) through cell membrane by using energy from the cell.

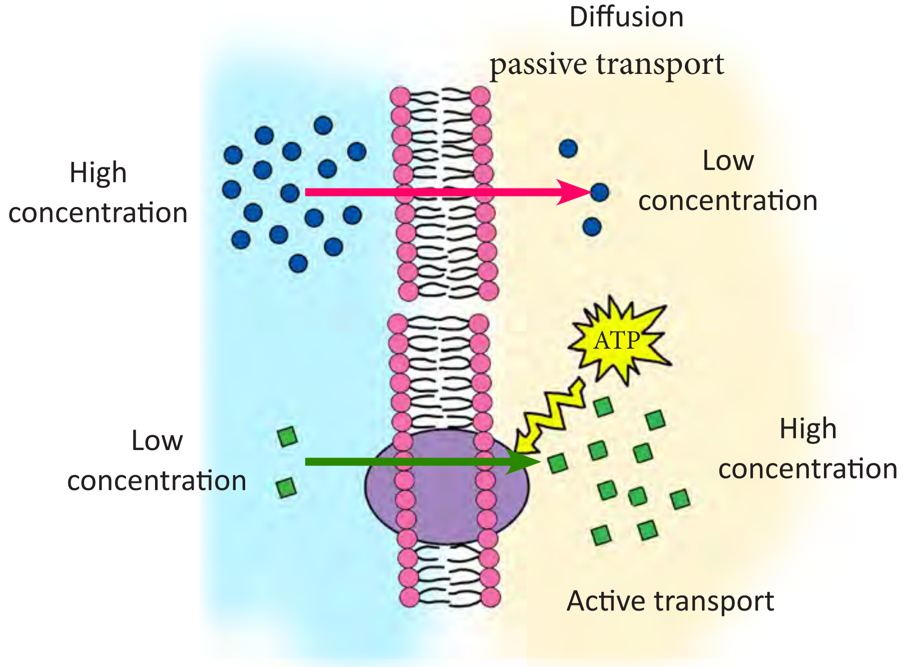


Figure 3.5. Passive and Active transport.

Activity 3.2. Understanding Osmosis and Diffusion

Use PhET simulation with the link below to understand the concept of osmosis and process of absorption of water and minerals.

https://phet.colorado.edu/en/simulation/legacy/membrane-channels

Questions

1. Write the differences between diffusion and osmosis.
2. Why do plants have numerous root hairs?
3. Define active transport.

WEBLINK

http://www2.estrellamountain.edu/faculty/farabee/biobk/biobooktransp.html
http://www.diffen.com/difference/Active_Transport_vs_Passive_Transport

2. Organic and Inorganic farming

Learning Objectives

On completion of this topic, you should be able to:

- differentiate between organic and inorganic farming.
- explain different methods of organic farming.
- name some of the common chemical fertilisers.

The nutrients in the soil are gradually used up by plants. Therefore, the nutrients in the soil need to be replenished by applying organic or chemical fertilisers. The use of organic matter improves the quality of soil and crops, which are free of harmful chemicals. Therefore, organic fertilisers are preferred to chemical fertilisers.

There are two types of farming: organic farming and inorganic farming.

a. Organic Farming

Organic farming is a way of growing crops that relies on several methods such as mulching, biological pest control methods, crop rotation, mixed cropping, etc. to maintain soil fertility and crop productivity. In this method, organic fertilisers like manure, compost, and crop residues are used; and, the use of chemical fertilisers and pesticides are avoided.

(i) **Mulching**

Mulch is a layer of decaying organic matter on the ground. It occurs naturally in all forests in the form of decaying forest leaves, twigs, and branches. It can also be made from hay, grasses, and compost mixtures. The process of covering the soil surface around the plants with mulch to maintain moisture and improve soil condition is called **mulching**. It also helps to control weeds. Mulching can be done using different types of mulch as shown in Figure 3.8.

Figure 3.6. Mulching.

Reprint 2024

(ii) Biological Pest Control

The ladybird feeds on the harmful pests called aphids (green flies). Ground beetle feeds on caterpillars of pest called gypsy moth. These are living organisms that control pest. These friendly organisms can be reared and released into the field as and when necessary. Some crops like onion, garlic, coriander, etc. produce odours that repel pests of other crops. When such crops are inter-cropped with other crops, they help to suppress insect attacks. This method of control of pest by living animals and plants is called **biological pest control**.

(a) Ground beetle feeds on moth caterpillar

(b) Ladybird feeds on aphids

Figure 3.7. Beetles feeding on pests.

Activity 3.3. Explaining Crop rotation and Mixed cropping

Work in groups and use presentation software to explain crop rotation and mixed cropping. Present it to the class.

Advantages of organic farming

- Organic farming improves the soil fertility as it replaces the nutrients through crop rotation, mixed cropping, and use of manure and compost.
- Organic farming enables farmers to control weeds without the use of chemicals.
- Organic farming helps to maintain pH of the soil for the proper growth of crops.
- Products of organic farming are eco-friendly and good for health.

Reprint 2024

b. Inorganic Farming

Inorganic farming is a type of farming in which crops are grown using chemical fertilisers. Chemical fertilisers are compounds manufactured in factories, which add specific nutrients to make the soil fertile. Some of the commonly used chemical fertilisers are urea, suphala, muriate of potash, superphosphate, calcium ammonium nitrate and limestone.

In inorganic farming, chemicals are used to control pests like fungi, bacteria, viruses, insects, animals and weeds, which harm the crops. These chemicals are called **pesticides**. Some of the commonly used pesticides are fungicides, insecticides and weedicides. Fungicides, like Bordeaux mixture, are sprayed on crop plants to prevent fungal diseases. Insecticides, like malathion, are used to kill insects that cause damage to crops. Weedicide, like atrazine, destroys weeds but does not harm the crops.

Disadvantages of inorganic farming

- Inorganic fertilisers are washed away easily from the topsoil when watering or irrigating the fields.
- Extensive use of inorganic fertilisers affects the soil texture, pH of the soil, aeration and water holding capacity of the soil.
- Chemical fertilisers and pesticides also kill helpful insects, worms and microorganisms.
- Chemical fertilisers get into rivers causing **eutrophication**. Severe eutrophication kills fish and other aquatic animals.
- Chemical fertilisers and pesticides get into drinking water, which can cause health problems.
- Manufacturing fertilisers and pesticides pollute environment.

Activity 3.2. Visiting agriculture garden

Instruction:

Visit an agriculture garden in your school or locality.

Make a list of the crops grown.

Reprint 2024

Find out the information to answer the following questions.

i. What type of farming is practiced?
ii. Identify the type of fertilisers used.
iii. Is there any sign of pest control being used? If yes, what method is used?
iv. If you are a school agriculture focal person, what type of farming would you suggest to the school? Give reasons.

Questions

1. What is organic farming?
2. What are some of the disadvantages of organic farming?
3. What are some of the advantages of inorganic farming?
4. How do organic farmers manage soil fertility?
5. Ap Rinzin has been practicing inorganic farming. He gets good crop yield and makes good profit every year. You as a concerned citizen, what environmental problems do you foresee in his farming practice?
6. A farmer plants chillies in the first year. He then plants beans in the same field next year.
   i. What is the term used for this kind of practice?
   ii. Why does he do so?

WEBLINK
http://www.oisat.org/control_methods/cultural__practices/crop_rotation.html

Reprint 2024

3. Reproduction in Plants

Learning Objectives

On completion of this topic, you should be able to:

- explain reproduction in plants: sexual and asexual reproduction.
- describe methods of natural and artificial vegetative propagation.
- mention advantages and disadvantages of vegetative propagation.

You have already studied reproduction in animals. In this topic, you will study the two types of reproduction in plants namely, sexual and asexual reproduction.

Sexual reproduction is a kind of reproduction in which sex cells or gametes are involved. In flowering plants, gametes are produced in the reproductive parts of the flowers. The female and male gametes fuse to form a zygote. The zygote undergoes several divisions to form an embryo, which later develops into a mature plant.

Asexual reproduction is a kind of reproduction in which no gametes are involved. In asexual reproduction, plants multiply through vegetative parts such as roots, stems, leaves and buds. This type of asexual reproduction in plants is called **vegetative reproduction** or **vegetative propagation**.

Vegetative propagation is categorised into natural and artificial based on the methods of propagation.

a. Natural Vegetative Propagation

In natural methods of vegetative propagation, a vegetative part such as stem, leaf, or root, develops into a new independent plant under suitable environmental conditions.

i. Vegetative Propagation by stems

The underground stems that are modified for storage of food have buds. New plants develop from these buds. For example, stems like tuber, bulb, rhizomes, and corn help the plant to multiply.

Reprint 2024

Potato tuber Onion bulb Rhizome of ginger Rhizome of turmeric

Figure 3.8. Underground stem.

ii. Vegetative propagation by roots

In this method, the roots of some plants help in vegetative propagation. For example, the root of Sweet potato and Dahlia give rise to new plants from their fleshy roots, when conditions are favorable.

Figure 3.9. Sweet potato.

iii. Vegetative propagation by leaves

In Plants like Bryophyllum and Begonia buds are produced on leaf margins,these buds after falling on the ground grows into new plants.

Figure 3.10. Leaves of Bryophyllum.

Reprint 2024

b. Artificial Vegetative Propagation

In artificial vegetative propagation, plant parts like stem and buds are used to develop new plants by horticulturists and gardeners. Some of the methods include cutting, layering, budding and grafting.

i. Stem cutting

Figure 3.11. Stem cutting.

In this method, a stem or a branch of a plant is cut and planted in moist soil. This planted stem gives rise to roots and buds, and grows into a new plant. For stem cutting, the stem cut should have one or more nodes. Cut stems need right humidity, air, soil, sunlight and temperatures to enable nodes to grow into leaves and branches. This method can be practised in the propagation of sugar cane, grapes, rose, china rose, *Bougainvillea*, etc.

ii. Layering

Figure 3.12. Mound layering in plant.

Layering is one of the methods used for propagating plants. There are two types of layering: mound layering and aerial layering.

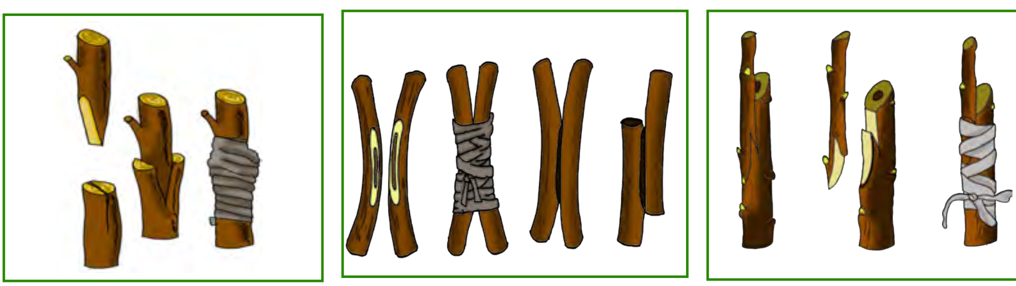
a) **Mound layering**: In this method, the lower branch of the plant is bent close to the ground and covered with moist soil in such a way that it's growing tip remains above the soil surface. This bent branch is called a layer. Once the layer produces roots, it is cut from the parent plant and grown separately. This method is used with plants like lemon, rose, jasmine, etc.

Figure 3.13. Aerial layering.

b) **Aerial layering**: This method is practised in those plants, where the branches are not near the soil. A ring of bark is removed from the base of the aerial branch. It is covered with moist clay and wrapped in polythene sheet to prevent evaporation. After a few weeks, the covered part of the branch develops roots. The branch along with roots is cut off from the parent plant and planted into the soil. This method is practised in mango, litchi, lemon, orange, guava, apple, etc.

iii. Grafting

In this method, a small shoot or bud of selected variety of plant is carefully fixed on the stem of another plant of the same species or allied species (orange and lemon). The plant receiving the bud or the shoot is called **stock**. While the bud or the shoot fixed on the stock is called **scion**. The grafted point is bound together with tape and covered with wax to keep it moist and prevent infection. In course of time, new cells develop from the stock and scion forming a close union. The scion grows into new plant on the stock. There are different ways of grafting.



(a) Cleft grafting (b) Approach grafting (c) Whip or tongue grafting

Figure 3.14. Different ways of grafting.

Advantages of Vegetative Propagation

- It is quicker and more certain.
- Plants which do not produce seeds, or whose seeds fail to germinate can be reproduced by vegetative propagation.
- It produces new plants having the same qualities as the parent.

Disadvantages of vegetative propagation

- It does not produce new varieties.
- It leads to over crowding around the parent plant.

WEBLINK

http://www.biology-resources.com/plants-vegetative-reproduction.html
http://education-portal.com/academy/lesson/asexual-plant-reproduction-vegetative-propagation-and-bulbs.html#lesson

Reprint 2024

Activity 3.3. Try vegetative propagation in school

Try the different methods of artificial vegetative propagation with suitable plants. Get help from nearest Agriculture Extension Centre.

Materials required

Stem of any kind of plant, depending on the type of vegetative propagation that you select, knife, cutters, plastic sheet, wax, string, fertile soil and water .

Procedure

Divide the class into four groups. Each group select a type of vegetative propagation. Follow the steps for the type of propagation selected by your group as described in figures 3.11 to 3.14.

Table 3.2 *Methods of Vegetative Propagation*

Method	Name of the Plant
1. Stem cutting	
2. Mound layering	
3. Aerial layering	
4. Budding	

Questions

1. State two differences between sexual reproduction and vegetative reproduction in plants.
2. What is essential for an organism to reproduce by sexual method?
3. Why is reproduction essential for living organisms?
4. Identify the part of the following plants which can be used for vegetative propagation.

   [potato, ginger, dahlia, sugarcane, sweet potato]

Reprint 2024

Exercise

Multiple choice questions

1. Materials of biological origin which is commonly used to maintain soil fertility is
   A. bordeaux mixture.
   B. suphala.
   C. compost.
   D. urea.
2. Which of the following is a suitable outcome of mulching?
   A. Destroys harmful pest.
   B. Maintains moisture and improve soil condition.
   C. Increases the life span of the crop.
   D. Decreases crop yield.
3. The process by which water enters the root hairs from the soil is
   A. diffusion.
   B. active transport.
   C. osmosis.
   D. root pressure.
4. People prefer organic products because
   A. they are rich in minerals.
   B. they do not contain harmful chemicals.
   C. they are fresh and juicy.
   D. they are expensive.
5. The grafted plants bear the flowers and fruits which has the characteristics of
   A. scion.
   B. stock.
   C. new species.
   D. a mixture of scion and stock.
6. Sugarcane is usually cultivated through
   A. cutting.
   B. grafting.
   C. layering.
   D. seeds.

Reprint 2024

7. A small piece of cactus breaks off the plant, falls on the ground, and begins to grow.

   The above statement describes

   A. natural propagation.
   B. artificial propagation.
   C. both natural and artificial propagation.
   D. sexual reproduction.

8. Pesticides are generally

   A. toxic and remain in the soil for a long time.
   B. nontoxic and remain in the soil for a long time.
   C. toxic and break down soon in the environment.
   D. toxic to insects but safe for humans.

9. Which is NOT the method used to improve the fertility of top soil?

   A. Crop rotation.
   B. Planting same crops all the times.
   C. Addition of fertilisers.
   D. Mixed cropping.

Fill in the blank

1. In grafting, a stock is joined with a _____________.
2. Unwanted plants in the field are removed by using _____________.
3. Preying mantis feeding on aphids is an example of _____________pest control.
4. Generally, _____________ are sprayed on crops to prevent fungal diseases.
5. Root hairs absorb water and _____________ from the soil.

Match column A with column B.

Method	Name of the Plant
1. Affect aquatic life	a. Crop residue
2. Gametes	b. Eutrophication
3. Organic farming	c. Beans
4. Vegetative propagation	d. Sexual reproduction
5. Root nodules	e. Budding

Reprint 2024

Check whether the following statements are True or False. Correct the false statements.

1. Organic farming is environment friendly.
2. Minerals are absorbed by plants through diffusion.
3. Ginger is a root.
4. Arial layering of stem is a method of natural vegetative propagation.
5. Growing different crops at the same season in the same field decreases soil fertility.

Answer the following questions

1. Use Figure 3.15 to answer the questions i to iv.

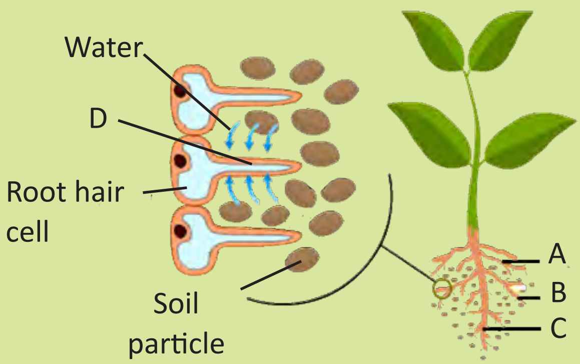


Figure 3.15.

i. Label the parts A, B, C and D.
ii. Name the ions present in the soil.
iii. Identify the processes that take place for ions to move into the root hair.
iv. Plants absorb water through root hairs. How do you think this water is used by the plants?

2. What would happen if living cells of a plant were placed first in a strong sugar solution, and then in water?
3. Why are weeds considered harmful for crops?
4. Inorganic farming affects soil health. Justify the statement.
5. Differentiate between weedicide and fungicide.

6. What are the benefits of organic farming?
7. Mention three advantages of vegetative propagation.
8. Observe the Figure 3.16 and answer the question i to iii.

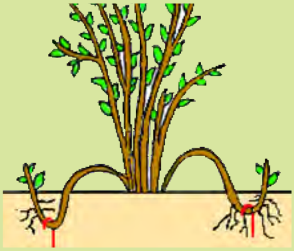


Figure 3.16.

   i. Identify the type of propagation.
   ii. Name two plants in which such method can be practised.
   iii. Why is such method not practised in mango and banana?

Reprint 2024

Chapter 4
Living Things and their Environment

Our environment is home to thousands of species of plants and animals. Every organism is, in one way or the other, dependent on the other for its survival and the continuation of life. Organisms have adapted to live in various habitats of the Earth, from the cold polar regions to the extremely hot deserts. Organisms acquire adaptive characters through the process of evolution.

The variety of life forms on the Earth is called biodiversity. Biodiversity provides various benefits to the humans. However, increasing population and human activities remain one of the major threats to our environment. As a result, habitats are being lost constantly and plant and animal species are becoming extinct.

Bhutan has rich biodiversity of flora and fauna. Majority of the people in Bhutan depend on forest products and agriculture. Improved varieties of crops and animals are being raised to increase the income of our people.

In this chapter, you will learn more about adaptation of plants and animals, biodiversity and improved varieties of plants and animals.

1. Adaptation and Survival

Learning Objectives

On completion of this topic, you should be able to:

- explain how plants and animals adapt to their habitats.
- illustrate the role of predation in determining the size of population.
- differentiate between intra-specific and inter-specific competition.
- explain biomagnification and its effects.

The increasing population and overcrowding of plants and animals in the habitat lead to the competition for food and shelter among organisms. This competition amongst organisms for their survival is called struggle for existence. In the

Reprint 2024

struggle for existence, the individuals with suitable characters to a particular environment, survive. Organisms that survive change over generations and ultimately form newer organisms, which are better adapted to the changing environment. Ability of an organism to change to better suit with their changing environment is called **adaptation**.

a. Adaptation to Habitat

Organisms adapt to their habitat in the following ways:

i. **Changes in body parts:** Many plants and animals develop special body parts that help them to survive in their habitat. Such changes are termed as modifications. For example, long neck in giraffe for feeding, needle shaped leaves in pine to reduce transpiration, limbs of birds have modified into wings, etc.

ii. **Changes in behaviour:** Many organisms show specialised behaviour to survive in their habitat. For example, some animals undergo sleep during winter to overcome the cold (hibernation), and in summer some organisms undergo sleep to overcome the heat (aestivation). Polar bear, snake and ladybird hibernate, while snail, crabs and earthworm aestivate. Frogs and some species of snail and salamander undergo both hibernation and aestivation. Seeds undergo dormancy during unfavourable conditions for germination.

Certain animals like birds and fishes move from one region to another in response to change in temperature, food availability and for breeding. This seasonal movement of animals from one region to another is called **migration**. For example, migration of black necked crane, salmon fish, etc.

WEBLINK
http://www.britannica.com/EBchecked/topic/5263/adaptation

Reprint 2024

Activity 4.1. Solving the mystery

Study the flow chart in Figure 4.1. Copy and complete Table 4.1.

Adaptation

Adaptations in desert

Plants like cactus have adapted to survive in deserts by developing the following modifications:
- Its leaves are modified as thorns to reduce loss of water.
- Its stem is enlarged to store water.

Animal like camel have adapted to live in deserts by developing the following features:
- It has long legs to keep its body away from the hot sand.
- It has a hump to store fat.

Some desert animals and insects underground aestivation during the day to escape from the heat. They usually obtain water from the food they eat.

Adaptations in water

Organisms living in water have to adapt themselves to several factors such as breathing in water, water current, pressure of water and less amount of light.

Aquatic plants show the following adaptations:
- Their stems are long and narrow and flexible to withstand water currents.
- Floating leaves are large and flat.

Some adaptations in aquatic animals are:
- They have streamlined bodies to swim in water.
- They have gills for breathing under water.
- They have fins and tails that help them to swim in water.
- They have air bladder that helps them to float in water.
- Birds like duck have webbed feet for swimming.

Adaptations in snow

Plants have smaller leaves to prevent water loss. Some plants are able to grow under snow.

Animal like polar bear has thick fur and a layer of fat under the skin to protect from cold. It also hibernates during colder months.

Yaks have long and thick coat of hair to protect themselves from cold. They also have strong hooves to break the frozen ice and graze on the grass below.

Figure 4.1. Types of adaptation.

Table 4.1 *Animals and their Adaptive Features*

 Camel	Type of habitat	Name another organism which lives in this type of habitat.
	1	
	adaptive features.	
	2	3 ....
 Duck	Type of habitat	Name another organism which lives in this type of habitat.
	4	
	adaptive features.	
	5	6 ....
 Yak	Type of habitat	Name another organism which lives in this type of habitat.
	7	
	adaptive features.	9 ....
	8	
 Black necked crane	Type of habitat	Name another organism which follows similar adaptive means .
	10	
	It flies from Tibet to Bhutan in winter. adaptive features.	12 ....
	11	
 Rattle snake	Type of habitat	Name another organism which lives in this type of habitat.
	13	
	It sleeps during winter. adaptive features.	15 ....
	14	

b. Natural Selection

Nature plays a very important role in the survival of organisms. The ability of the population of organisms to change overtime is important for survival. The process by which organisms adapt to its environment by means of selectively reproducing changes in its genetic constitution is called **natural selection**.

By a continuous process of variations and natural selection, the unsuitable characteristics of an organism are eliminated while the suitable characteristics are retained. This results in the formation of a new species. This is called **speciation**.

The number of species living in a particular habitat is determined by factors, such as predation and competition for food and shelter.

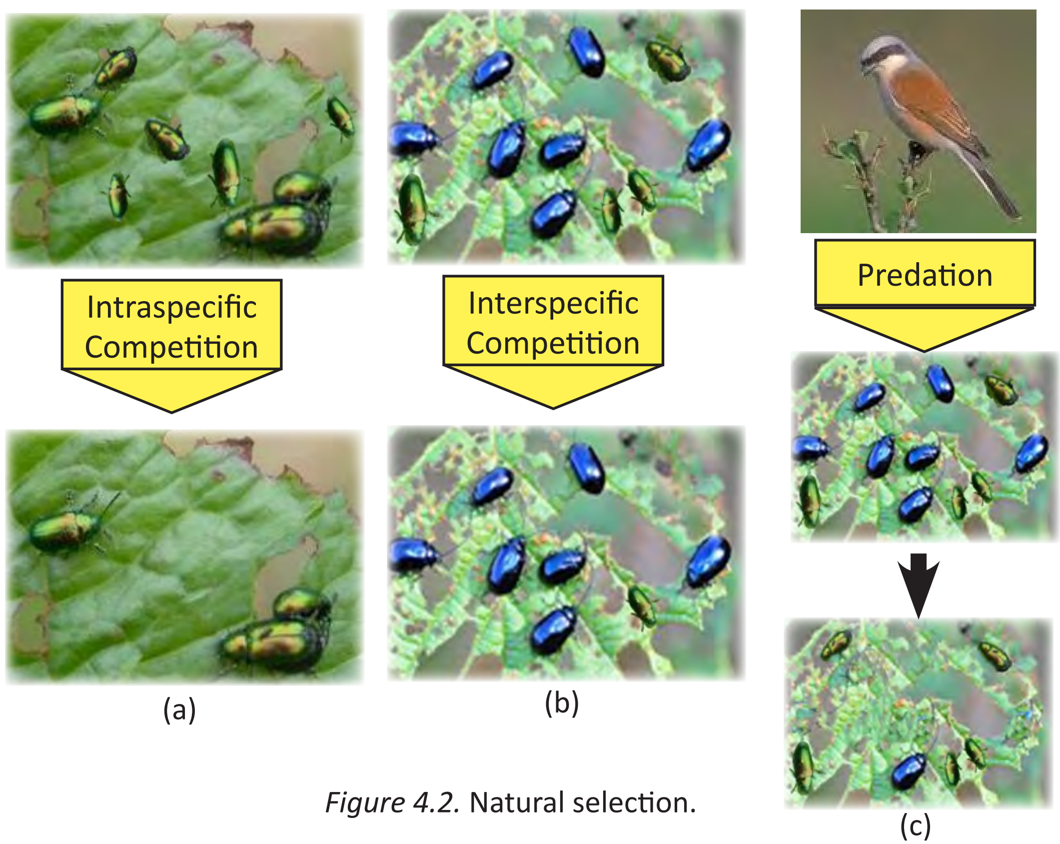


Figure 4.2. Natural selection.

The limited resources in the ecosystem lead to the competition for food and shelter amongst organisms. Competition between individuals of the same species for same resources in an ecosystem is called **intraspecific competition**.

Reprint 2024

For example, in Figure 4.2, the green beetles compete for food and space. The stronger beetles have better chance of survival.

The competition between individuals of two different species for same resources in an ecosystem is called **interspecific competition.** For example, in Figure 4.2, the blue beetles compete with green beetles for food and space. If blue beetles get more food and space than the green beetles, the blue beetles have more chance of survival.

In Figure 4.2, the bird is more likely to feed on blue beetles than green beetles as the green beetles have ability to camouflage among the green leaves. Therefore, green beetles have more chance to survive and reproduce.

Questions

1. How are the following animals adapted for their mode of life?
   a. Chameleon
   b. Orchid
   c. Langur
2. Differentiate between intraspecific competition and interspecific competition with examples.

Reprint 2024

2. Biodiversity

Learning Objectives

On completion of this topic, you should be able to:

- explain biodiversity.
- describe the ways to protect the environment.
- explain sustainable development in relation to conservation of environment.

The environment of an organism is its physical and biological surroundings with which it interacts. Every organism is in one way or the other dependent on each other. Our Earth is home to thousands of varieties of flora and fauna. This vast variety of life on Earth is called **biodiversity**.

Bhutan has a rich biodiversity of flora and fauna due to varied altitude and climatic conditions. The vegetation (flora) changes from tropical broad-leaf in the foothills to alpine shrubs and meadows in the higher altitudes. These forests are home for a large variety of animals (fauna).

It is the policy of our government to preserve the rich biodiversity of our country through sustainable utilisation of resources. The government is trying to ensure that a minimum of 60 percent of country's land area is maintained under forest cover for all time.

Activity 4.2. Biodiversity in my school campus

Materials required

Metre ruler, thermometer, watch and data table sheet.

Procedure

Choose two locations in and around your school campus, grassland habitat and forest habitat.

Case I: Grassland habitat

Step 1. Record location, date, temperature, and time. Record your observation as shown in Table 4.2.

Step 2. Measure two plots of 3 m X 3 m and label them as Plot 1 and Plot 2.

Step 3. Count the number of different plant species in Plot 1 and Plot 2.

Step 4. Calculate and record the average number of different plants for the habitat.

Case II: Forest habitat

Step 1. Repeat Step 1 to 4 for the forest habitat as in Case I.

Table 4.2 *Data Tabulation*

Location: ....Date and Time:.......................Temperature:..................

Habitat	Number of different Plant Species in each plot		Average
	Plot 1	Plot 2	
Grassland			
Forest			

i. Draw a bar graph to represent your data.

ii. Why do you choose two plots in the same habitat for the study?

iii. What can you conclude about plant biodiversity in the two habitats?

a. Importance of Biodiversity

Biodiversity provides the conditions that are essential to sustain life on the Earth. The following are some of the importance of biodiversity in ecosystems.

Reprint 2024

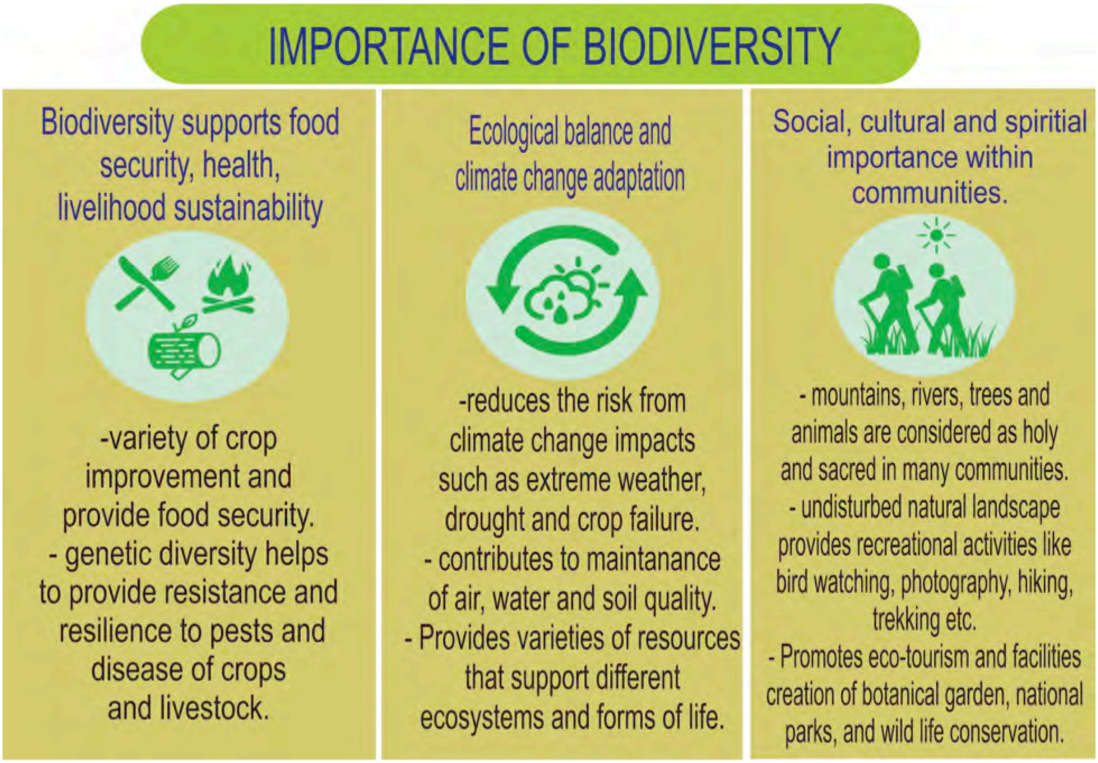


Figure 4.3. Importance of biodiversity.

b. Sustainable Development

The **renewable** and **non-renewable** natural resources are required for socio-economic development. Renewable resources can be replenished while non-renewable resources cannot be replaced. The rising population, industrialisation and urbanisation increase pressure on the natural resources. Further, mismanagement of resources and waste add pressure on the environment. However, responsible consumption and production can contribute to minimizing the resource use and generation of waste. The practice of careful planning and management of natural resources and developmental activities is considered as **sustainable development.**

Sustainable development, as guided by the development philosophy of 'Gross National Happiness', is an important objective for Bhutan. This mandates Bhutan to maintain 60% of the land under forest cover and sustainable uses of natural resources. In order to preserve the country's rich biodiversity we believe that the socio-economic development of the country should not be at the cost of the natural environment.

Reprint 2024

Activity 4.3. Case study on Forest Act

Read the case study and answer the questions i to iii.

Case Study

The Bhutan Forest Act of 1969 declared all unclaimed land to be government forest reserves, and banned felling and burning of trees by shifting cultivators, fishing and hunting. Grazing in critical watershed areas was also restricted as was logging on steep slopes. In 1974, the National Forest Policy declared that all logging was to be done by the Department of Forests in order to control the number of trees felled and prevent environmental damage.

National Environment Commission, 1974

i. How does The Bhutan Forest Act of 1969, affect the lives of shifting cultivators?

ii. In what ways, the Bhutan Forest Act of 1969, help in biodiversity protection?

iii. What would have happened in Bhutan if the National Forest Act and Policy 1969 had not been introduced?

Activity 4.4. Survey on the economic importance of the livestock

Conduct a survey in your community using the questionnaire provided. Answer questions i to v.

i. How many people (sample population) did you survey?

ii. What are the reasons for rearing livestock? Draw a pie chart to represent your data.

iii. How does the rearing of the livestock improve the living standard of the community?

iv. How does livestock in the community affect the environment?

v. How does community minimise the impact of livestock on the environment?

Questionnaire

Name of the farmer:............................Village: ....Dzongkhag...........................

Age:.................Number of family members.................................

Tick more than one, if applicable.

1. What types of animal do you rear?
   a) Cow ☐ b) Yak ☐ c) Pig ☐ d) Horse ☐
   e) Chicken ☐ f) Sheep ☐ g) Goat ☐ h) Other ☐
2. For what reason do you rear animals?
   a) Meat ☐ b) Egg ☐ c) Milk ☐ d) Transportation ☐
   e) Work ☐ f) Wool ☐ g) Skin ☐ h) Other ☐
3. Income statement per month in rearing livestock

Table 1

Name of livestock	**Total expenditure**	**Income**	**Net profit**
Cow/yak			
Chicken			
Horse			
Pig			
Sheep			
Goat			
Other			

4. How do you spend the income generated from the livestock?
   a) Education ☐
   b) Buy food ☐
   c) Buy clothing ☐
   d) Transportation ☐
   e) Improve agriculture yields ☐
   f) Construct house ☐
   g) Clear the debt ☐
   h) Other ☐
5. How do you rear the animals?
   a) Open ☐
   b) Close ☐
   c) Free ☐
   d) Other ☐
6. What are the threats to your livestock?
   ....
7. What do you do to counter the threats to livestock?
   ....

Reprint 2024

Questions

1. Name the following:
   i. The resources which cannot be replaced naturally.
   ii. Establishment of forests in a barren land.
2. Mention any two ways in which water can be conserved.
3. Are human beings responsible for forest fire? Discuss the damages caused by forest fires.
4. It is important to build cities by cutting down all the tress and clearing the forest for the development of country. Do you agree with the statement? Justify your answer.
5. Why is biodiversity important? Support your answer with examples.

Reprint 2024

3. Breeding

Learning Objectives

On completion of this topic, you should be able to:

- explain selective breeding and hybridisation.
- identify examples of some plant and animal hybrids.
- describe the advantages and disadvantages of hybridisation.
- explain the economic importance of livestock and crops.

Agriculture is the main livelihood for majority of the population in our country. Most of the food products like cereals, vegetables, fruits and spices are obtained from plants. Other food products such as milk, eggs and meat are derived from animals. The study and practice of cultivating land for growing crops, and rearing livestock is called **agriculture**. The aim of agriculture is to improve the production of crops and livestock through the practice of different farming methods. Some of them are discussed in this topic.

a. Selective Breeding

Many farmers breed animals and **horticulturists** cultivate crops that have desirable characteristics through the processes of selective breeding. **Selective breeding** is a process of breeding plants and animals for a particular character through hybridisation. Saddle black pig is selectively bred for high yield of meat. **Hybridisation** is a technique of combining two different varieties to produce a new variety. The new variety obtained is called a **hybrid**. It is mainly for better yield or better quality; tolerance to heat, cold or drought, disease, and better taste or high nutritional values superior to their parents. Thus, new varieties or improved varieties of crops and animals are developed by selective breeding.

Example of selective breeding:

Yak X Cow = Yakow or 'Dzo' (are stronger than parents and used as pack animal for transporting heavy goods high up in the mountains)

'Jersey bull' X Cow = Jersey (high yield milk)

Horse X Donkey = Mule (Stronger)

Figure 4.4. Yakow.

i. Crop Improvement

In recent years, the quality and yield of crops have increased due to the use of modern agricultural practices and use of hybrid seeds. Many hybrids of plants are produced artificially, but some hybrids occur naturally. Plant species hybridise more readily than animal species; and the resulting hybrids are more fertile. The increase in the number of plant species is the result of hybridisation. The hybridisation is used to produce improved seeds, fruits or other plant parts, or to make a plant more tolerant to cold, heat or diseases.

Some of the new hybrids produced in Bhutan are: rice variety **(BR 153, BW 293, Yusi Ray Maap 1,** etc.); wheat variety **(Bajoka I)**; and apple (**golden delicious and royal delicious).**

ii. Livestock Improvement

Livestock plays an integral role in the lives of Bhutanese farmers as they provide food, clothing and transportation. Majority of our population, besides cultivating crops, raise domestic animals like cows, pigs, horses, hens, donkeys, etc. Breeding and raising of animals for their products and services is called **domestication**. The domesticated animals which are economically useful are called **livestock**. Livestock can be divided into following categories depending on their uses:

i. **Meat yielding animals:** These include pig, goat, fish, and yak.
ii. **Egg yielding animals:** These include hen, duck, turkey etc.
iii **Milk yielding animals**: These include cow, yak, and goat.
iv. **Drought animals**: These include mule, horse, donkey, bull, and yak. These animals help in transportation and other farm works such as ploughing and threshing.
v. **Wool and hide yielding animals**: These include sheep, cow, goat, and yak.

New varieties of cattle, pigs and poultry are introduced for better yield. Similar to plants, new hybrids are produced by selective breeding in animals. Breeding of cattle can be done in two ways: natural services with bulls, and through artificial insemination. **Artificial insemination** is commonly used for breeding cattle. This technique involves collecting sperm from a male animal and manually depositing them into the reproductive tract of a female. The sperm is collected from the best male to get a desired variety of off springs. Examples of newly introduced animal breeds in Bhutan are shown in Table 4.3.

Reprint 2024

Table 4.3 *Hybrid Livestock*

Cattle	Pig	Hen
• Jersey • Brown Swiss • Holstein Friesian • Australian milking Zebu	• Large black Hampshire • Large white Yorkshire • Saddle black • Duroc	• White leg horn • Rhode Island Red

Hybrid varieties generally have better quality or higher yield; better taste and high nutritional values; tolerance to diseases, cold, heat; and grow faster to maturity. However, hybrid varieties are usually sterile and some species may become extinct.

Questions

1. Define the following terms.
   i. Selective breeding.
   ii. Artificial insemination.
2. A hybrid is produced as a result of breeding a donkey and a horse.
   i. Name the hybrid.
   ii. What will be the characteristics of the hybrid?
3. Why do farmers prefer to rear hybrid pigs to local pigs?

Reprint 2024

Exercise

Multiple Choice Questions.

1. The inter-relationship between different organisms living in a habitat is called
    A. population.
    B. community.
    C. ecosystem.
    D. environment.
2. The disappearance of all the members of a species is called
    A. natural selection.
    B. endangered species.
    C. extinction.
    D. threatened species.
3. The process through which organisms are more adapted to their environment to survive and reproduce more successfully than less adapted organisms is called
    A. evolution.
    B. adaptation.
    C. migration.
    D. natural selection.
4. Organisms struggle for existence as a result of
    A. overpopulation.
    B. variation.
    C. origin of new species .
    D. hybridisation.
5. The selecting agent in natural selection is
    A. environment.
    B. food.
    C. prey.
    D. man.

Reprint 2024

6. Table 4.4 represents the number of animals of different species that were counted in three forest communities. Which of the following statements best interpret these data?

Table 4.4

Species	Community A	Community B	Community C
Deer	20	23	21
Rabbit	2	13	20
Squirrel	1	14	34
Mouse	1	12	23

A. Community A has greater species evenness than Community B and C.
B. Community A has greater species population than Community B.
C. Community B has greater species evenness than Community C.
D. Community C has greater species population than Community B and A.

7. Sustainable development aims at
A. socioeconomic development.
B. accumulation of resources.
C. increased resource consumption.
D. meeting the needs of the present and future.

8. The major reason for decrease in biodiversity is
A. habitat pollution.
B. overexploitation.
C. habitat destruction.
D. introduction of new plants and animals.

9. According to IUCN (The international Union for Conservation of Nature and Natural Resources) Red list, what is the status of Red Panda (*Ailurusfulgens*)?
A. Extinct.
B. Abundant.
C. Vulnerable.
D. Endangered.

Reprint 2024

10. The process of choosing parent organisms for the characteristics that we want in their offspring is
    A. active selection.
    B. reproductive selection.
    C. selective breeding.
    D. breeding selection.

Fill in the blanks.

1. The place where an animal lives and grows is …………………...
2. The evolutionary process by which new biological species arise is ....
3. Competition among animals contributes to …………………... and population control.
4. Taking the sperm from a bull and placing it directly into a cow's uterus is an example of …………………...
5. The resources which are replaced naturally are called …………………...

Match the following

Column A	Column B
Hybrid	Biodiversity
Natural Selection	Water
Non-renewable resource	Adaptation
Renewable resource	Food chain
Pine leaves	Yakow
	Petrol

Reprint 2024

Check whether the following statements are True or False. Correct the false statements.

1. The changes that make an organism better suited to their environments are developed through a process called adaptation.
2. The competition between goat and sheep for food in same pasture is called intraspecific competition.
3. Renewable resources are those that can be replaced or renewed.
4. Biodiversity refers to plant diversity.
5. The method of breeding new plants by choosing the pollen from one variety of plant and placing it onto the stigma of another variety of plant is called natural selection.

Answer the following questions.

1. In a forest ecosystem, intraspecific competition and interspecific competition are common. Which competition will be stronger? Give one reason.
2. A farmer observed about an equal number of brown grasshoppers and green grasshoppers in his maize field. After a few days, he noticed the decrease in the number of brown grasshoppers. Write the possible reasons for his observation.
3. What can you do to help save biodiversity?
4. Explain the following terms.
   i. Sustainable development.
   ii. Reforestation.
   iii. Biodiversity.
5. An ecosystem consists of the following organisms shown in Figure 4.5. Using the key given, answer the following questions.

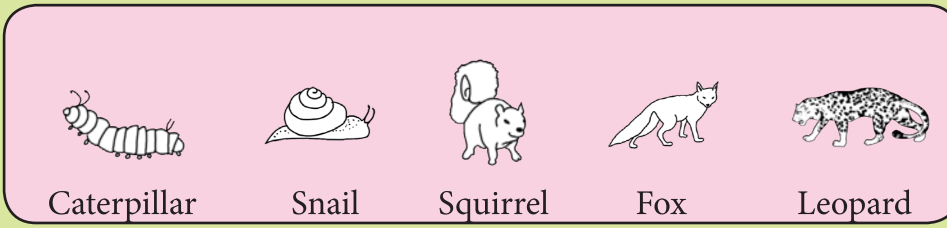
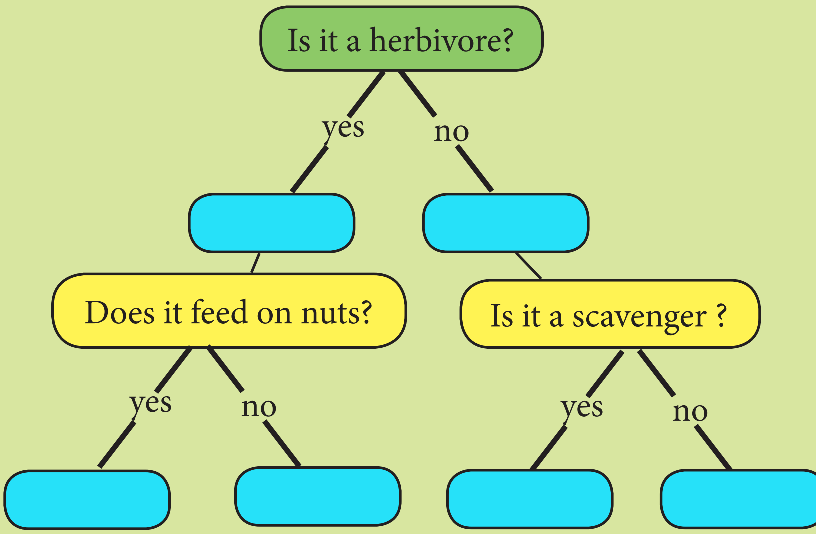


Figure 4.5.



i. Which animals may compete for the same kind of food? What type of competition is it?

ii. What type of competition is evident amongst the squirrels?

iii. Which animal has a better chance of survival, fox or leopard?

iv. What characteristics is used in the key to classify the animals?

6. A tour operator owns 5 acre land which is filled with a variety of plants and is home to many small animals. He wishes to construct a hotel in the land. Do you think it is a wise idea on his part to start the construction there? Write your argument on this issue.

7. Bhutan defines sustainable development as the capacity and political will to effectively address present development and environment problems, and tomorrow's challenges, without compromising unique cultural integrity and historical heritage, or the quality of life of future generations of Bhutanese citizens. How can your community contribute to sustainable development?

Chapter 5
Classifying Material

As early as 400 B.C., a few people believed that atoms were the building blocks of all matters. The introduction of the atomic theory by John Dalton in 1808 marks the beginning of modern era about the existence of atom. According to this theory, every matter is composed of very small particles called atoms. The atoms were regarded to be tiny, indivisible and indestructible particles. With the development of science, scientists have proven that atom consists of further smaller particles such as electrons, protons, neutrons, etc. These smaller particles are called sub-atomic particles.

Atoms of an element have fixed number of protons, but may have different number of neutrons. Atoms can combine to form molecules. Formation of molecules or compounds can be represented by chemical equations.

1. Atomic Structure

Learning Objectives

On completion of this topic, you should be able to:

- explain the composition of an atom.
- define atomic number and mass number.
- draw the atomic structure of first twenty elements.
- explain the term isotope with some common examples.
- relate the uses of isotope in our daily life.

Reprint 2024

Activity 5.1. Structure of an atom

Figure 5.1 illustrates a typical structure of an atom.

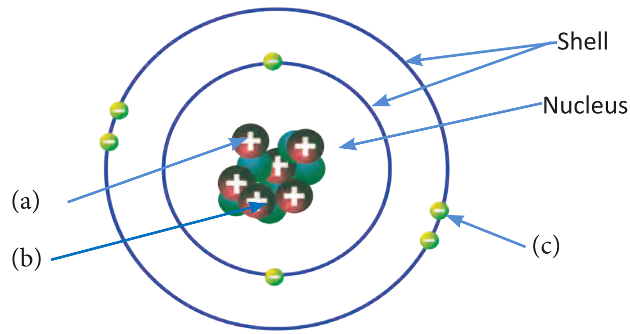


Figure 5.1. Structure of an atom.

i. Label the parts (a), (b) and (c).
ii. Which particles are present in the nucleus of the atom?
iii. Write down the types of charge found in the parts labelled (a), (b) and (c).
iv. What is the charge of the atom?

From Activity 5.1, it is clear that electrons and protons are charged, while neutrons are neutral particles.

Activity 5.2. Completing the concept map of atomic sub-particles

Complete the concept map.

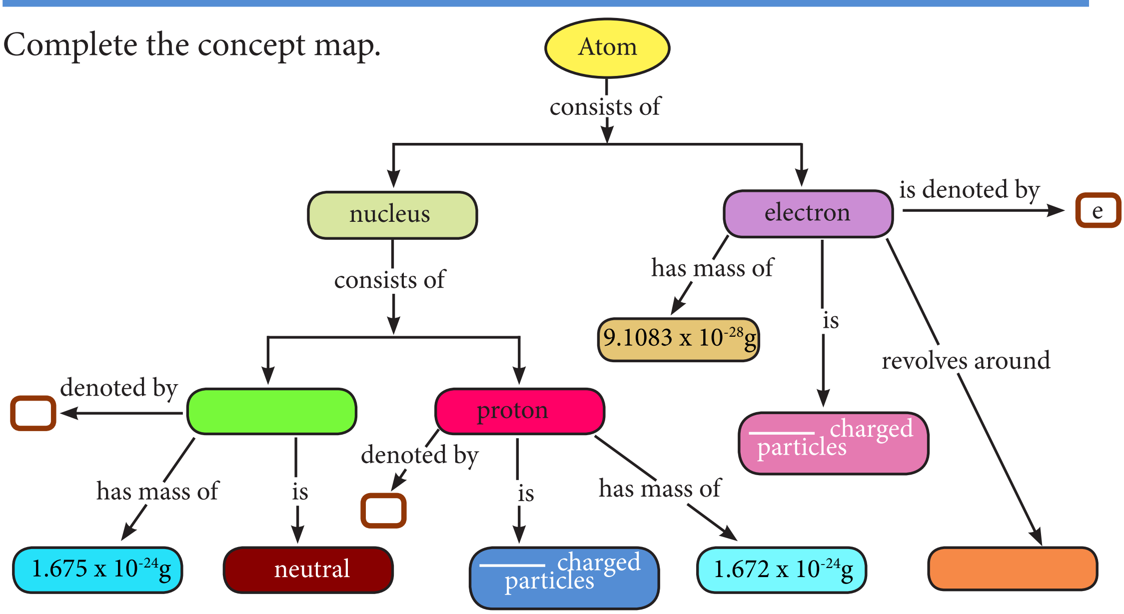


Figure 5.2. Concept map of atomic sub-particles.

i. Describe proton, neutron and electron in your own words.
ii. Which particle is the lightest?
iii. Why is an atom neutral?

Atomic number is the number of protons present in the nucleus of an atom. It is specific for each atom, and is denoted by letter 'Z' as shown in Figure 5.3.

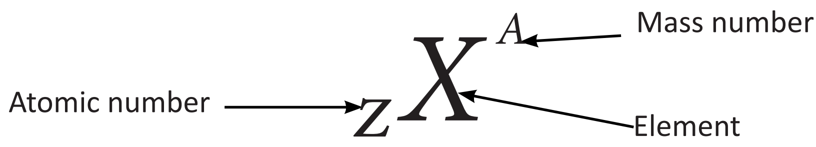


Figure 5.3. General representation of an element.

In an atom, the number of protons is equal to number of electrons. Therefore, an atom is electrically neutral.

Atomic number (Z) = number of protons (p) = number of electrons (e)

$$\mathbf{Z = p = e}$$

The sum of the number of protons and neutrons present in the nucleus of an atom is called **mass number**. It is denoted by letter 'A'.

Mass number (A) = number of protons (p) + number of neutrons (n)

Or,

Mass number (A) = atomic number (Z) + number of neutrons (n)

$A = p + n$ or $A = Z + n$

Therefore, $n = A - p$

or $n = A - Z$

For example, a potassium atom has an atomic number of 19 and a mass number of 39. It is represented as:

$${}_{19}\mathbf{K}^{39}$$

From the above representation, we can understand that, in a potassium atom :

1. number of protons = 19
2. number of electrons = 19
3. number of neutrons = (39 – 19) = 20

a. Distribution of Electrons in an Atom

The electrons are not scattered around the nucleus. They are distributed in different shells in an orderly manner as per certain rules. The distribution of electrons in various shells of an atom is known as **electronic configuration**. The shells are numbered 1, 2, 3, 4, and so on. They are also known as K, L, M, N,... shells.

The number of electrons in different shells is determined by the following rules.

Rule 1

The maximum number of electrons in any particular shell can be calculated by using the formula $2n^2$, where 'n' denotes the shell number. For example, the maximum number of electrons in second shell is $2n^2 = 2 \times 2^2 = 8$.

Rule 2

The outermost shell of an atom can accommodate maximum of two or eight electrons. For example, if 'K' shell becomes the outermost shell, it can accommodate only two electrons. If any other shell becomes the outermost shell, then it can accommodate only eight electrons. For example, if 'M' shell is the outermost shell of an atom, it can accommodate only eight electrons even though it has the capacity to accommodate eighteen electrons. The remaining electrons are accommodated in the 'N' shell.

Activity 5.3. Distributing electrons in shells of an atom

Using the rules of electronic configuration, copy and complete Table 5.1 and answer the questions.

Table 5.1 *Distribution of Electrons in Shells*

Element	Atomic Number	Shells			
		K	L	M	N
A	1	1			
B	6				
C	8	2	6		
D	11				
E	18				
F	20	2	8	8	2
G	25				

Reprint 2024

i. How many shells are present in elements A and F?

ii. Name the outermost shell for element E?

iii. How many electrons are present in the outer most shell of element G?

The outermost shell of an atom is called **valence shell**. The electrons present in the valence shell are called **valence electrons**.

The arrangement of electrons, protons and neutrons in an atom is called **atomic structure**. For example, atomic number of oxygen is 8 and the mass number is 16. Hence, its nucleus has 8 protons and 8 neutrons. The 8 electrons are distributed in K and L shells as shown in Figure 5.4

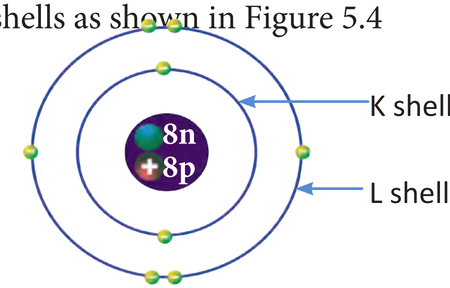
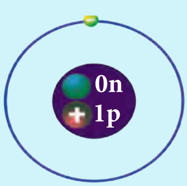
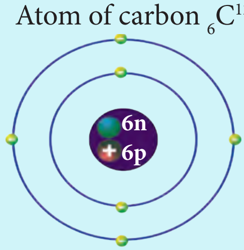
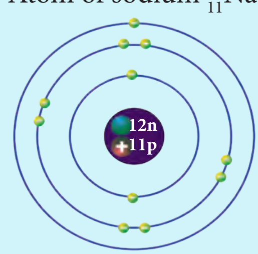
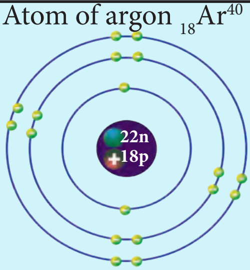
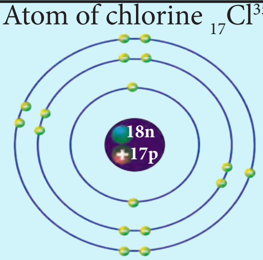
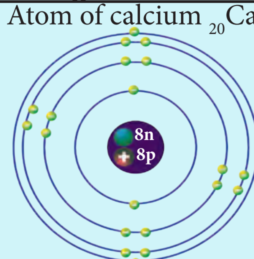


Figure 5.4. Structure of an oxygen atom.

The atomic structures of some other elements are shown in Table 5.2

Table 5.2 *Atomic Structures of Some Elements*

Atom of hydrogen $_1H^1$  $_1$H:1	Atom of carbon $_6C^{12}$  $_6$C: 2, 4	Atom of sodium $_{11}Na^{23}$  $_{11}$Na: 2, 8, 1
Atom of argon $_{18}Ar^{40}$  $_{18}$Ar: 2, 8, 8	Atom of chlorine $_{17}Cl^{35}$  $_{17}$Cl: 2,8,7	Atom of calcium $_{20}Ca^{40}$  $_{20}$Ca: 2, 8, 8, 2

Activity 5.4. Identifying the element

Carry out the following activity.

Procedure

Use the Phet Simulation from the given link to construct atomic model of different elements.

https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

Now, look at figure 5.5 and answer the following questions.

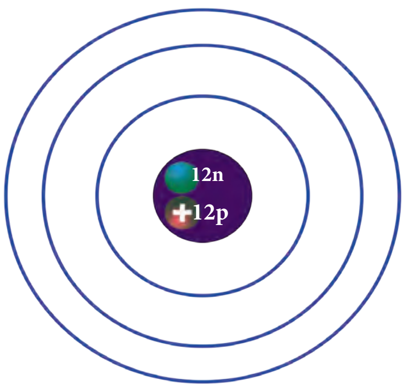


Figure 5.5. Atomic structure.

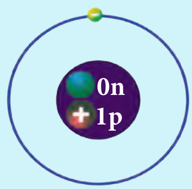
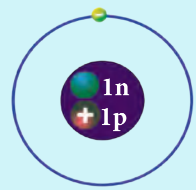
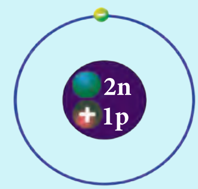
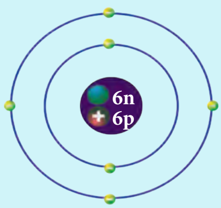
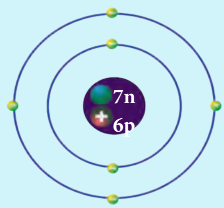
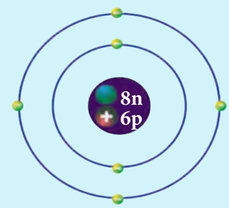
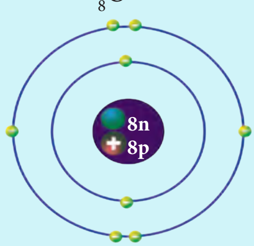
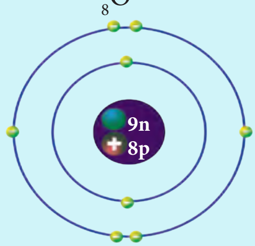
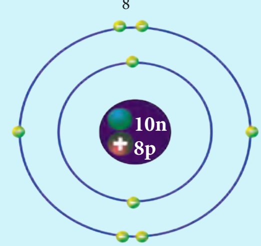
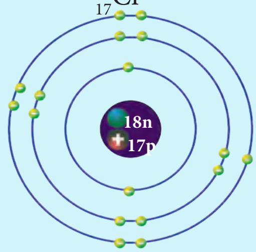
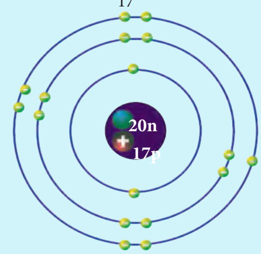
i. The atomic number of the element in Figure 5.5 is ……….
ii. Number of the electron is ……….
iii. Calculate the mass number of the element.
iv. Show the arrangement of electrons in the atomic structure given in Figure 5.5.
v. Identify the element represented in Figure 5.5. Give reason.

b. Isotopes

Some elements have two or more atoms with the same atomic number, but have different mass numbers. The difference is due to the different number of neutrons present in the atoms of same element.. Such atoms are called **isotopes.** For example, chlorine has two isotopes with mass number 35 and 37. The isotopes of some elements are given in Table 5.3.

Reprint 2024

Table 5.3 *Isotopes of Some Common Elements*

Element	Number of Isotopes		
Hydrogen	$_{1}H^{1}$ 	$_{1}H^{2}$ 	$_{1}H^{3}$ 
Carbon	$_{6}C^{12}$ 	$_{6}C^{13}$ 	$_{6}C^{14}$ 
Oxygen	$_{8}O^{16}$ 	$_{8}O^{17}$ 	$_{8}O^{18}$ 
Chlorine	$_{17}Cl^{35}$ 	$_{17}Cl^{37}$ 	

Activity 5.5. Identifying isotopes

Study in Figure 5.6, and answer the questions that follow.

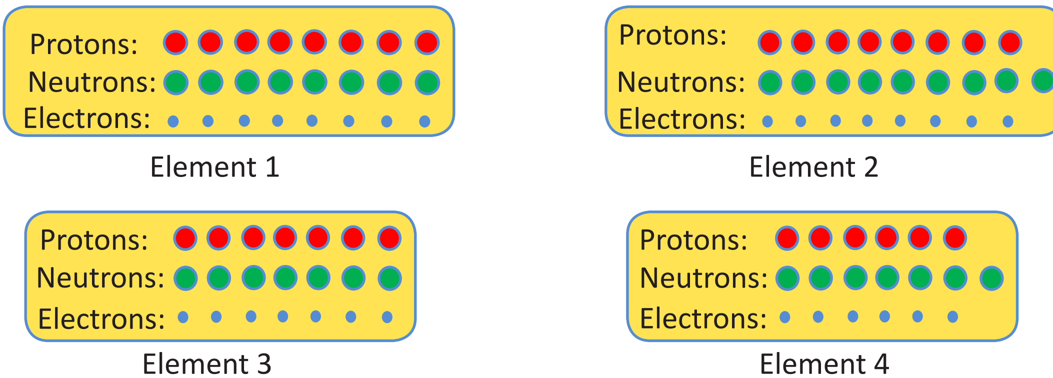


Figure 5.6. Representation of elements.

i. Which of the following pairs would be the isotopes?

   A. Element 1 and Element 2

   B. Element 1 and Element 3

   C. Element 2 and Element 3

   D. Element 3 and Element 4

ii. Represent an isotope of an Element 4 with similar diagrams as in Figure 5.6.

Do You Know?

***Isobars**: Isobars are the atoms of different elements having same mass number, but different atomic number. E.g:* $_{18}Ar^{40}$ *and* $_{20}Ca^{40}$

***Isotones:** Isotones are atoms of different elements with same number of neutrons, but different numbers of protons. E.g:* $_{11}Na^{23}$ *and* $_{12}Mg^{24}$.

Reprint 2024

Application of Isotopes

i. $_{6}C^{14}$ is used to determine the age of the Earth, rocks, minerals and trees.

ii. Isotopes such as $_{15}P^{31}$, $_{27}Co^{60}$, $_{53}I^{123}$ and $_{53}I^{131}$ are used in the field of medicine in locating brain tumour and treatment of cancer.

iii. $_{15}P^{32}$ and $_{7}N^{15}$ are used in agriculture to study plant nutrition, plant diseases, uptake of fertilizer, and photosynthesis.

iv. $_{92}U^{238}$ is used in generation of nuclear energy and rock dating.

Questions

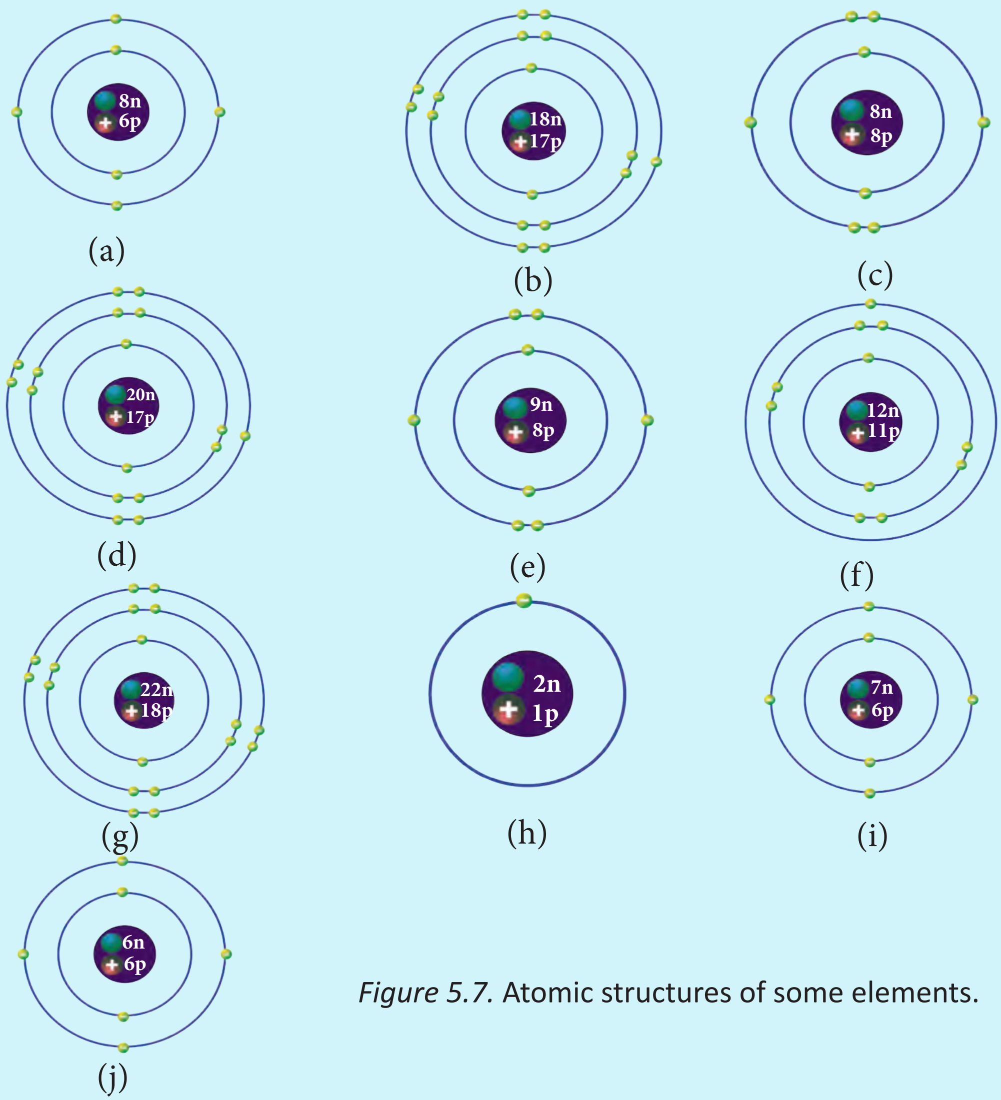
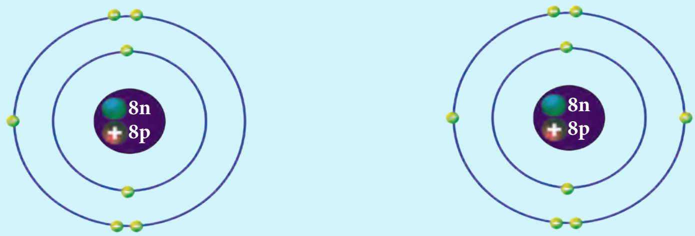


Figure 5.7. Atomic structures of some elements.

1. Which of the atomic structures represented in Figure 5.7 are isotopes of the same element?
2. Why do isotopes of the same element have same chemical properties?
3. Draw the atomic structure of the following elements.
   a. Lithium ($_3Li^7$)
   b. Neon ($_{10}Ne^{20}$)
   c. Magnesium ($_{12}Mg^{24}$)
   d. Potassium ($_{19}K^{39}$)
4. Which one of these two atoms in Figure 5.8 is electrically neutral? Why?



(a) (b)

Figure 5.8.

2. Element, Compound and their Formula

Learning Objectives

On completion of this topic, you should be able to:

- define compound, valency and radical.
- investigate the characteristics of compounds.
- write the chemical formula of different compounds.

Pure substances can be either elements or compounds. If the pure substance contains only one type of atom, it is called an element. However, two or more atoms of different elements chemically combine, in a fixed proportion, to form a compound. For example, sodium chloride (common salt) is a compound. It is made up of two elements, sodium and chlorine. All the things that people use in their daily life are made up of either elements, compounds, or mixtures. Figure 5.9 shows some of the compounds used in our daily life.

Figure 5.9. Examples of compounds used in our daily life.

Activity 5.6. Investigating the characteristics of compound.

Carry out the following activity and answer the questions that follow. Copy and complete Table 5.4.

Materials required

Sulphur, iron filings, magnifying glass, bar magnet, match box, spirit lamp, china dish, mortar and pestle, wire gauze, pair of tongs and spatula.

Producer

Procedure	Observation	Inference
i. Take a spatula each of iron filings and sulphur powder in a china dish, and mix them thoroughly. Observe the mixture with a magnifying glass.	Yellow particles of sulphur and black iron fillings are seen.	Constituents retain their properties. Hence, it is a mixture.
ii. Run the bar magnet over the mixture of iron filings and sulphur powder.		Constituents of the mixture can be separated by physical means.
iii. Heat the mixture of iron filings and sulphur powder for about five to ten minutes, and observe with the magnifying glass.	A black shiny substance is formed.	
iv. Run the bar magnet again over the heated content of the china dish.		

Table 5.4 *Identifying Characteristics of Compound*

i. Based on Activity 5.6, list down two properties of compounds.

ii. Would your inference change if two spatulas of iron fillings were taken in Step i? Explain.

Reprint 2024

a. Chemical Formula

Symbol is an abbreviation used to represent an atom of an element. For example, symbol of an atom of hydrogen is 'H'. Similarly, two atoms of hydrogen is represented by '2H' and not by 'HH', while a molecule of hydrogen is represented by 'H_2'. Water is a compound of two atoms of hydrogen and one atom of oxygen. So its chemical formula is H_2O. **Chemical formula** is a shorthand of representing the number and types of atoms in a molecule of an element or a compound. To write the formula of compounds, we need to know more about radical and valency.

Radical is an atom or a group of atoms which carries positive or negative charge and behave as a single unit. For example, in a molecule of sodium carbonate (Na_2CO_3), sodium radical (Na^+) is a positive radical, and carbonate radical (CO_3^{2-}) is a negative radical, each behaves as a single unit.

Radicals are classified into simple radical and compound radical. A radical which contains only single type of atom is called **simple radical**. Example, Na^+, K^+ , Cl^-, I^-, etc. A radical which contains atoms of more than one element is called **compound radical**. For example, CO_3^{2-}, NO_3^-, SO_4^{2-}, NH_4^+ , etc.

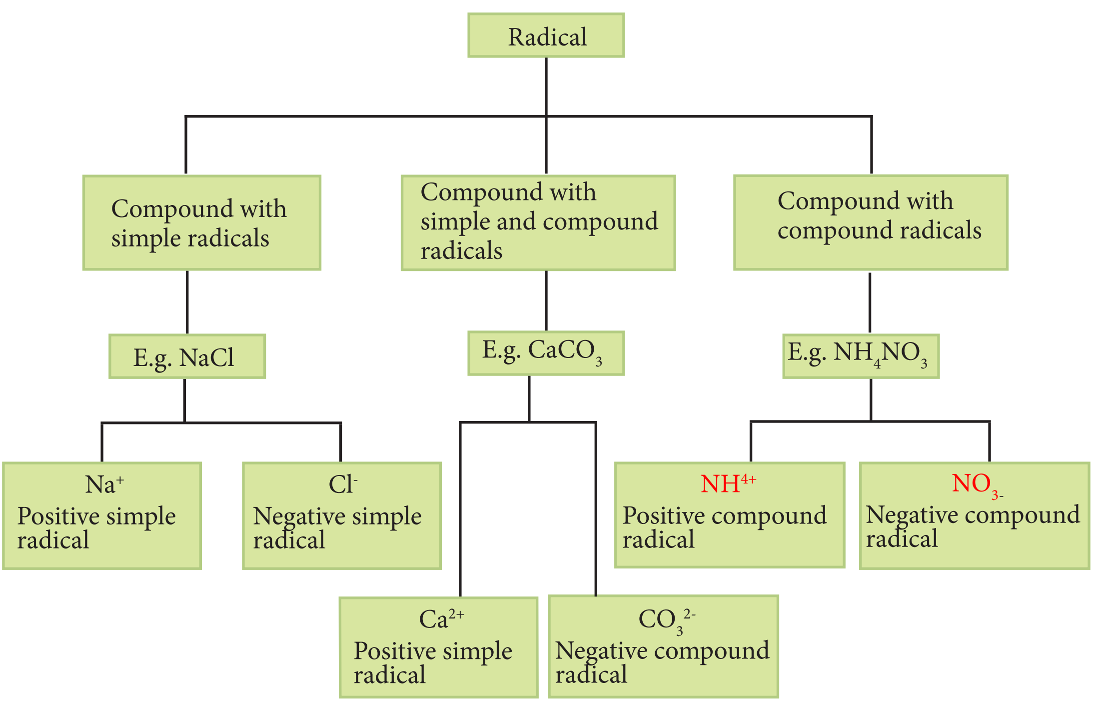


Figure 5.10. Flow chart on radical.

Activity 5.7. Identifying radicals

Study the given radicals. Copy and complete Table 5.5. Answer the questions that follow.

Zn^{2+}, CO_3^{2-}, Fe^{2+}, S^{2-}, Ca^{2+}, NO_3^{-}, Na^{+}, Cl^{-}, H^{+}, SO_4^{2-}, K^{+}, O^{2-}, $Cr_2O_7^{2-}$, OH^{-}, HCO_3^{-}

Table 5.5 *Types of Radicals*

Type of Radical	Example
Simple radical	
Compound radical	
Positive radical	
Negative radical	

1. Compare simple and compound radicals.
2. Identify the negative radicals in the following substances:
   i. table salt ($NaCl$)
   ii. baking soda ($NaHCO_3$)
   iii. washing soda (Na_2CO_3)
   iv. lime water ($Ca(OH)_2$)

b. Valency

Compounds are formed when two or more elements combine chemically. During chemical combination, valence electrons are lost, gained, or shared between the atoms of the elements. The number of electrons, which an atom gains, loses, or shares is called its **valency**. There are some elements such as Cu, Hg, Fe, Pb, Sn, etc., which shows more than one valencies. These elements are said to possess **variable valency**.

Table 5.6, Table 5.7 and Table 5.8 show monovalent, bivalent and polyvalent radicals respectively.

Table 5.6 *Monovalent Radicals (valency 1)*

Name of the Radical	Symbol
Hydrogen carbonate (bicarbonate)	HCO_3^-
Hydroxide	OH^-
Hydrogen sulphate (bisulphate)	HSO_4^-
Hydrogen sulphite (bisulphite)	HSO_3^-
Nitrate	NO_3^-
Nitrite	NO_2^-
Cyanide	CN^-
Cyanate	CNO^-

Name of the Radical	Symbol
Acetate	CH_3COO^-
Ammonium	NH_4^+
Hydrogen	H^+
Sodium	Na^+
Potassium	K^+
Silver	Ag^+
Fluoride	F^-
Chloride	Cl^-
Bromide	Br^-
Iodide	I^-

Table 5.7 *Bivalent Radicals (valency 2)*

Name of the Radical	Symbol
Barium	Ba^{2+}
Calcium	Ca^{2+}
Magnesium	Mg^{2+}
Zinc	Zn^{2+}
Oxygen	O^{2-}
Sulphide	S^{2-}
Carbonate	CO_3^{2-}

Name of the Radical	Symbol
Chromate	CrO_4^{2-}
Dichromate	$Cr_2O_7^{2-}$
Sulphate	SO_4^{2-}
Sulphite	SO_3^{2-}
Peroxide	O_2^{2-}
Silicate	SiO_3^{2-}
Zincate	ZnO_2^{2-}

Reprint 2024

Table 5.8 *Polyvalent Radicals (valency more than 2)*

Name of the Radical	Symbol	Valency
Aluminium	Al^{3+}	3
Chromium	Cr^{3+}	3
Nitrogen	N^{3-}	3
Bismuth	Bi^{3+}	3
Carbon	C^{4-}	4
Phosphate	PO_4^{3-}	3
Phosphite	PO_3^{3-}	3

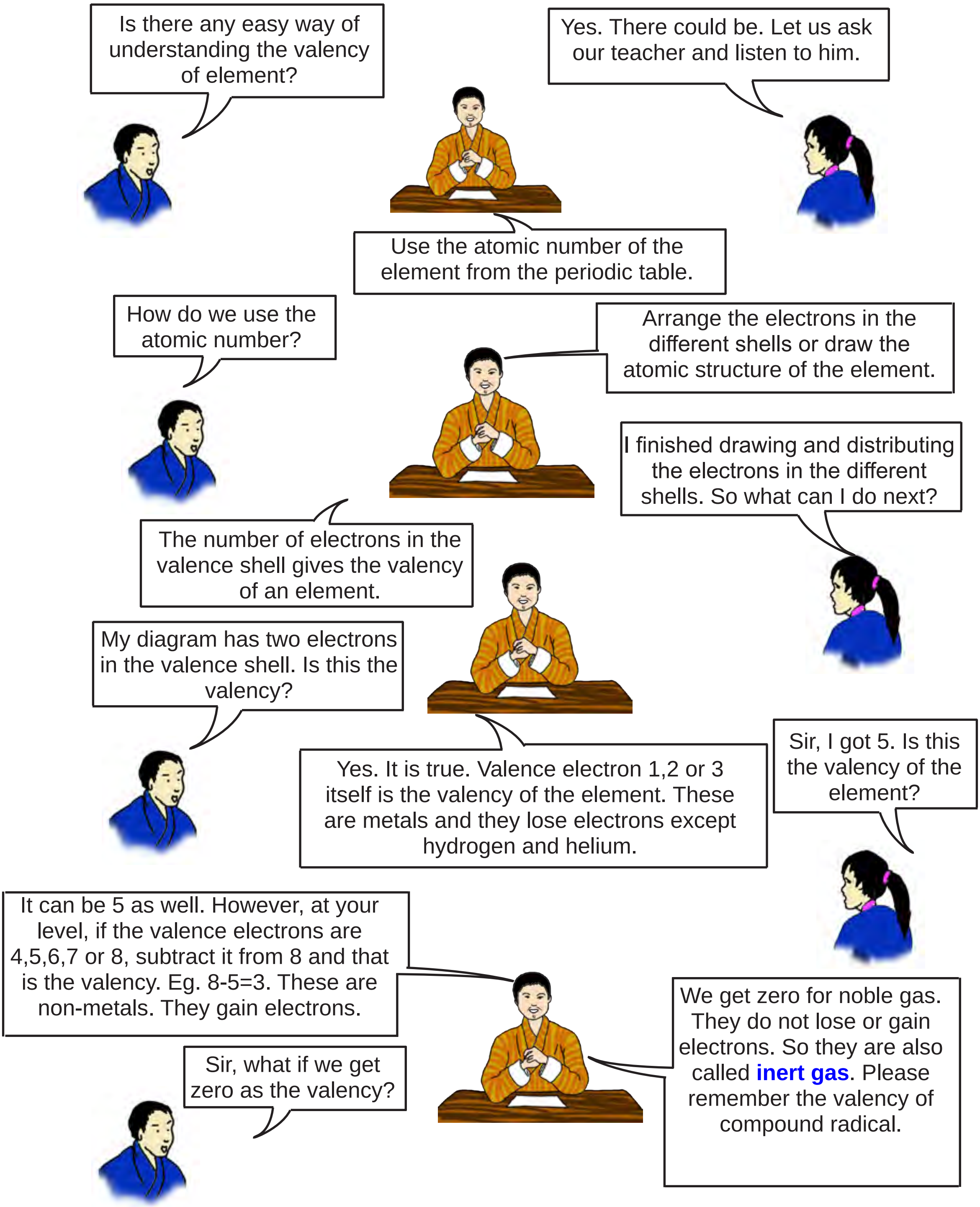
Some radicals exhibit more than one valency. Table 5.9 shows some radicals with the variable valencies.

Table 5.9 *Radicals with Variable Valencies*

Name of the Radical	Symbol	Valency
Copper (cuprous)	Cu^{+}	1
Copper (cupric)	Cu^{2+}	2
Mercury (mercurous)	Hg^{+}	1
Mercury (mercuric)	Hg^{2+}	2
Iron (ferrous)	Fe^{2+}	2
Iron (ferric)	Fe^{3+}	3
Tin (stannous)	Sn^{2+}	2
Tin (stannic)	Sn^{4+}	4
Lead (plumbous)	Pb^{2+}	2
Lead (plumbic)	$Pb^{4}+$	4

Reprint 2024

Understanding the Nature of Element and Valency Using Atomic Number



Activity 5.8. Finding the valency of element

Refer the following elements to answer the questions that follow.

a) ${}_{12}Mg^{24}$ b) ${}_{8}O^{16}$ c) ${}_{10}Ne^{20}$ d) ${}_{7}N^{14}$ e) ${}_{15}P^{31}$ f) ${}_{20}Ca^{40}$

1. Find the valency of the elements using the atomic number.
2. Classify the elements into metals and non-metals.

Chemical formula.

Activity 5.9. Writing chemical formula

A. Formula involving simple radicals.

i. What are the positive and negative radicals present in calcium chloride?
ii. Write the symbols for the positive radical first followed by the negative radical.
iii. What are the valencies of Ca and Cl?
iv. Write the valencies of each radical above their symbols.
v. Interchange the valencies of the radicals.
vi. Write the formula of the calcium chloride.

B. Formula involving compound radicals.

i. Write the symbols for the radicals present in calcium carbonate.
ii. What are the valencies of Ca and CO_3?
iii. Write the valencies of each radical above their symbols.
iv. Interchange the valencies of the radicals.
v. Write the chemical formula of the sodium carbonate.

Case (i): If interchanged valency is 1, it is not required to write its valency. Therefore, in the activity 5.9 A, the chemical formula of calcium chloride is written as $CaCl_2$ not Ca_1Cl_2.

Case (ii): If the valencies of the two radicals are divisible by a common factor, divide the valencies with common factor and write the formula. For example, in $Ca_2\ (CO_3)_2$ the common factor is 2; thus, divide the valencies with 2. After the division, the formula we get is $Ca_1\ (CO_3)_1$. Therefore, formula is $CaCO_3$.

Reprint 2024

Let us practice

1. Write the chemical formulae for the following compounds.
   A. Calcium nitrate.
   B. Copper (II) sulphate.
   C. Ammonium chloride.
   D. Potassium chloride.
2. Name the chemical compound represented by each formula.
   A. $Ca_3(PO_4)_2$
   B. $BaSO_4$
   C. Na_2CO_3
   D. KOH
3. Write the missing valency in the compounds represented with subscript 'y'.
   A. Na_yCO_3
   B. $MgCl_y$
   C. $Al_2(SO_4)_y$
   D. Fe_2O_y

Questions

1. Give the chemical formulae of five compounds that we use in our daily life.
2. What does the chemical formula $Ba(HCO_3)_2$ tell us about the number of atoms of each element present?
3. Look at the cover of the toothpaste and list down the ingredients present in it.
4. The constituents of water are included in the periodic table. However, water is not shown in the periodic table. Explain.
5. $FeSO_4$ and $Fe_2(SO_4)_3$ are the compounds of the same element iron (Fe). What is the valency of Fe in each compound?

Reprint 2024

3. Chemical Equation

Learning Objectives

On completion of this topic, you should be able to:

- define chemical equation.
- explain why reactions take place.
- identify the reactants and products of a chemical reaction.
- write the word equations.
- balance chemical equations.
- explain the need to balance a chemical equation.

Activity 5.10. Investigating a chemical reaction

Carry out the following activity and answer the questions that follow.

Materials required

Test tube, test tube holder, spatula, spirit lamp or candle, matchbox, sugar crystals or glucose, glass tube, cork, and freshly prepared lime water.

i. What do you think will happen to the sugar crystals when you heat it?
ii. What do you think will happen to lime water when you blow air through it?

Procedure I

Step 1. Take about 5 mL of freshly prepared lime water in a clean dry test tube.

Step 2. Close the mouth of the test tube with a cork fitted with a delivery tube.

Step 3. Make sure that the lower end of the delivery tube is completely immersed in lime water.

Step 4. Blow air from the other end of the glass tube into the lime water.

Step 5. Observe what happens.

i. What happens to the lime water?
ii. What can you conclude from this activity?

Precaution

Delivery tube should be clean before you blow air.

Reprint 2024

iii. Write the word equation for the chemical reaction.

Procedure II

Step 1. Take a spatula of sugar in a clean dry test tube.

Step 2. Heat the test tube strongly.

i. What happens to the sugar?

ii. What can you conclude from this activity?

iii. Write the word equation for the chemical reaction.

During a chemical change, elements combine to form compounds, or compounds split to form elements. The chemical interaction of elements or compounds to produce new substance is called a **chemical reaction**. The substances which undergo reaction are called **reactants**. The new substance(s) formed are called **products**.

In a chemical reaction, atoms of reactants rearrange themselves to form products. For example, hydrogen combines with oxygen to form water. Word equation describes chemical reaction using words.

Example 1

$$\underbrace{\text{Hydrogen} + \text{Oxygen}}_{\text{Reactants}} \longrightarrow \underset{\text{Product}}{\text{Water}}$$

Example 2

$$\underbrace{\text{Mercury (II) oxide}}_{\text{Reactant}} \xrightarrow{\Delta} \underbrace{\text{Mercury} + \text{Oxygen}}_{\text{Products}}$$

Example 3

$$\underbrace{\text{Calcium carbonate}}_{\text{Reactant}} \xrightarrow{\Delta} \underbrace{\text{Calcium oxide} + \text{Carbon dioxide}}_{\text{Products}}$$

The chemical reaction can also be represented by using symbols and formulae. Representation of chemical reaction by means of symbols and formulae is called

Reprint 2024

chemical equation. The chemical equation for the formation of water is,

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

Chemical equation for burning of magnesium

$$2Mg + O_2 \longrightarrow 2MgO$$

Balancing the Chemical Equation

The number of atoms of reactants and the number of atoms of products must be balanced in order to fulfill the **law of conservation of mass**. The law states that matter can neither be created nor destroyed. The numbers used in front of the molecular formulae (coefficients) in the balanced chemical equations tell us the ratio of the reactants and the products.

The following points must be considered to balance the chemical equations. For example, in the reaction between magnesium and oxygen,

Step 1. Write down the unbalanced chemical equation. The unbalanced chemical equation is called skeletal chemical equation.

$$Mg + O_2 \rightarrow MgO$$

Step 2. Write down the number of atoms present in the reactant side and product side as shown below.

Reactant side		Product side
$Mg + O_2$	$\longrightarrow$	MgO
$Mg = 1$		$Mg = 1$
$O = 2$		$O = 1$

Number of magnesium atoms in the reactant side is equal to the number of magnesium atoms on the product side (balanced). But the number of oxygen atoms in the reactant side is not equal to the number of oxygen atoms in the product side (unbalanced).

Step 3. Now, change the coefficient of MgO by putting 2 in front of it to balance the number of atoms of oxygen in reactant side and product side. This again unbalances the number of atoms of Mg. Add 2 to increase the coefficient of Mg in the reactant side.

Step 4. Continue step 3, till the number of atoms of each reactant and product are equal on both sides. Never change subscript in the molecular formulae to balance a chemical equation:

Reprint 2024

The balanced equation is $2Mg + O_2$ ---------→ $2MgO$

Write word and balanced chemical equations for the following reactions.

i. Hydrogen reacts with bromine to give hydrogen bromide.
ii. Nitrogen reacts with hydrogen to give ammonia.
iii. Barium chloride reacts with sodium sulphate to give barium sulphate and sodium chloride.

Questions

1. Why should we balance a chemical equation?
2. Figure 5.11 models the results of mixing atoms of different substances. Each atom is represented by a different symbol. Which diagram correctly models a chemical reaction?

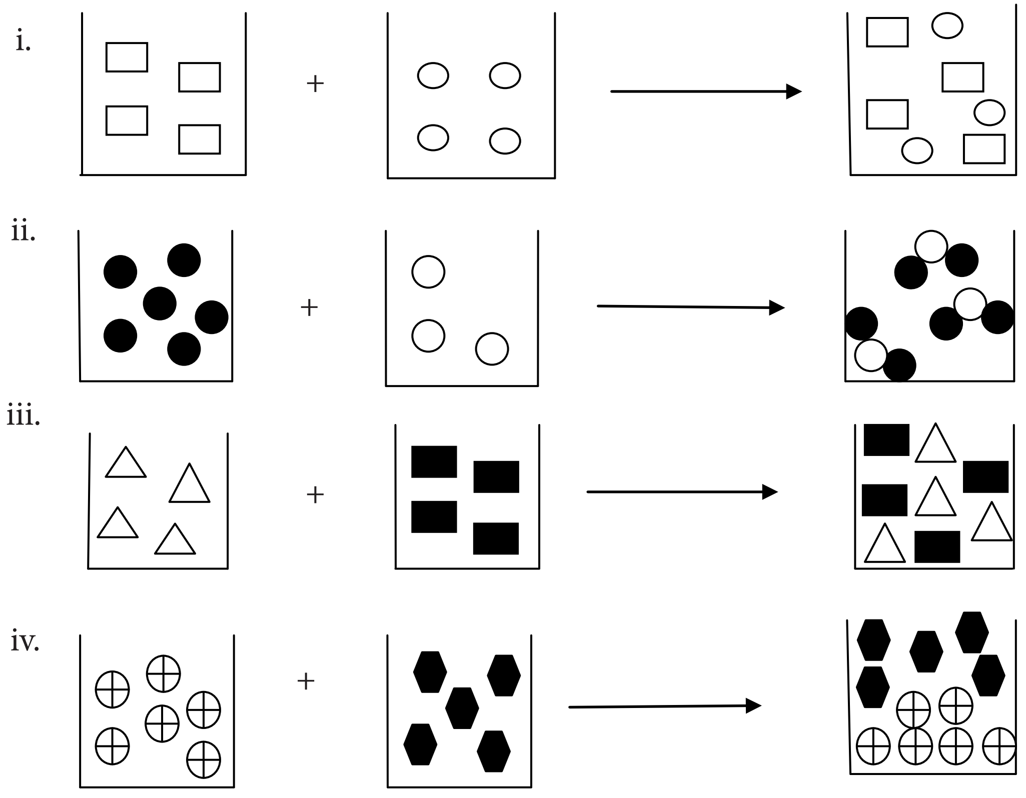


Figure 5.11. Model of chemical reaction.

Exercise

Fill in the blanks.

1. Mass number of an element is the sum of the number of ______________ and _________.
2. The number of neutron in $_8O^{16}$ is ______________________.
3. The electrons present in the outermost shell are called ______________ electrons.
4. A group of atoms of more than one element forms ____________radical.
5. The number of electrons that are lost, gained, or shared by the atoms during a chemical reaction is equal to ________________ of an element.

Check whether the following statements are True or False. Correct the false statements.

1. Protons and electrons together form the nucleus of an atom.
2. An atom is the smallest unit of an element that retains the properties of that element.
3. Iron reacts with sulphur on heating to form a black substance called iron sulphate.
4. A balanced chemical equation is in accordance to the law of conservation of mass.
5. The number of proton in an atom is equal to its atomic mass.

Multiple Choice Questions

1. Which of the following statement best describes an atom?
   A. Protons and electrons are grouped together in a random pattern.
   B. Protons and electrons are grouped together in an alternating pattern.
   C. A core of protons and neutrons surrounded by electrons.
   D. A core of electrons and neutrons surrounded by protons.
2. Table 5.10 shows the atomic mass of four stable isotopes of an element X.

Reprint 2024

Table 5.10

Isotope	Atomic Mass
X – 40	40
X – 42	42
X – 43	43
X – 44	44

What is different in each isotope?

A. The position of the element in the periodic table.
B. The net charge of the nucleus.
C. The mass of the protons.
D. The number of neutrons in the nucleus.

3. Iron (Fe) reacts with oxygen (O_2) to form iron (III) oxide (Fe_2O_3). The properties of Fe_2O_3 are most likely to be

A. different from both iron and oxygen.
B. similar to both iron and oxygen.
C. similar only to iron.
D. similar only to oxygen.

4. The following equations in Table 5.11 represent chemical reactions.

Table 5.11

1	$Na + 2H_2O \rightarrow 2NaOH + H_2$
2	$H_2 + O_2 \rightarrow H_2O$
3	$Mg + Cl_2 \rightarrow MgCl_2$
4	$NaOH + MgCl_2 \rightarrow NaCl + Mg(OH)_2$

Which equation shows that the total mass during a chemical reaction stays the same?

A. 1
B. 2
C. 3
D. 4

Reprint 2024

5. The atomic number of calcium is 20. The maximum possible number of electron in M-shell is

   A. 2
   B. 8
   C. 18
   D. 10

Answer the following questions

1. Figure 5.12 shows the geometric structure of a molecule of water (H_2O).

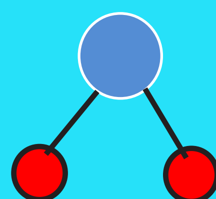


Figure 5.12.

   What do the symbols  and  represent in the model?

2. C^{12}, C^{13} and C^{14} are atoms of carbon. What term best describes them? Define the term.

3. Use the information from the part of the periodic table in Figure 5.13 to answer the following questions.

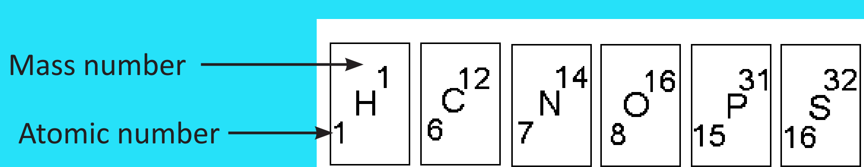


Figure 5.13.

   a. How many neutrons are present in the nucleus of a phosphorus atom?
   b. How many electrons would be expected in the outermost shell of an atom of sulphur?
   c. What is the valency of an atom with six electrons in its outermost shell?

4. Write down the electronic configuration and draw the atomic structure

of:

i. Sodium
ii. Chlorine
iii. Argon
iv. Calcium

5. List down two applications of isotopes.
6. The atomic number and mass number of five elements are given in Table 5.12. The letters A, B, C, D and E represent the elements.

Table 5.12

Element	Atomic number	Mass number
A	3	7
B	7	14
C	8	18
D	9	19
E	17	37

i. Which element contains the highest number of neutrons?
ii. Which element contains the least number of electrons?
iii. Which of these contains equal number of electron and neutron?
iv. In which group and period does D belong in the periodic table?
v. The valency of element 'A' is 1. If it combines with an element 'C' with valency of 2, write down the chemical formula of the compound.
vi. Draw the atomic structure of an element A?

7. Use Figure 5.14 to answer the questions.

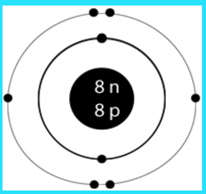


Figure 5.14. Element X.

i. What is the charge of the nucleus of element 'X'?
ii. What would be the electrical charge of element 'X', if two more electrons are added to its valence shell?

8. Complete Table 5.13 for isotopes of some common elements.

Table 5.13

Isotopes	Number of		
	Proton	Neutron	Electron
${}_{6}C^{12}$	6		
${}_{6}C^{13}$			
${}_{6}C^{14}$			
${}_{8}O^{16}$		8	
${}_{8}O^{18}$			
${}_{17}Cl^{35}$			17
${}_{17}Cl^{37}$			

9. Write the balanced chemical equations for the following word equations.
   a. Sodium + Sulphuric acid → Sodium sulphate + Hydrogen
   b. Nitric acid + Calcium hydroxide → Calcium nitrate + water

10. What is a chemical formula? What information is conveyed by the formula 'H_2O'?

11. Write the name for each of these chemical formulae.
   i. $Ca(NO_3)_2$
   ii. KOH
   iii. $NaHCO_3$

Chapter 6
Material and Change

Substances undergo either physical or chemical change. In physical change, no new substances are formed, but in chemical change, new substances are formed. Both physical and chemical changes are brought about by various factors such as temperature, size, contact area, etc. For example, dissolution of salt in a solvent to form a solution is a physical change. The amount of solute that dissolves in a fixed amount of solvent is called solubility. Solubility is affected by various factors, such as temperature, pressure, and nature of solute and solvent.

Any chemical reaction is a chemical change. A chemical reaction takes place when two or more substances interact to form one or more new substances. There are many types of chemical reactions.

1. Solubility

Learning Objectives

On completion of this topic, you should be able to:

- explain the factors affecting solubility.
- investigate the solubility of a solute in different solvents.
- interpret solubility curves.

Solubility is measured as the mass of solute that will saturate 100 g of water at a particular temperature. It is also expressed in grams per litre.

Different substances have different solubilities as shown in Table 6.2. For example, at 20°C, 35.9 g of sodium chloride dissolves in100 g of water, and 203.9 g of sugar dissolves in 100 g of water. However, if the temperature is changed, the amount of each solute that dissolves in 100g of water will also change.

Reprint 2024

Table 6.1 *Solubility of Substance in Water*

Substance	Solubility in g/100 g of Water		
	At 20°C	At 40°C	At 50°C
Salt (sodium chloride)	35.9	36.37	36.69
Baking soda (sodium bicarbonate)	9.6	12.7	16
Washing soda (sodium carbonate)	21.4	49	46
Lye (sodium hydroxide)	109	129	174
Sugar (sucrose)	203.9	235.6	259.6

The ability of many substances to dissolve in water is essential for the survival of living organisms. For example, absorption of minerals by plants, dissolved oxygen and carbon dioxide in water for aquatic life, digestion of food etc. Some applications of solubility in everyday life are given in Figure 6.1.

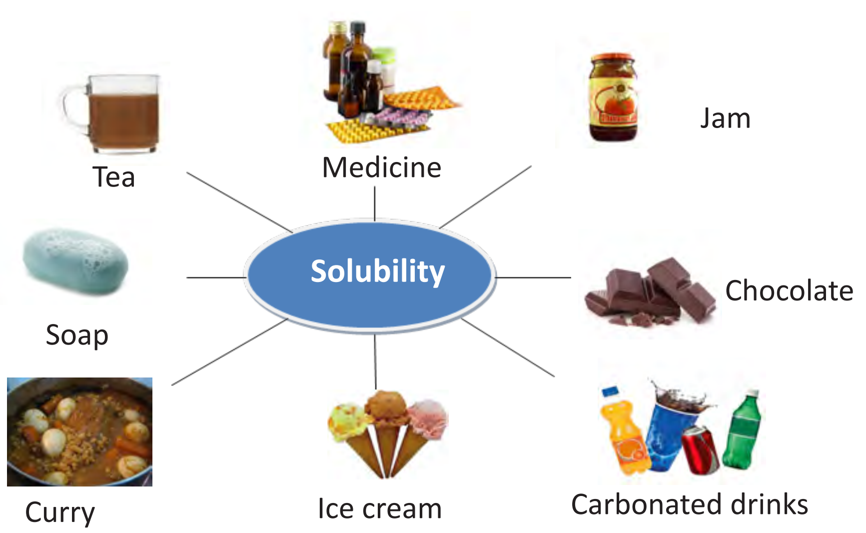


Figure 6.1. *Applications of solubility in everyday life.*

Reprint 2024

Activity 6.1. Finding the solubility of salt

Carry out the following activity and answer the questions that follow.

Materials required

Beaker, china dish, wire gauze, spirit lamp, weighing balance, tripod stand, sodium chloride or potassium chloride, and water.

Procedure

Step 1. Prepare a saturated solution of the given salt in 100 mL of water.

Step 2. Weigh empty china dish and record its mass as W_1 g.

Step 3. Add 10 mL of a saturated solution in the china dish and weigh it. Record its mass as W_2 g.

Step 4. Heat the dish until all the solvent evaporates leaving behind the residue.

Step 5. Let the dish cool down and weigh again. Record its mass as W_3 g.

Step 6. Calculate the solubility of the salt by using the given formula:

Mass of solvent = $(W_2\text{-}W_3)$g

Mass of solute = $(W_3\text{-}W_1)$g

$$\text{Solubility (in 100 g of solvent)} = \frac{(W_3-W_1)}{(W_2-W_1)} \times 100$$

i. What is the solubility of the given salt?

ii. Carry out the following activity and answer the questions that follow.

a. Factors Affecting the Solubility of a Solute in a Solven

i. Nature of solute and solvent:

Solubility depends on the nature of solute and solvent. For example, solubility of sugar in water is higher than in oil. Similarly, solubility of salt is less in water than solubility of sugar in water.

ii. Temperature:

In general, an increase in temperature increases the solubility of a substance. However, it depends upon whether the dissolution process is exothermic or endothermic. For some substances to dissolve in a given solvent, heat is absorbed. The reaction is **endothermic**. In this case, an increase in temperature increases the solubility, like potassium nitrate in water. However, for some substances, heat is released when substances dissolve in a given solvent, like sodium hydroxide in water. The reaction is called **exothermic**. In this case, an increase in temperature decreases the solubility.

iii. Pressure:

In gases, the solubility increases with increase in pressure. For example, solubility of carbon dioxide in fizzy drinks increases with increase in pressure.

Activity 6.2. Investigating the solubility of sugar in water and ethanol.

You are provided with the following materials. Design and carry out an experiment to investigate the solubility of sugar in water and ethanol. Answer the questions that follow.

water, ethanol (ethyl alcohol), sugar, weighing balance, measuring cylinder, glass rod and beaker.

i. What is the solubility of sugar in water and ethanol at room temperature?

ii. What can you say about the solubility of sugar in water and in ethanol?

iii. Identify dependent, independent and controlled variables in the experiment.

In endothermic reaction, solubility of a salt increases with the rise in temperature. For exothermic reaction, the solubility decreases with the rise in temperature. The effect of temperature on the solubility of a solute can be expressed in the form of graph called **solubility curve**.

b. Solubility Curve

Solubility curve is a line graph that plots the changes in the solubility of a solute in a solvent against temperature. In the graph, y-axis represents the solubility (dependent variable). Similarly, x-axis represents the temperature (independent variable). The solubility curves of sodium nitrate ($NaNO_3$), potassium nitrate (KNO_3), sodium chloride ($NaCl$), cerium sulphate ($CeSO_4$), and potassium chloride (KCl) are shown in Figure 6.2.

Reprint 2024

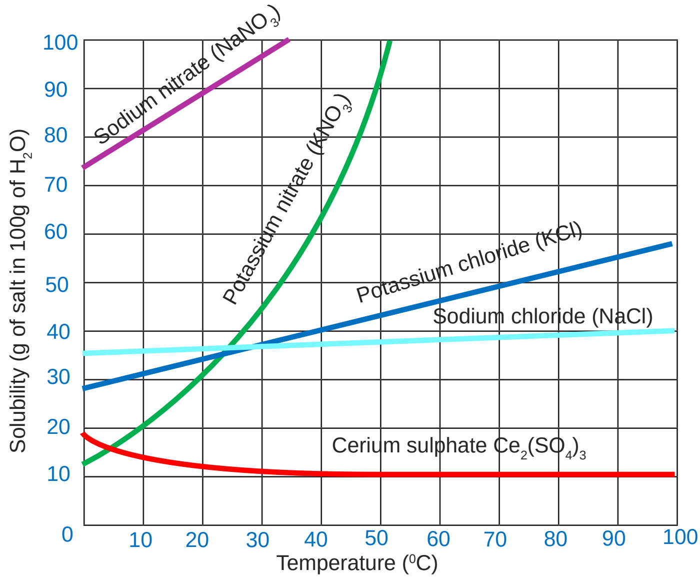


Figure 6.2. Solubility curve.

Interpreting the Solubility Curve

i) Sodium nitrate ($NaNO_3$) has the highest solubility at 0^0C.

ii) Potassium nitrate (KNO_3) has the lowest solubility at 0^0C.

iii) The solubility of potassium nitrate (KNO_3) is low at 0 ^{0}C but increases rapidly with increase in temperature.

iv) The solubility of potassium chloride(KCl) increases constantly with the increase in temperature.

v) The solubility of cerium sulphate $Ce_2(SO_4)_3$ is high at 0 ^{0}C but decreases and remains constant with increase in temperature.

vi) The solubility of sodium chloride (NaCl) is slightly affected by the increase in temperature.

Uses of Solubility Curve

It determines the solubility of a solute at a particular temperature. In Figure 6.2, the solubility of potassium nitrate at 30 ^{0}C is approximately 45 g and at 50^0C it is approximately 91 g.

It helps to compare the solubility of different solutes in a solvent at a particular temperature. For example, at 40^0C the solubility of potassium nitrate is greater than that of potassium chloride.

Reprint 2024

A solubility curve is useful in the purification and separation of solutes by fractional crystallisation. The solute with lower solubility crystallises first.

Activity 6.3. Plotting graphs - temperature versus solubility

Carryout the following activity and answer the questions that follow.

1. Use data given in Table 6.2 to plot independent variable along X-axis and dependent variable along Y-axis in spreadsheet.
2. Scale each axis so that the smallest and the largest data values can be plotted.
3. Label each axis with appropriate quantity and unit.
4. Plot a graph for all three salts (A, B, and C).

Table 6.2 *Temperature versus solubility*

Temperature (°C)	Effect of temperature on solubility of salts A, Band C		
	Solubility (g of A per 100 g of H_2O)	Solubility (g of B per 100 g of H_2O)	Solubility (g of Cper 100 g of H_2O)
0	33	20	32
10	40	13	34
20	47	9	35
30	54	9	35
40	66	9	36
50	74	8	36
60	89	8	37
70	100	8	37
80	-	8	37
90	-	7	37
100	-	7	37

Reprint 2024

1. What mass of solute will dissolve in 100 g of water at the following temperatures?
   a. A at 55°C = ____________
   b. B at 15°C = ____________
   c. C at 43°C = ____________
2. If we put A, B, and C in a container and stir them, which salts will dissolve faster? Is there any possibility of separating mixture of A, B, and C?
3. What is the solubility of A, B, and C at 40°C? What can you conclude from this observation?
4. At 20°C, 47 g of 'A' is dissolved in 100 g of water. Is this solution saturated or unsaturated? How do we know?
5. Name the salt whose solubility decreases with increase in temperature.
6. Which salt has the highest solubility at 30°C?

Questions

1. Study Figure 6.3 and answer the questions that follow.

(a) Stirring (b) Boiling (c) Decreasing size of particles (d) Presence of light

Figure 6.3.

   i. Identify the factors given in Figure 6.3 that affect solubility.
   ii. Explain with example, the factor that affects the solubility of solid in a liquid other than the ones shown in Figure 6.3.

2. Chemical Reaction

Learning Objectives

On completion of this topic, you should be able to:

- explain chemical reaction.
- differentiate exothermic reaction and endothermic reaction.
- describe different types of chemical reaction with examples.
- observe the pattern in chemical reactions and group them according to the type of reactions.
- investigate some of the chemical reactions.

Chemical reactions occur all around us. Some chemical reactions are visible, like an explosion or a firework display. Other chemical reactions are too slow to be noticed such as rusting of iron, fading of colour from clothes, and weathering of rocks. In a chemical reaction, atoms of the reacting substance rearrange themselves to form products. This can occur only if the bonds in the reacting substances are broken and new bonds are formed. A **bond** is an attractive force, which binds the atoms in a molecule.

For example, in the reaction between hydrogen and oxygen to form water, the hydrogen and oxygen molecules break up into atoms.

$$H_2 \longrightarrow H + H$$

$$O_2 \longrightarrow O + O$$

One atom of oxygen combines with two atoms of hydrogen to form a molecule of water.

$$2H + O \longrightarrow H_2O$$

$$2H + O \longrightarrow H_2O$$

$$2H_2 + O_2 \longrightarrow 2H_2O \quad \text{(Over all reaction)}$$

The rearrangement of atoms during the formation of water molecule from hydrogen and oxygen is shown in Figure 6.4.

Reprint 2024

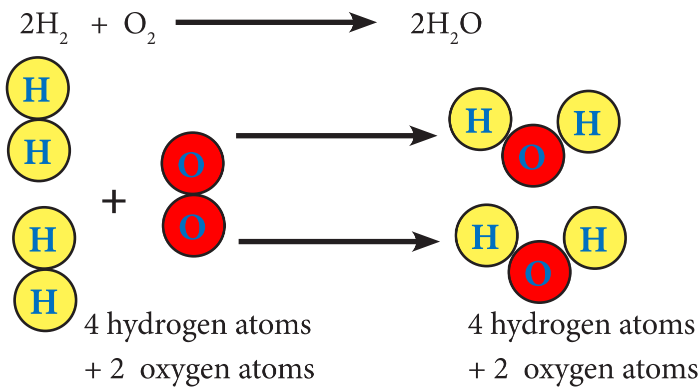


Figure 6.4. Formation of water molecule.

When chemical reaction takes place, there are some changes that indicate and confirm the occurrence of reaction. These changes are called the indicators of chemical reaction.

Explore about chemical reaction from the link given below

https://phet.colorado.edu/en/simulation/reactants-products-and-leftovers

Activity 6.4. IInvesting indicators of chemical reaction

Carry out the following activity and answer the questions that follow. Copy and complete Table 6.4.

Materials required

Granulated Zinc, dil. HCl, lead nitrate, potassium iodide, water, test tube, test tube holder, spatula, spirit lamp, matchbox, test tube rack, beaker, and splint.

Procedure

Table 6.4 *Observing Chemical Reactions*

Experiment No.	Procedure	Observation	Chemical indicator
1	1. Add a piece of granulated zinc in a test tube containing 2- 3 mL of dilute HCl. 2. Touch the bottom of the test tubes with your fingers during the reaction.		i) Effervescence ii) Exothermic reaction or energy change.

2	1. Dissolve 2 spatulas of lead nitrate in 20 mL of water in a beaker. 2. Take another beaker and dissolve 2 spatulas of potassium iodide in 20 mL of water. 3. Add potassium iodide solution slowly to the lead nitrate solution.		Change of state
3	1. Take a clean dry test tube. 2. Add a spatula of lead nitrate into the test tube. 3. Hold the test tube with test tube holder. 4. Heat it gently in a slanting position facing away from you and your friends. 5. Introduce a glowing splint into the test tube after the evolution of dense brown fumes. ***Precaution*** *Do not inhale the gas produced. This activity must be carried out in a well-ventilated room. Handle acid with care.*		i. Change in colour ii. Irritating smell. iii. Endothermic reaction or energy change.

i. Write a balanced chemical equation for the word equation provided.

Lead nitrate → Lead oxide + Nitrogen dioxide + Oxygen

ii. What do you observe when you add potassium iodide solution to the lead nitrate solution?

iii. Write a balanced chemical equation for the word equation provided.

Lead nitrate + Potassium iodide → Lead iodide + Potassium nitrate

iv. How do you feel as you touch the bottom of the test tube in experiment no.1? Justify your answer.

v. What can you conclude from experiments 1, 2 and 3 about the chemical reaction?

Reprint 2024

In a chemical reaction, mass is always conserved. This is in accordance to the law of conservation of mass. The law of conservation of mass in chemical reaction can be explained by using the concept of molecular mass. The proportion of masses of the reactants and products can be calculated from a balanced chemical equation using the atomic mass. The total molecular mass on the reactant side and total molecular mass on the product side are always equal. For example, in the burning of magnesium ribbon, two atoms of magnesium combine with two atoms of oxygen to form two molecules of magnesium oxide.

$$\text{Magnesium} + \text{Oxygen} \longrightarrow \text{Magnesium oxide}$$

$$2Mg + O_2 \longrightarrow 2MgO$$

The atomic mass of magnesium = 24 and the atomic mass of oxygen = 16.

Therefore,

$$\begin{array}{lcll} 2Mg & + & O_2 & \longrightarrow 2MgO \\ 2(24) & + & 2(16) & \longrightarrow 2(24+16) \\ 48 & + & 32 & \longrightarrow 80 \\ \hline & 80 \text{ unit} & & \longrightarrow 80 \text{ unit} \end{array}$$

Activity 6.5. Does mass change in a chemical reaction?

Carry out the following activity and answer the questions that follow:

Materials required

Copper sulphate solution, sodium hydroxide solution, conical flask, test tube, cork, thread, spatula, and weighing balance.

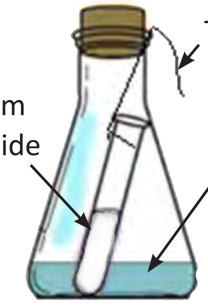


Figure 6.5. Finding mass in chemical reaction.

Procedure

Step 1. Dissolve 1 spatula of copper sulphate in 10 mL of water in a conical flask.

Step 2. Take a test tube and dissolve 1 spatula of sodium hydroxide in 10 mL of water.

Step 3. Lower the test tube into the conical flask containing copper sulphate solution as shown in Figure 6.5.

Step 4. Cover the mouth of the conical flask with a cork.

Step 5. Weigh the whole apparatus.

Step 6. Tilt the conical flask so that the two solutions mix.

Step 7. Allow the reaction to complete and weigh it again.

i. What is the weight of whole apparatus before and after the reaction?

ii. Word equation for the above reaction is given below. Write the balanced chemical equation and calculate the molecular mass of reactants and products. (Atomic mass of copper = 63.5, sodium = 23, sulphur =32, oxygen=16 and hydrogen =1)

   Sodium hydroxide + copper sulphate → copper hydroxide + sodium sulphate

iii. What do you conclude from this activity?

There are various types of chemical reactions. They are classified depending on the way the products are formed.

Activity 6.6. Types of chemical reaction

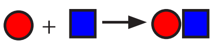
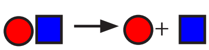
Carry out the following activity and answer the questions that follow. Copy and complete Table 6.5.

Materials required

Magnesium ribbon, copper carbonate, copper sulphate solution, iron nail, test tube, test tube holder, pair of tongs, spirit lamp, match box and watch glass.

Procedure

Table 6.5 *Types of Chemical Reaction*

Type of chemical reaction	Procedure	Observation/ Chemical equation	Inference
1. Direct combination or synthesis reaction 	i. Take a clean piece of magnesium ribbon. ii. Hold the ribbon with a pair of tongs. iii. Burn it using a burner (keeping Mg ribbon as far as possible from your eyes) iv. Collect the ash in the watch glass and observe it.	i. Magnesium ribbon burns with a dazzling white light. ii. White ash is seen. $2Mg + O_2 \rightarrow 2MgO$	Magnesium oxide is formed
2. Decomposition reaction or dissociation reaction 	i. Take about 2 g of copper carbonate powder in a dry test tube. ii. Note the colour of the copper carbonate. iii. Heat copper carbonate in a test tube. iv. Observe the change after heating	i. Colour changes from green to black. $CuCO_3 \rightarrow CuO + CO_2$	
3. Displacement or substitution reaction 	i. Dip half of a rust-free iron nail into the test tube containing copper sulphate solution. ii. Leave it for about 5 – 10 mins.		i. Iron displaces copper from $CuSO_4$ solution. ii. This change confirms that iron is more reactive than copper.

i. What is the difference between displacement reaction and decomposition reaction?

ii. Why does copper carbonate change its colour from green to black on heating?

Questions

1. Classify the following reactions as synthesis reaction, displacement reaction and decomposition reaction.

   a. $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

   b. $Fe + S \rightarrow FeS$

   c. $Na_2CO_3 \rightarrow Na_2O + CO_2$

   d. $Pb(NO_3)_2 + 2KI \rightarrow 2KNO_3 + PbI_2$

2. Chemical reaction is a chemical change. Justify with an example.

WEBLINK

http://www.kentchemistry.com/links/Kinetics/SolubilityCurves.htm
http://education-portal.com/academy/lesson/solubility-and-solubility-curves.html#lesson
http://chemistry.about.com/od/chemicalreactions/a/reactiontypes.htm

Reprint 2024

Exercise

Fill in the blanks.

3. The solubility of cerium sulphate initially .... and remains........................... with increase in temperature.
4. In a .... reaction, two or more reactants add up to form a product.
5. When lead nitrate is heated, it decomposes into lead oxide, ... and ....
6. In .... reaction heat is absorbed.
7. The measure of mass of solute that will saturate 100 g of water at a particular temperature is called............................

Give one word answer for the following statements.

1. The mixture of solute and solvent.
2. The ability of a solute to dissolve.
3. The reaction in which heat is given out.
4. The reaction in which the reactive metal displaces the less reactive metal.
5. The formation of bubbles as the gas escapes during a chemical reaction.

Multiple Choice Questions.

1. Study Figure 6.6 and answer the questions that follow.

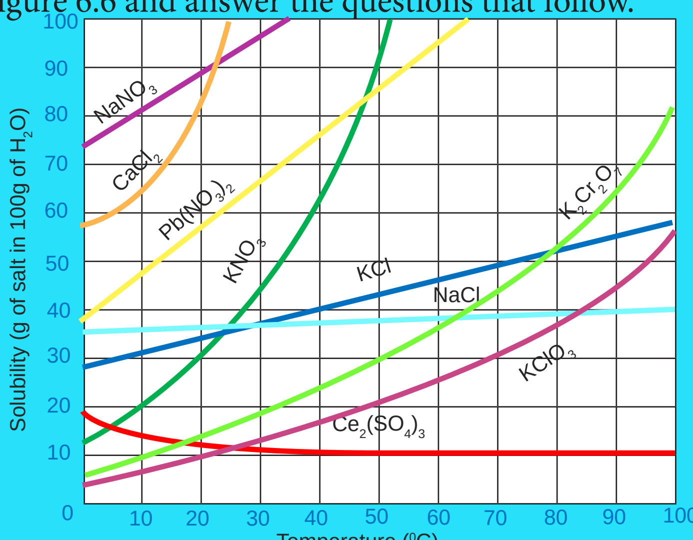


Figure 6.6.

i. Which salt is least soluble at 0°C?

A. KNO_3.
B. $KClO_3$.
C. $Ce_2(SO_4)_3$.
D. $K_2Cr_2O_7$.

ii. At what temperature does the solubility of sodium chloride, match the solubility of potassium dichromate?

A. 50°C.
B. 83°C.
C. 63°C.
D. 30°C.

iii. Which of these salts decreases in solubility as the temperature increases?

A. KNO_3.
B. $K_2Cr_2O_7$.
C. $Ce_2(SO_4)_3$.
D. $KClO_3$.

iv. Which one of the following reactions is exothermic?

A. NaCl in water.
B. $K_2Cr_2O_7$ in water.
C. $Ce_2(SO_4)_3$ in water.
D. KNO_3 in water.

v. Which of the following statement is TRUE?

A. KNO_3 is more soluble in water than $KClO_3$.
B. As water temperature increases, the solubility of KNO_3 decreases.
C. $KClO_3$ is more soluble in water than KNO_3.
D. Water temperature has no effects on the solubility of KNO_3 and $KClO_3$ chemicals.

Answer the following questions.

1. The solubility of potash alum, at various temperatures, is given in Table 6.5.

   Table 6.5

Temperature ^0C	0	10	20	30	40	50	60	70	80
Solubility/g per 100 g of water	4	10	15	23	31	49	67	101	135

   a. Plot a graph of solubility against temperature.
   b. From your graph, find the solubility of potash alum at 67°C.
   c. At what temperature will 90 g of potash alum form a saturated solution in 100 g of water?
2. Differentiate endothermic reaction and exothermic reaction.
3. Explain at least two indicators of chemical reaction.
4. In an experiment, a student dipped an iron nail in copper sulphate solution and left it for few days. He observed the following changes as shown in Figure 6.7.

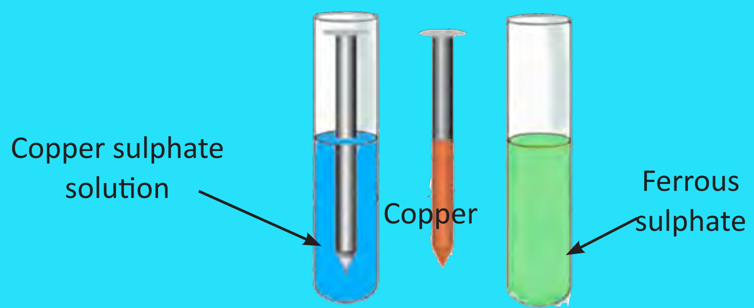
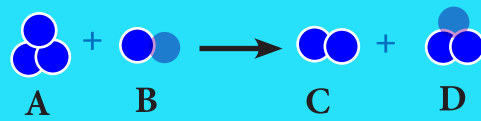


Figure 6.7.

   a. Blue copper sulphate solution changes to green. Why?
   b. Why did the iron nail acquire brown colour?
   c. What type of reaction is this? Support your answer with an equation.

Reprint 2024

5. In a given experiment, the two types of molecules are mixed together:



Apply the law of conservation of mass to explain your answer.

6. You have a chemical in a sealed glass container filled with air. This set-up is placed on a balance as shown in Figure 6.8. Next, the chemical is ignited by focusing sunlight on it with the help of a magnifying glass..

Figure 6.8.

i. After the chemical has completely burned, which of the following is true?
   a. The balance will read less than 250.0 g.
   b. The balance will read 250.0 g.
   c. The balance will read greater than 250.0 g.
   d. The balance will read 25.0 g.

ii. Explain your answer.

Reprint 2024

Chapter 7
Separating Mixture

Many things that we use are mixtures. A mixture is a physical combination of two or more pure substances. For example, air is a mixture of oxygen, nitrogen, carbon dioxide, etc. Mixtures can be either homogeneous or heterogeneous. Most of the mixtures that you come across are heterogeneous. The homogeneous mixtures are mostly in the form of solutions.

The components of a mixture can be separated by using physical means, such as filtration, gravity separation, distillation, chromatography, solvent extraction, fractional crystallisation, etc.

1. Mixture and Its Separation

Learning Objectives

On completion of this topic, you should be able to:

- differentiate mixture and compound.
- apply different techniques to separate mixtures.
- explain the uses of common separating techniques.

A compound is formed when two or more elements chemically combine in a fixed proportion, while a mixture is formed when two or more elements or compounds physically combine in any proportion.

a. Mixture and Compound

Activity 7.1. Investigating mixture and compound

Carry out the following activity and answer the questions that follow. Copy and complete Table 7.1.

Reprint 2024

Materials required

Test tube, magnifying glass, glass rod, watch glass, bar magnet, test tube holder, iron (II) sulphide, iron filings, sulphur powder and carbon disulphide.

Procedure

Table 7.1 *Observing Mixtures and Compounds*

Step	Mixture	Observation	Compound	Observation
1	Mix a spatula each of iron filings and sulphur powder in a watch glass. Examine the mixture carefully using a magnifying glass.		Take few pieces of iron (II) sulphide in a watch glass and observe carefully with a magnifying glass.	
2	Bring a magnet over the mixture of iron filings and sulphur, and observe carefully.		Bring a magnet over iron (II) sulphide. Observe carefully.	
3	Take a spatula of the mixture of iron filings and sulphur in a test tube. Add 5 mL of carbon disulphide to the mixture and observe carefully.		Take a few pieces of iron (II) sulphide in a test tube. Add 5 mL of carbon disulphide on iron (II) sulphide and observe carefully.	

1. Based on the observation of the experiments, describe the differences between a mixture and a compound.
2. Name three mixtures and three compounds that we use in our day-to-day life.

Reprint 2024

b. Separating Mixture

From Activity 7.1, it is evident that the components in a mixture are in physical contact with one another, and can be separated by physical means. The constituents of the mixture retain their individual properties. Some of the techniques used for separating the components of a mixture are filtration, distillation, magnetic separation, chromatography, gravity separation, centrifugation, fractional crystallisation, fractional distillation, solvent extraction, etc.

Filtration

The process of separating the components of a mixture containing an insoluble solid in a liquid by passing the mixture through a porous medium is called **filtration**. Figure 7.1 shows how a filter works.

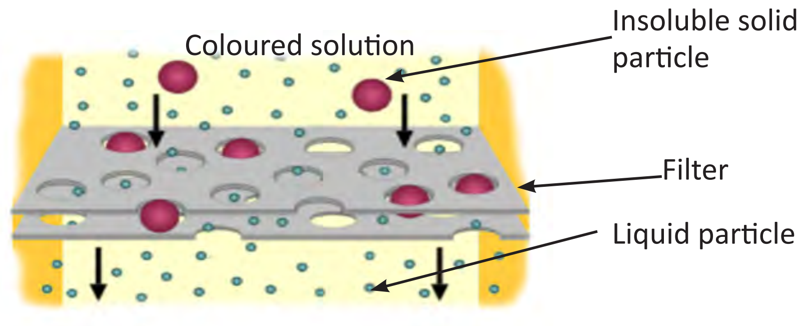


Figure 7.1. Working of a filter.

Filtration is used extensively in our daily life. Figure 7.2 shows some of the uses of filtration.

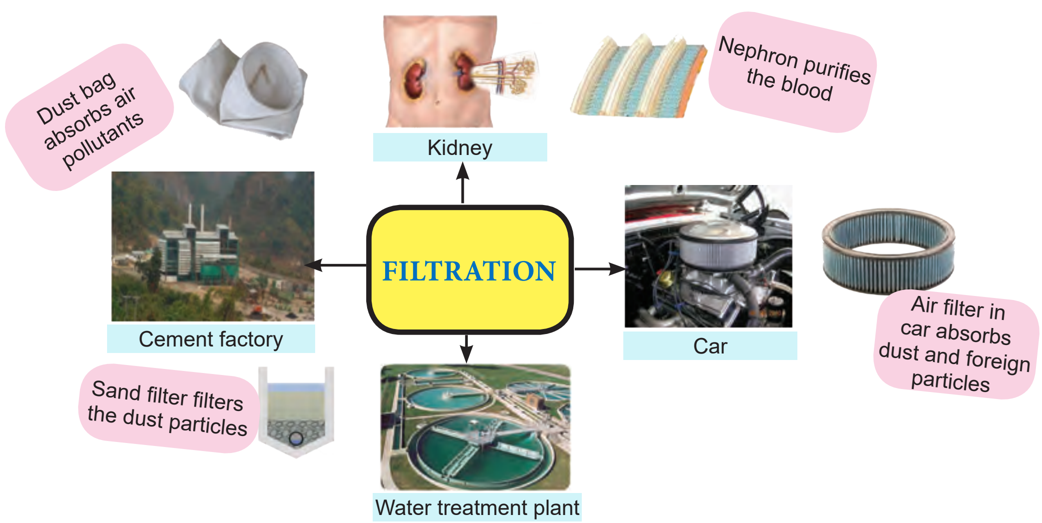


Figure 7.2. Application of filtration.

Distillation

Distillation is a method for purifying liquids and separating mixtures of liquids into their individual components. In this method, the liquid to be separated is evaporated by boiling, and its vapour is collected by condensation.

The three types of distillation are:

Simple Distillation

Simple distillation is used for separating constituents from mixtures in which the boiling points of the components are different. In this method, the hot vapours produced flow into a condenser that cools and condenses the vapours. Figure 7.3 shows a simple distillation set.

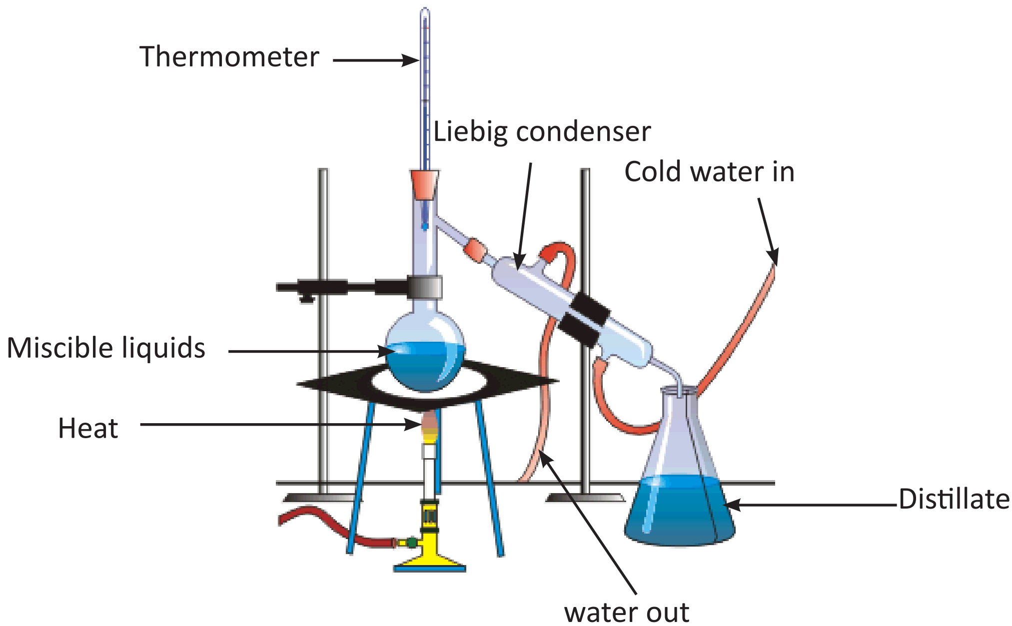


Figure 7.3. Simple distillation.

Simple distillation is used on small scale in our locality and in the laboratory to prepare distilled water. It is used in industries for the production of alcoholic beverages on a large scale. It is also used in desalinisation (separation of salt from water) processes, which involves the production of drinking water from salt water.

Reprint 2024

Steam Distillation

Steam distillation is used to purify mixtures, which have components that decompose at high temperature.

Steam distillation is used for the preparation of perfumes and essential oils such as, lemon grass oil, eucalyptus oil, clove oil, olive oil, etc.

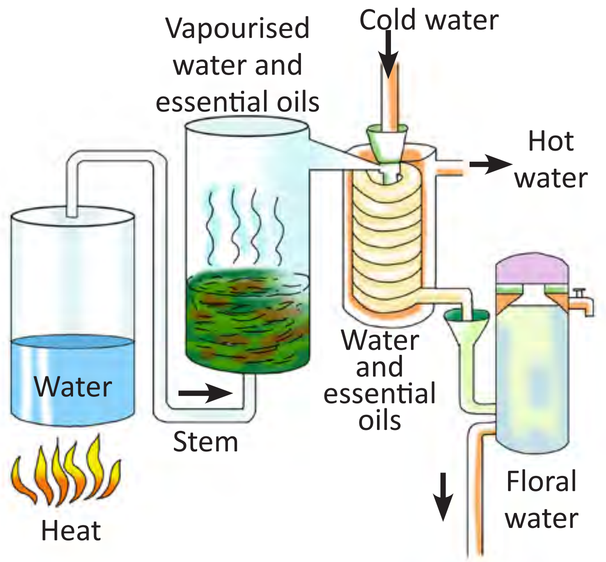


Figure 7.4. Steam distillation.

Fractional Distillation

Fractional distillation is used for separating constituents from mixtures in which the boiling points of the components are different, by using fractionating column.

It is similar to simple distillation, except the same process is repeated in successive cycles.

It is mostly used in petroleum industries to separate different fractions of oil such as kerosene, petrol, diesel, etc., from crude oil.

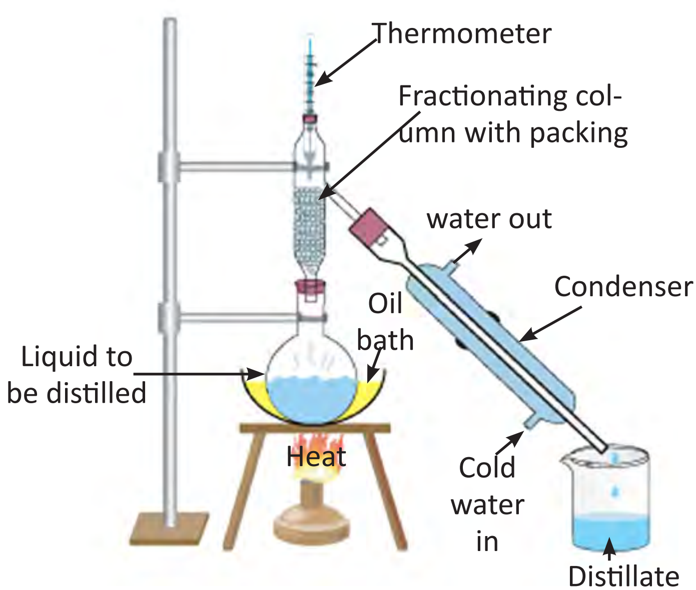


Figure 7.5. Fractional distillation set.

Chromatography

The term chromatography is derived from the Greek word "chroma" meaning colour and "graphy" meaning writing.

A mixture of colours or two or more soluble solids can be separated by chromatography. Chromatography is also used for separation of different dissolved components of a mixture.

Chromatography is classified as column chromatography, gas chromatography and paper chromatography.

Paper Chromatography

In paper chromatography, a strip of chromatography paper acts as a stationary phase, whereas the pure solvent or mixture of solvent is used as the moving phase. The moving phase travels through the chromatography paper by capillary action. **Capillary action** is the ability of a liquid to flow in narrow spaces without the assistance, and opposition to, external forces like gravity.

When a mixture of dyes is applied to the chromatography paper, the paper adsorbs the dye on its surface. The chromatography paper adsorbs the components, whereas the solvent dissolves them. A component, which is highly soluble in the solvent, travels through the paper faster than the component, which is slightly soluble.

Hence, different components in the dyes travel at different speed. This is how components in a dye are separated using paper chromatography. The paper, which contains the components of a mixture separated by chromatography, is called a **chromatogram**.

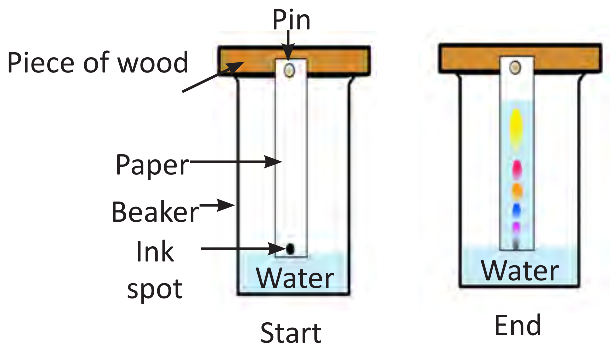


Figure 7.6. Paper chromatography.

Activity 7.2. Separating components of a mixture

Carry out the activity and answer the questions that follow.

Materials required

Chromatography paper, leaf extract, capillary tube, beaker, acetone, glass rod or pencil, paper clips or sellotape, and scissors.

Procedure

Step 1. Cut two strips of chromatography papers of length 10 cm and breadth 4 cm.

Step 2. Draw a horizontal line with a pencil, about 2 cm from the lower end of both the chromatography papers and draw a small circle at the centre of the horizontal line with a pencil.

Step 3. Add a drop of black ink on the pencil mark on one of the chromatography paper strips, and let it dry.

Step 4. Similarly, using a capillary tube, add a drop of leaf extract on the pencil mark on the other strip.

Step 5. Firmly tie the two chromatography paper strips on the glass rod or the pencil using sellotape or paper clips.

Step 6. Pour some acetone in a beaker.

Step 7. Place the strips of chromatography paper separately in the same beaker, in such a way that only the bottom of the papers touches the acetone.

Step 8. Leave the set up for about ten to fifteen minutes without disturbing.

Step 9. Dry the chromatography papers, and observe the patterns formed.

i. How many colours were present in the ink?
ii. Which colour travels the farthest distance? Why?
iii. Why do you dip the base of the strip of chromatography paper with black ink and leaf extract in the acetone?
iv. Compare the two chromatograms.

Column Chromatography

The column chromatography requires a vertical column which can be a glass cylindrical column packed with silica gel. It is used to purify individual chemical

Reprint 2024

compounds from mixture of compounds. The separated components of the mixture is collected through the opening at the bottom of the column as shown in Figure 7.7.

The mixture that is to be separated is placed at the top of the column packing.

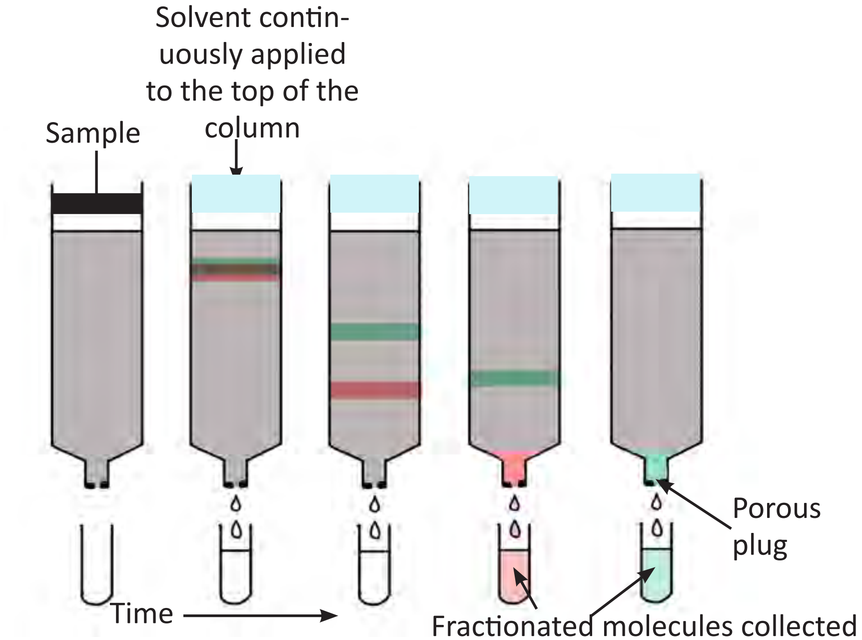


Figure 7.7. Column chromatography.

Open the following link and watch the video on column chromatography.
https://www.youtube.com/watch?v=2R2iq_XR1IY

Applications of Chromatography

Chromatography is used in many fields. Some of its applications include identification of the components in a mixture, crime scene investigation, trace quantities of contaminants such as Dichlorodiphenyltrichloroethane (DDT) in the groundwater, control quality of food in the food industry, and detect drug compounds in urine or other body fluids.

Questions

1. The laboratory assistant in your school has accidentally mixed alcohol with water in a beaker. Unfortunately, the school science laboratory ran out of the alcohol stock, which is required for starch test in the leaf.
   i. If you are asked to help the laboratory assistant in separating the mixture, which method will you use?
   ii. Which component will be separated first? Why?
   iii. Give an example of another mixture, which can be separated by the same method.
2. Use your knowledge of mixture and compound to differentiate between sodium chloride and sodium chloride solution.
3. What is chromatography?
4. Write two applications of chromatography.

WEBLINK

http://www.chemguide.co.uk/analysis/chromatography/paper.html

http://antoine.frostburg.edu/chem/senese/101/matter/chromatography.shtml

Reprint 2024

Exercise

Fill in the blanks.

1. Two liquids having different boiling points can be separated by ....
2. The original substance can be obtained from a .... by physical means.
3. The solvent in a chromatography paper rises due to .... action.
4. Lemon grass oil is extracted by ....

Match items in column A with those in column B.

Column A	Column B
1. Filtration	a. Salt water
2. Fractional distillation	b. Crime scene investigation
3. Simple distillation	c. Muddy water
4. Chromatography	d. Refining crude oil
	e. Lemon grass oil extraction

Answer the following questions.

1. Classify the following as mixture or compound.

   Tap water, sodium nitrate, rust, distilled water, paint, sugar, carbon dioxide, brine, apple juice, petrol, ink, and alcohol.

2. From the following techniques; simple distillation, fractional distillation, filtration, and chromatography, select the suitable method to separate:

   a. the constituent of colouring matter of ink.
   b. petrol from crude oil.
   c. sodium chloride from seawater.
   d. dust particles from the air.

Reprint 2024

3. Draw a labelled diagram of the apparatus you would use to obtain pure alcohol from a mixture of alcohol and water.
4. Draw a flow chart to show how the components of gunpowder (potassium nitrate, carbon and sulphur) can be separated.
5. Figure 7.9 shows the results of a chromatography experiment. 1 and 2 are mixtures. A, B, C, D, E and F are pure substances. The distance travelled by the component of the mixture will be same to that of the pure substance if that pure substance is present in the mixture.

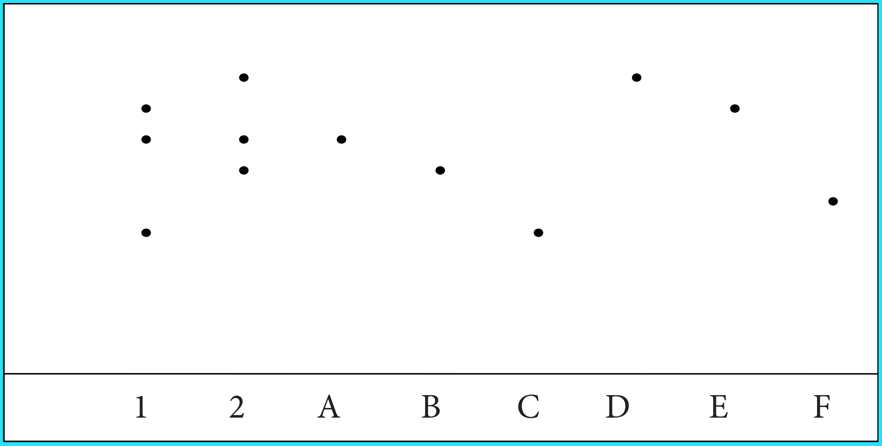


Figure 7.8. Results of chromatography.

i) Which pure substance is:
   a. not there in both the mixtures
   b. in both the mixtures

ii) Which pure substances are there
   a. in mixture 2?
   b. in mixture 1?

6. A student adds a mixture of oil, sand and salt in a beaker of water and stirs. The student stops stirring, and observes that the salt is no longer visible. It is also observed that the oil floats on the top and the sand sinks to the bottom of the beaker.
   a. Why does oil float on water?
   b. Why is salt no longer visible after the stirring?
   c. Identify one way to remove the sand from the mixture in the beaker.

7. Study Figure 7.9 and answer the questions that follow.

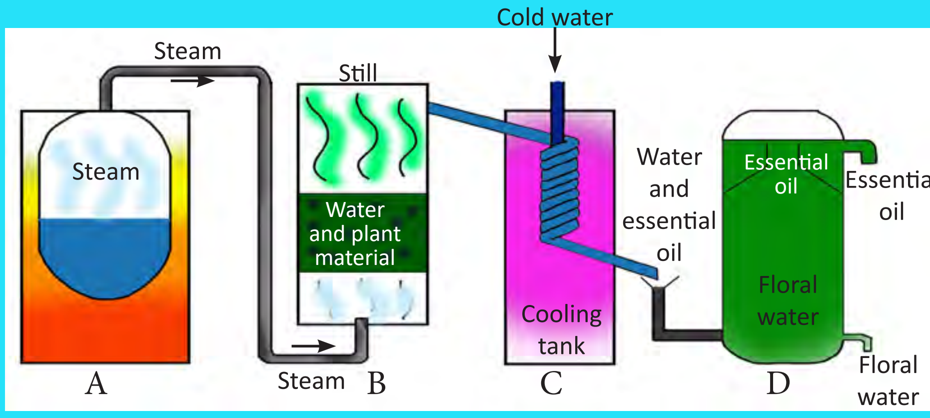


Figure 7.9.

a. Why is this process used instead of fractional distillation for the extraction of essential oil?
b. Why is the condenser in the form of a coil?

Reprint 2024

Chapter 8
Patterns in Chemistry

Chemical compounds can be broadly divided into three categories: acids, bases and salts. Acids are sour in taste, corrosive in nature, and change blue litmus to red. Bases are generally slippery in nature, bitter in taste, and change red litmus to blue. The reaction of acids and bases with other substances helps us to understand their properties and their uses in our lives.

Non-metallic oxides such as oxides of nitrogen, sulphur and carbon, dissolve in rainwater, making rainwater slightly acidic. This leads to acid rain. Acid rain has many implications on the environment.

1. Acid and Base

Learning Objectives

On completion of this topic, you should be able to:

- explain the reaction of acid on metals.
- explain the reaction of base and acid with examples.
- investigate the action of alkali on metal salt.
- apply the knowledge of neutralisation reaction in everyday life.

WEBLINK

http://www.chemtutor.com/acid.htm
http://www.chemguide.co.uk/physical/acidbaseeqia/theories.html
https://www.khanacademy.org/science/chemistry/acids-and-bases

Reprint 2024

a. Acid

The elements which appear on the right hand side of the periodic table are non - metallic in nature. These elements combine with oxygen forming acidic oxides, which dissolve in water to form acids. **An acid** is a substance that dissolves in water to produce hydrogen ions.

Some common acids are hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3), phosphoric acid (H_3PO_4), acetic acid (CH_3COOH), and carbonic acid (H_2CO_3).

Vinegar, fruit juices, and soft drinks that you see in Figure 8.1 are acidic. These liquids are known for their acidic character by their tart, sour, or sharp taste. Many acids are highly corrosive and should not be tasted. One example of a corrosive acid is sulphuric acid (H_2SO_4), which is used in car batteries. Another example of a corrosive acid is hydrochloric acid (HCl), which is used to treat water in swimming pools.

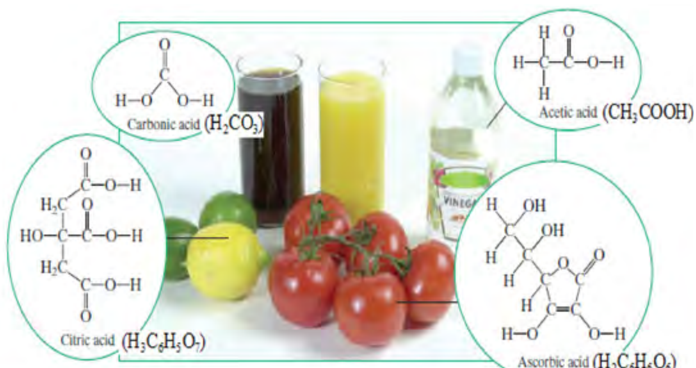


Figure 8.1. Some common acids used in our daily life.

Classification of Acid

Acids are classified into various types based on:

I. Strength

The strength of an acid depends on the degree of ionisation.

Ionisation is the process of breaking down of compounds into their constituent ions. For example HCl breaks down into H^+ and Cl^-

a. Strong acids: These are acids which ionise completely in water.
   For example, HCl, H_2SO_4, HNO_3, etc.
b. Weak acids: These are acids which ionise partially in water.
   For example, CH_3COOH, H_2CO_3, HCOOH, etc.

II. Concentration

a. Concentrated acid: It is an acid having a relatively high percentage of acid in its aqueous solution.

b. Dilute acid: It is an acid having a relatively low percentage of acid in aqueous solution.

Chemical Properties of Acid

Generally, metals react with dilute acids to form their respective salt and give out hydrogen. This is represented by the following equation:

Metal + Acid → Salt + Hydrogen

Calcium + sulphuric acid → calcium sulphate + hydrogen

$Ca + H_2SO_4 \rightarrow CaSO_4 + H_2$

The salt that is produced depends upon the type of acid and the metal that reacts with acid.

Activity 8.1. Exploring the reaction between acid and metal.

Carry out the following activity and answer the questions that follow.

Table 8.1 gives the name of the salt produced in each case by different reactions between acids and metals. Copy and complete the table (Hint – look for the patterns).

Table 8.1 *Reaction of Metals with Acids*

Name of Metal	Name of the Salt formed with the Acid		
	Hydrochloric Acid	**Nitric Acid**	**Sulphuric Acid**
Iron	Ferrous chloride		Ferrous sulphate
Zinc	Zinc chloride	Zinc nitrate	
Magnesium			

i. What can you conclude from the type of salts formed by each acid?

ii. Write down both the word equation and chemical equation for each of the above reactions.

Reprint 2024

Activity 8.2. Investigating the action of acid on carbonates and hydrogen carbonates

Carry out the following activity and answer the questions that follow.

Materials required

Baking soda ($NaHCO_3$), dilute HCl, washing soda (Na_2CO_3), lime water, cork, delivery tube, clamp stand, and test tube.

Procedure

Step 1. Take two test tubes, label them as I and II.

Step 2. Add a spatula of washing soda (Na_2CO_3) in test tube I, and a spatula of baking soda ($NaHCO_3$) in test tube II.

Step 3. Set up your apparatus as shown in Figure 8.2.

Step 4. Add dilute hydrochloric acid to both the test tubes.

Step 5. Pass the gas produced in each case through lime water $Ca(OH)_2$.

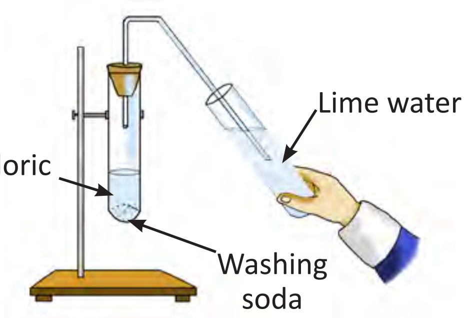


Figure 8.2. Reaction of washing soda with acid.

i. What do you observe? Explain.

ii. Write down both the word and chemical equations for the reactions occurring in test tube I and test tube II.

iii. What can you conclude about the property of acid from this activity?

Reprint 2024

Activity 8.3. Investigating the action of an acid on metal oxide

Carry out the following activity and answer the questions that follow. Copy and complete Table 8.2.

Materials required

Copper (II) oxide, dilute hydrochloric acid, dilute sulphuric acid, watch glass, dropper, and spatula.

Procedure

Table 8.2 *Investigating the Action of an Acid on Metal Oxide*

Exp No.	Procedure	Observation	Inference
1	1. Take a small amount of copper (II) oxide with the help of spatula in a watch glass, and note the colour of CuO. 2. Add a few drops of dilute hydrochloric acid slowly.		Copper (II) oxide reacts with dilute HCl to form copper chloride and water. $CuO + 2HCl \longrightarrow CuCl_2 + H_2O$
2	Repeat the above procedure in Experiment 1 with dilute sulphuric acid.		Copper (II) oxide reacts with dilute H_2SO_4 to form copper sulphate and water.

i. What happens to copper (II) oxide on reacting with acids?

ii. What are the safe ways of disposing the waste after the experiment?

Precaution

Acids are corrosive. Handle with care.

b. Base

In periodic table, the elements which appear on the left hand side are usually metallic in nature. These elements combine with oxygen forming basic oxides which dissolve in water to form base. Bases are oxides and hydroxides of metals, except ammonium hydroxide, which is a non-metallic hydroxide. Bases react with acids to form salt and water. The bases which are soluble in water are called **alkalis**.

Reprint 2024

Some bases are highly corrosive and should not be touched or tasted. For example, sodium hydroxide and potassium hydroxide.

Classification of Base

Bases are classified into following types based on:

I. Strength

i. Strong bases:- These are bases which ionise completely in aqueous solution.

   For example, NaOH and KOH

ii. Weak bases:- These are bases which ionise partially in aqueous solution.

   For example, NH_4OH, and $Ca(OH)_2$

II. Concentration

Concentrated base: It is a base having a relatively high percentage of base in its aqueous solution.

Dilute base: It is a base having a relatively low percentage of base in its aqueous solution.

Chemical Properties of Base

I. Base reacts with acid to form corresponding salt and water.

Base + Acid → Salt + Water

a. Sodium hydroxide + Sulphuric acid → Sodium sulphate + Water

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

b. Sodium oxide + Hydrochloric acid → Sodium chloride + Water

$$Na_2O + 2HCl \rightarrow 2NaCl + H_2O$$

II. Strong alkali absorbs carbon dioxide when they come in contact with the air and forms the corresponding metal carbonates and water. Thus, alkalis are generally stored in air-tight containers.

Alkali + Carbon dioxide → Metal carbonate + Water

a. Sodium hydroxide + Carbon dioxide → Sodium carbonate + Water

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

b. Potassium hydroxide + Carbon dioxide → Potassium carbonate + Water

$$2KOH + CO_2 \rightarrow K_2CO_3 + H_2O$$

Reprint 2024

Figure 8.3. Some common substances that contain base.

Do You Know?

Some bases are soapy substances, i.e. they are slippery to touch because base reacts with oil to form soap. Since our skin contains oil in the form of fat, therefore when we touch base such as NaOH, a reaction takes place and soapy solutions are formed.

Activity 8.4. Investigating chemical reaction of bases

Carry out the following activity and answer the questions that follow. Copy and complete Table 8.3.

Materials required

Ferrous sulphate, sodium hydroxide, copper nitrate, potassium hydroxide, ammonium chloride, red litmus paper, spirit lamp, dropper, match box, test tube, test tube holder, distilled water, and spatula.

Procedure

Table 8.3 *Investigating Chemical Reactions of Bases*

Exp. No.	Procedure	Observation	Inference
1	1. Dissolve a spatula of ferrous sulphate in 5 mL of water in a test tube. 2. Dissolve a spatula of sodium hydroxide in 5 mL of water in another test tube. 3. Add 2-3 drops of sodium hydroxide solution to the ferrous sulphate solution.		An insoluble metal hydroxide (ferrous hydroxide) is formed.

2	1. Dissolve a spatula of copper nitrate in 5 mL of water in a test tube. 2. Dissolve a spatula of potassium hydroxide in 5 mL of water in another test tube. 3. Add 2-3 drops of potassium hydroxide solution to the copper nitrate solution		An insoluble metal hydroxide (copper hydroxide) is formed.
3	1. Dissolve 1 spatula of ammonium chloride in 5 mL of water in a test tube. 2. Dissolve one spatula of sodium hydroxide in another test tube. 3. Add 2 – 3 drops of sodium hydroxide solution to the test tube containing ammonium chloride solution. 4. Warm it gently. 5. Bring a moist red litmus paper near the mouth of the test tube. 6. Waft the air from the mouth of the test tube towards the nose and smell it.		The gas is basic in nature. Ammonium chloride + Sodium hydroxide → Sodium chloride + Water + Ammonia $NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$

1. Write the word equations for the final reactions in experiment no. 1 and 2.
2. Write the balanced chemical equations for experiment no.1 and 2.
3. What conclusion can you draw from the experiments about the properties of bases?

c. Neutralisation

The reaction in which an acid reacts with the base to form salt and water is called **neutralisation** reaction.

In general, a neutralisation reaction can be written as:

Base + Acid → Salt + Water

Sodium hydroxide	+	Hydrochloric acid	→	Sodium Chloride	+	Water
$NaOH$	+	HCl	→	$NaCl$	+	H_2O
Ammonium hydroxide	+	Sulphuric acid	→	Ammonium sulphate	+	Water
$4NH_4OH$	+	$2H_2SO_4$	→	$2(NH_4)_2SO_4$	+	$4H_2O$

A **salt** is a compound formed by the displacement of hydrogen of an acid by a metal, or a positive radical.

Activity 8.5. Observing neutralisation reaction

Carry out the following activity and answer the questions that follow.

Materials required

Sodium hydroxide, dilute hydrochloric acid, lime water, test tube, phenolphthalein, delivery tube, conical flask, droppers, measuring cylinder, and glazed tile.

Precaution

HCl and NaOH are corrosive. Handle with care.

Procedure

Procedure I

Step 1. Take 1mL of lime water in a test tube.

Step 2. Add a drop of phenolphthalein to it. Shake the test tube till permanent pink colour appears.

Step 3. Take a delivery tube and blow air gently into the lime water for about 2 minutes.

Step 4. Observe and record the change, if there is any.

Procedure II

Step 1. Dissolve a pellet of sodium hydroxide in 20 mL of water in a conical flask.

Step 2. Place the conical flask on a white tile.

Step 3. Add a drop of phenolphthalein in the sodium hydroxide solution. Gently shake the solution till permanent pink colour appears.

Step 4. Now, add dilute hydrochloric acid into the same conical flask drop by drop. Shake continuously as drops of dilute hydrochloric acid are added, till till you observe the change.

Step 5. Record the change.

i. What is the colour of sodium hydroxide solution and lime water before and after adding phenolphthalein?

ii. What can you say about the nature of lime water and sodium hydroxide?

iii. What is the purpose of phenolphthalein in Procedure I?

iv. Why does the pink colour of lime water disappear as you bubble air through it in Procedure I?

iv. Write down the balanced chemical equation for the reaction:

  a. after bubbling air through the lime water.

  b. after the disappearance of pink colour of sodium hydroxide.

v. What can you conclude from Procedure I and Procedure II?

Application of Neutralisation Reaction

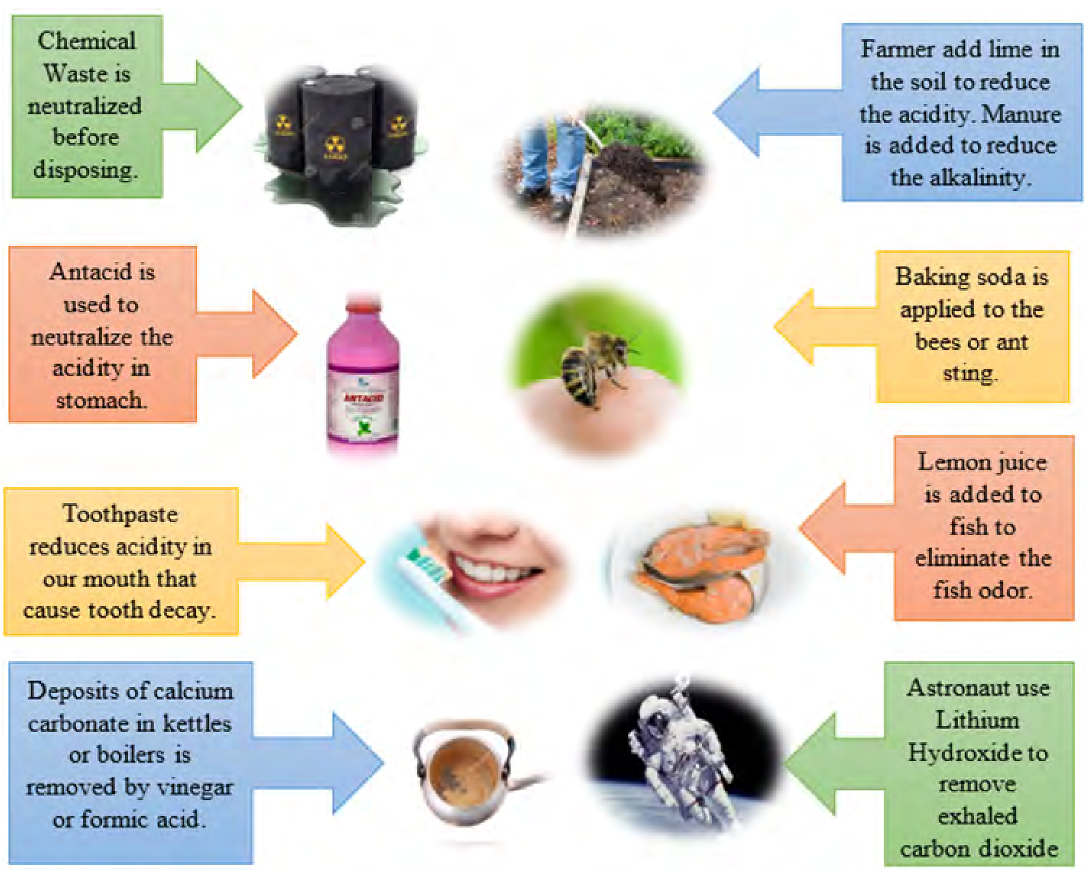


Figure 8.4 Application of neutralisation reaction.

Questions

1. With the help of a balanced chemical equation, explain what happens when
   a. zinc metal is treated with dilute sulphuric acid.
   b. sodium is treated with dilute hydrochloric acid.
   c. calcium oxide is treated with dilute nitric acid.
2. Some people rinse their freshly shampooed hair in diluted lemon juice or vinegar. Why is this done?
3. Dorji was provided with four colourless solutions. He was asked to identify the type of solution using universal indicator. Dorji's finding is recorded in Table 8.4. Use the information from the Table 8.4 to answer the questions that follow.

Table 8.4

Solution	Colour Change of Universal Indicator
A	Red
B	Blue
C	Purple
D	Yellow

i. What type of solutions are solution A and solution C?

ii. Which solutions do you think are:
   a. acidic in nature?
   b. basic in nature?

iii. What will happen if equal volume of solution B and solution D are mixed?

WEBLINK

http://www.chem.memphis.edu/bridson/FundChem/T16a1100.htm
http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa/acids/acidsbasesrev2.shtml

Reprint 2024

2. Acid Rain

Learning Objectives

On completion of this topic, you should be able to:

- define acid rain.
- explain the causes of acid rain.
- explain the effects of acid rain on environment.
- describe the ways to reduce acid rain.

Activity 8.6. Which gases in the air change the pH of water?

Carry out the following activity and answer the questions that follow. Copy and complete Table 8.5.

Materials required

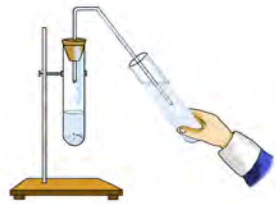
Zinc metal, calcium carbonate, lead nitrate, hydrogen peroxide, manganese dioxide, pH paper or universal indicator, measuring cylinder, dilute hydrochloric acid, test tubes, cork, delivery tube, clamp stand, spatula, spirit lamp, match box and distilled water.

Procedure

Table 8.5 *Investigating Nature of Gases*

Gas	Procedure	Colour Change with pH Indicator	Result
Carbon dioxide Precaution : *[Acids are corrosive in nature, so handle it carefully.* *Dip the delivery tube well inside the distilled water]*	1. Take a spatula of calcium carbonate in a test tube. 2. Add about 2 mL of dilute HCl into the same test tube and pass the gas through distilled water in another test tube as shown in the Figure 8.8. 3. Add the pH indicator in the second test tube.		

Reprint 2024

	 *Figure 8.8.*		
Hydrogen Precaution : *[Acids are corrosive in nature, so handle it carefully.* *Dip the delivery tube well inside the distilled water]*	4. Take a piece of zinc metal in a test tube. 5. Add about 2 mL of dilute HCl into the same test tube and pass the gas through distilled water in another test tube. 6. Add the pH indicator in the second test tube.		
Nitrogen dioxide Precaution : *[The experiment should be carried out in a well- ventilated room.* *The brown fumes of nitrogen dioxide should not be inhaled.* *Avoid putting hot test tube in cold water.* *Dip the delivery tube well inside the distilled water]*	1. Take a spatula of lead nitrate in a test tube. 2. Set up the experiment as shown in the Figure 8.9. 3. Heat the test tube containing lead nitrate and pass the gas through distilled water in another test tube. 4. Add the pH indicator in second test tube.  *Figure 8.9.*		

Reprint 2024

Oxygen *Precaution :* *[Dip the delivery tube well inside the distilled water]*	1. Take half a spatula of manganese dioxide in a test tube. 2. Set up the experiment as shown in the Figure 8.7. 3. Add 2 mL of hydrogen peroxide to the same test tube and pass the gas through distilled water in another test tube. 4. Add the pH indicator in the second test tube.		

i. Which solutions are acidic in nature? Why?

ii. Which solution has no effect on the pH indicators?

iii. Which of the gases produced have adverse impact on the environment? Why?

Humans have been using many things found in nature for fulfilling their basic needs since the beginning of human civilization. To make living easier, humans invented many things that consume energy. Most of the energy comes from burning fossil fuels such as coal, oil, and natural gas. Burning of the fossil fuels and waste produces harmful gases such as sulphur dioxide, nitrogen oxides, carbon monoxide, etc. Natural sources like volcanoes, forest fires and lightning also add these harmful gases into the atmosphere causing air pollution. Air Pollution is the addition of harmful gases to the atmosphere resulting in damage to the environment, human health, and quality of life. One of the consequences of air pollution is acid rain. **Acid rain** is any form of rain that is more acidic than normal with pH lower than 5.6.

a. Causes of Acid Rain

The main causes of acid rain are gases such as sulphur dioxide, carbon dioxide, and nitrogen oxides. These gases dissolve in rain water in the atmosphere to form acid. The equations given below show the formation of acid.

$2SO_2 + O_2 \rightarrow 2SO_3$ (sulphur trioxide)

$SO_3 + H_2O \rightarrow H_2SO_4$ (sulphuric acid)

$2NO + O_2 \rightarrow 2NO_2$ (nitrogen dioxide)

$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$ (nitric acid)

$CO_2 + H_2O \rightarrow H_2CO_3$ (carbonic acid)

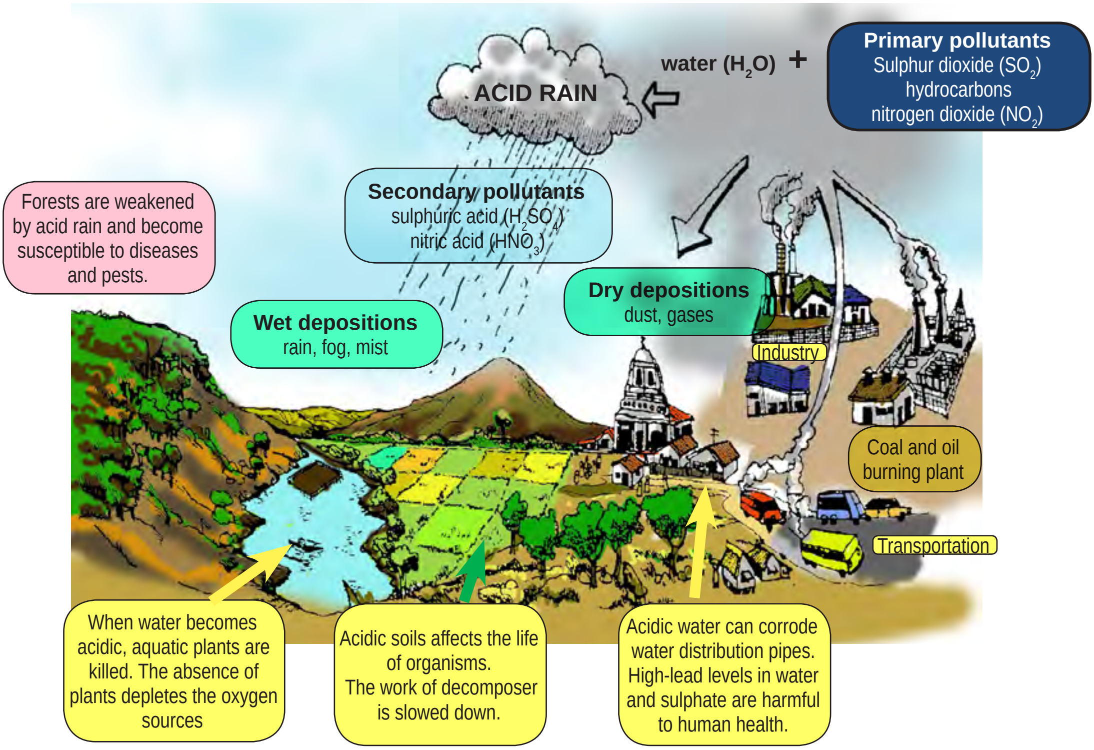


Figure 8.10. Acid rain and its impacts.

These acids fall back to the Earth along with the rain water causing harm to the environment.

b. Harmful Effects of Acid Rain

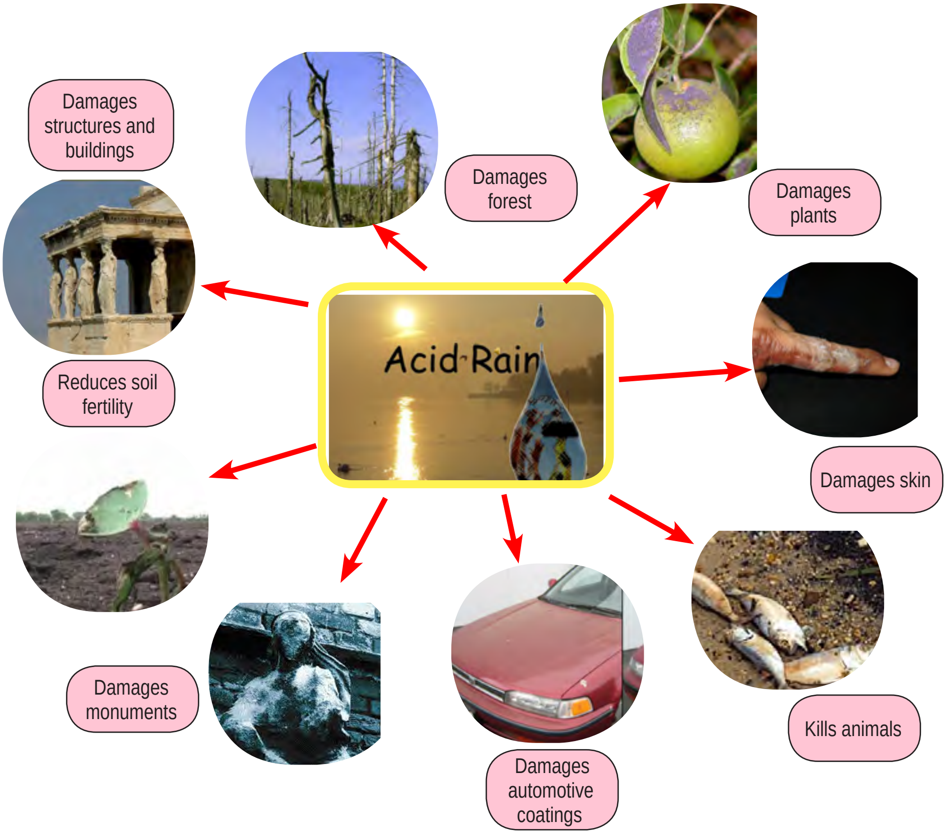


Figure 8.11. Harmful effects of acid rain.

c. Acid Rain and Chemical Weathering

The breaking down of rocks by chemicals is called chemical weathering. Chemical weathering is usually brought by chemical reactions such as carbonation, hydration, oxidation, and ion exchange in solution.

The process of dissolving carbon dioxide in water, and thereby reacting with the minerals in the rock is called carbonation. The dissolved carbon dioxide in the rain water forms carbonic acid. This acid reacts with rocks such as limestone (CaCO3) and dolomite (CaCO3.MgCO3) forming soluble calcium bicarbonates as shown in the reaction below.

Carbon dioxide + Water → Carbonic acid

$$CO_2 + H_2O \rightarrow H_2CO_3$$

Carbonic acid + Calcium carbonate → Calcium bicarbonate

$$H_2CO_3 + CaCO_3 \rightarrow Ca(HCO_3)_2$$

Carbonation leads to the formation of limestone pavements and limestone caves.

Limestone pavement is the natural land form consisting of a flat cut surface of exposed limestone that resembles an artificial pavement as shown in Figure 8.12.

When the acid rain falls on the limestone, it particularly attacks the weaker joints of the limestone rock, resulting in the formation of limestone pavements.

Figure 8.12. Limestone pavement.

When the acid rain sinks into the ground, it may come in contact with limestone. Acid rain reacts with limestone and erodes the limestone leading to the formation of large space called **limestone cave**. You can find limestone caves in different parts of our country such as Pagli (Samtse), Kalesor (Chukha), Nganglam (Pemagatshel), Khangku (Paro), and Barshong (Tsirang).

d. Acid Acid Rain and Corrosion

Corrosion is defined as the dissolving and wearing away of compounds by chemical reaction. Many materials made from limestone and marble get corroded over the time. Corrosion of these materials is brought about by acid rain. Acid rain reacts with the calcium carbonate present in limestone and marble to form calcium sulphate (gypsum), which then flakes off.

$$\underset{\text{Limestone}}{CaCO_3} + H_2SO_4 \rightarrow \underset{\text{gypsum}}{CaSO_4} + CO_2 + H_2O$$

Corrosion of limestone and marble by acid rain can result in the loss of art work, and increases the cost of maintaining them. Figure 8.13 shows an example.

Figure 8.13. Corrosion of art work.

Measures to Minimize Acid Rain

1. Minimise the use of fossil fuels.
2. Plant trees, as trees absorb polluted air.
3. Educate people through awareness campaigns on the harmful effects of acid rain.
4. Install air filters in the chimneys in the factories to minimize harmful gases.

Reprint 2024

Activity 8.7. To Investigating corrosion

Carry out the following activity and answer the questions that follow.

Materials required

Egg shell, dilute sulphuric acid, beaker, and water.

Procedure

Step 1. Take some pieces of egg shell in two beakers.

Step 2. Pour 5 mL of dilute sulphuric acid in one of the beakers and 5 mL of water in the other beaker.

Step 3. Observe the changes.

i. What happens to the egg shell?
ii. What do you conclude from the observation?
iii. Relate the effect of dilute sulphuric acid on the egg shell to the effects of acid rain on environment.

Questions

1. What are some of the causes of acid rain?
2. Why is acid rain a particular interest of study?
3. What are the main chemicals in air pollution that form acid rain?
4. How can we reduce the production of harmful gases that form acid rain?

WEBLINK
http://www.epa.gov/acidrain/

Reprint 2024

Fill in the blanks.

1. When sulphur trioxide dissolves in water, __________ acid is formed.
2. If a solution has a pH greater than 7, it is called __________.
3. Farmers neutralise the acidity of the soil by adding calcium hydroxide. This process is called __________.
4. When metal oxides react with acid, they form __________ and __________.
5. A compound which produces OH^- ions in solution is called __________.

Check whether the following statements are True or False. Correct the false statements.

1. The chemical composition of egg shell is calcium carbonate.
2. Acid reacts with metal hydrogen carbonates to form salt and carbonic acid.
3. The acidic oxides dissolve in water to form acids.
4. The acidic oxides are formed by the elements present on the right hand side of the periodic table.
5. Carbon dioxide is liberated by the action of sodium hydroxide with ammonium chloride.

Match the following

Column A	Column B
1. Oxides of nitrogen, sulphur and carbon dissolve in rain water.	A. Neutralisation
2. Calcium carbonate and magnesium carbonate.	B. Weathering
3. Action of carbonic acid on limestone.	C. Dolomite
4. Reaction between acid and base.	D. Acid rain
5. Breaking down of rocks	E. Carbonation
	F. Gypsum

Reprint 2024

Multiple Choice Questions

1. When sodium hydroxide reacts with hydrochloric acid, the salt produced is
   A. sodium chloride.
   B. sodium sulphate.
   C. sodium carbonate.
   D. sodium chlorate.
2. Oxides of nonmetal can dissolve in water to produce an acid. Which of these elements will not produce an acid?
   A. Sulphur.
   B. Nitrogen.
   C. Carbon.
   D. Hydrogen.
3. Tashi took a metal in a test tube and added an acid. Effervescence was observed. Tashi collected the gas and tested with a light splint. The gas produced a pop sound. Therefore, the gas produced in the reaction is
   A. water vapour.
   B. hydrogen.
   C. oxygen.
   D. carbon dioxide.
4. Which amongst the following activities will lead to the formation of acid rain?
   A. planting trees.
   B. riding bicycle.
   C. driving a petrol car.
   D. driving an electric car.
5. If equal quantities of hydrochloric acid and sodium hydroxide solution are mixed, what will be the nature of the final solution?
   A. Basic.
   B. Acidic.
   C. Neutral.
   D. Alkali.

Reprint 2024

6. A student takes a spatula each of bases W, X, Y, and Z in four different test tubes. Then she adds water over the bases. She observes that the bases W and Z dissolve in the water, while the bases X and Y do not. The student concludes that the bases W and Z are

   A. W and X.

   B. W and Z.

   C. X and Z.

   D. X and Y.

7. Which one of the following statements about acids is NOT correct??

   A. Acids produce hydrogen ions in solution.

   B. Acids produce hydroxyl ions in solution.

   C. Acids are generally corrosive.

   D. Acids are sour in taste.

Answer the following questions.

1. Mention at least two measures to reduce the acid rain.
2. What are the effects of acid rain on the environment and on building materials?
3. Calcium carbonate is the major component of limestone and marble. Sulphuric acid is one of the major components of acid rain. Write a balanced chemical equation that shows how sulphuric acid reacts with calcium carbonate.
4. Dawa ate junk food at breakfast and worried about the examination, which combined to give her an annoying case of acid indigestion. Suggest some ways of reducing the indigestion.

Reprint 2024

5. Table 8.6 provides some information about bee stings, wasp stings and substances that can relieve pain from the stings.

Table 8.6

Substance	Chemical Substance
Bee sting	Contains an acid
Wasp sting	Contains an alkaline irritant
Vinegar	A weak acid
Baking soda	A alkali when dissolved

   a. Which substance would be the best to rub onto a wasp sting?
   b. How will this substance ease the pain?

7. What is the application of neutralisation in the field of agriculture?
8. Why do astronauts use lithium hydroxide when they go into space?
9. Explain the pH difference between acid rain and pure water.
10. After using soap to wash dishes by hand, it is sometimes difficult to keep your hands from remaining slick. Explain why rinsing your hands in lemon juice would make them less slick.

Chapter 9
Force and Motion

Throughout our lives, forces have been acting on us even though we usually do not notice them. The gravitational force of the Earth keeps us on the surface of the Earth. We are so used to gravity that we do not notice it, though gravity is present along with other forces like a stretch, squeeze, friction, etc. These forces explain why a marble falls faster than a piece of paper, and why weights differ at different places.

1. Linear Motion

Learning Objectives

On completion of this topic, you should be able to:

- compare speed and velocity.
- interpret displacement-time graph.
- describe the effects of gravity on mass and weight.

Unbalanced forces acting on a body can make a body to move, stop, and change the shape or motion of a moving body. The body always moves along the direction of resultant force under the influence of unbalanced forces. When unbalanced forces act on a body and the motion of the body is along the straight line, it is called linear motion or translational motion.

a. Speed and Velocity

The speed of any moving body tells us the distance covered by the body in a unit time, but does not indicate the direction of the body. For example, if a car is at a speed of 50 km per hour, it covers a distance of 50 km in 1 hour. In this case, the direction of the car is unknown. However, when the body is moving with speed in a defined direction, then the speed is called velocity. In other words,

Reprint 2024

speed in a particular direction is called velocity. The shortest distance from the initial position to final the position is called displacement. Therefore, velocity is the rate of change of displacement. Thus, mathematically, velocity of a moving body along the direction of resultant force is given by

$$Velocity = \frac{Displacement}{Time} = \frac{m}{s} = ms^{-1}$$

Example 9.1

In a race, Pema covers the distance as shown in the Figure 9.1. The speed and the velocity is given in Table 9.1.

Figure 9.1. Distance covered by Pema.

Table 9.1.

Position	Distance	Displacement	Time taken	Speed = $\frac{s}{t}$	Velocity = $\frac{d}{t}$
A to B	200 m	150 m towards East	50 s	4 ms^{-1}	3 ms^{-1} towards East
B to C	50 m	50 m towards East	10 s	5 ms^{-1}	5 ms^{-1} towards East

The total displacement = 150m + 50m =200 m towards East

Total time taken = 50s + 10s = 60s

Therefore, $$Average\ Velocity = \frac{Total\ Displacement}{Total\ Time\ Taken} = \frac{m}{s} = ms^{-1}$$

$$= \frac{200m}{60s} = 3.33ms^{-1}\ towards\ East$$

Reprint 2024

Activity 9.1. Finding speed and velocity

Study Figure 9.2 carefully and complete Table 9.2

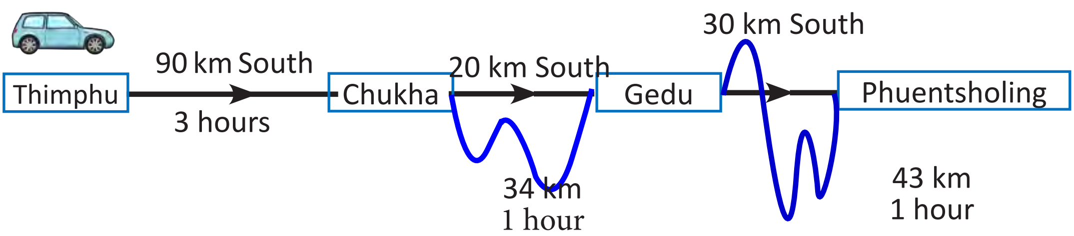


Figure 9.2. Journey from Thimphu to Phentsholing.

Table 9.2

Position	Distance Covered	Displacement Covered	Time Taken	Speed = $\frac{s}{t}$	Velocity = $\frac{d}{t}$
Thimphu to Chhukha			3 hours	30 km/h	
Chhukha to Gedu	34 km				20 km/h towards East
Gedu to P/ling		30 km towards south	1 hour		

Questions

1. Wangchuk participated in the 'Move for Health' walk. He covered a distance of 10 km due west in 1 hour.
   i. What was the walking speed of Wangchuk?
   ii. How long will he take to cover a distance of 833 m due west, if he walks with the same speed?
   iii. How much time will he take to cover 1500 m to the east, if he walks with the velocity of 10 m/s due east?
2. The distance between the Earth and the Moon is 384,400 km. How long does the rocket travelling with the velocity of 3,000 km/h take to reach the Moon?

Reprint 2024

Activity 9.2. Interpreting displacement time graph

Open the URL https://www.geogebra.org/m/AjWXqFVM#material/ZSeF7uCc) and use simulation to record time and displacement values in spreadsheet.

Answer the following questions.

i. Which part of the graph shows that the velocity of the car is zero in Traffic: Velocity 1? Why?
ii. What happens to the car after six seconds in Traffic: Velocity 2? Why?
iii. Calculate the average velocity of blue and red car in Traffic: Velocity 3.
iv. Interpret the graph for red car in Traffic Velocity 10.

When a body moves away from its initial position, the displacement is positive therefore velocity is also positive. The velocity of the body is negative if the body moves towards its initial position. The velocity of a stationary body is zero because the displacement is zero.

Speed is the rate of change of distance; whereas, velocity is the rate of change of distance in a given direction. Quantity which has only magnitude is called **scalar quantity**. Examples of scalar quantities are: distance, length, time, energy, power, work, etc. Velocity is a **vector quantity**, as it has both magnitude and direction. All the quantities that have both magnitude and direction are vector quantities. Examples of vector quantities are: acceleration, force, weight, displacement, etc.

b. Acceleration due to Gravity

Our earth attracts all the objects toward its centre by a force called **gravity.** This force acting on a mass of a body is known as its **weight**. Weight varies from place to place with the force of gravity. The force of gravity is more on the places closer to centre of the Earth. The force of gravity produces acceleration when objects fall under its influence. This is called **acceleration due to gravity**. It is denoted by letter 'g'. The value of 'g' of the Earth is 9.8 ms^{-2} (approximately 10 ms^{-2}). TThis means that every second an object is in free fall, gravity will cause the velocity of the object to increase 9.8 m/s.

The objects falling from greater height reach the ground with higher velocity than those falling from lesser height. The difference in velocities of the falling objects is due to the force of gravity.

Reprint 2024

The acceleration due to gravity of other planets and the Moon is different. Larger the mass of planet, greater is the acceleration due to gravity.

Factors affecting acceleration due to gravity

1. **Latitude** – The Earth is slightly flattened at poles, therefore, object at the poles are closer to centre of the Earth. Closer the object to the poles, more is the acceleration due to gravity; closer the object to the equator, lesser is the acceleration due to gravity.

Table 9.3 *Measurement of 'g' at Different Latitudes*

Latitude/ Degrees	g [ms^{-2}]
0	9.7804
15	9.7838
30	9.7933
45	9.8062
60	9.8191
75	9.8286
90	9.8321

Table 9.3 shows that the weight of a given mass varies over the surface of the Earth from 0 degree to 90 degree latitude. The differences in 'g' with the increase in latitude is negligible. Therefore, an average value of 'g' is taken as 9.8 ms^{-2}.

2. **Altitude** – With the increase in altitude, the acceleration due to gravity decreases and vice versa. The red arrow in Figure 9.3. shows the direction of increase in altitude. As you go away from the surface of the Earth, the value of 'g' decreases.

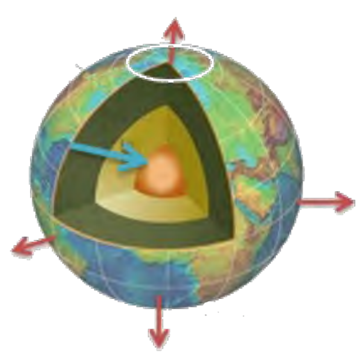


Figure 9.3. Centre of the Earth.

Reprint 2024

The Table 9.4 shows the value of 'g' at various locations from the Earth's center.

Table 9.4 *Variation of 'g' with Altitude*

Location	Distance from Earth's Center (m)	Value of g (ms^{-2})
Earth's surface	6.38×10^6	9.8
1000 km above surface	7.38×10^6	7.33
5000 km above surface	1.14×10^7	3.08
10000 km above surface	1.64×10^7	1.49
15000 km above surface	5.64×10^7	0.13

From Table 9.4, it is evident that acceleration due to gravity of the Earth is felt only to a certain height. Beyond the distance of 50,000 km into space from the surface of the Earth, the acceleration due to gravity is not felt.

3. **Depth** – If we go deeper inside the Earth's surface towards the centre of the Earth, the acceleration due to gravity will decrease, as indicated by the blue arrow in Figure 9.3. The value of acceleration due to gravity at the centre of the Earth is zero.

c. Effect of Gravity on Mass and Weight

Activity 9.3. Relating mass and force of gravity

Complete Table 9.5 and answer the questions that follow.

Table 9.5

Earth 'g'= 10 ms^{-2}		Jupiter 'g' = 24.79 ms^{-2}		Moon 'g' = $\frac{1}{6} \times 10\ ms^{-2}$		Unknown planet 'g'= 3.711 ms^{-2}	
Mass (kg)	Weight = mg (N)	Mass (kg)	Weight = mg (N)	Mass (kg)	Weight = mg (N)	Mass (kg)	Weight = mg (N)
40		40		40		40	

Reprint 2024

i. Which quantity remains constant in Table 9.5?
ii. Which quantity changes from planet to planet in Table 9.5? Give reason.
iii. What conclusion can you draw from Table 9.5?

The force of attraction between two bodies is determined by their masses and the distances between them. Greater the masses, more is the force of attraction and vice versa. The Sun has the largest mass in the solar system, therefore, all the heavenly bodies revolve around the Sun in our solar system.

The diameter of the Moon is 3480 km which is 27% of the Earth's equatorial diameter of 12,756 km. The mass of the Moon is 1.23% (about 1/80th) of the mass of the Earth. So the overall composition of the Moon is quite different from that of the Earth. The acceleration due to gravity on the Moon's surface is 1.62 m/s^2, nearly $\frac{1}{6}^{th}$ of the acceleration due to gravity on the Earth surface.

WEBLINK
http://physics.info/motion-graphs/
http://www.calculatorsoup.com/calculators/physics/displacement_v_a_t.php

Reprint 2024

Questions

1. Table 9.6 shows the displacement of a marathon runner at different intervals. Use spread sheet to plot a displacement -time graph for the data.

   Table 9.6

Location of the Runner	Displacement (km)	Time (min)
Start point A	0	0
Start point A to B	10	30
B to C	5	15
C to D	15	40
D to Finish point E	10	25

   i. What is the velocity of the runner between C and D?

   ii. When did the runner run with the highest speed?

2. A man weighs 600 N on the Earth. What would be his approximate weight on the Moon?
3. An object has a mass of 20 kg. What is its weight on the Earth and on the Moon?

Reprint 2024

2. Fluid Friction

Learning Objectives

On completion of this topic, you should be able to:

- define fluid friction.
- investigate the effects of friction due to fluids in moving objects.

Friction is the force that opposes the motion between the two surfaces which are in contact with each other. For instance, when an object moves under the action of a force, it comes to rest after some time due to friction. The friction on a moving body depends on the types of surfaces in contact.

Friction in the moving parts of an object is reduced by applying lubricants, polishing and by use of wheels. Friction can be also overcome by changing the shape of an object.

Take a sheet of paper and cut it into equal halves. Make a paper plane using one of the halves and keep the other half as it is. Take turn to throw both the papers applying equal force. Which paper moves smoothly? Why?

Activity 9.4. Streamlined body reduces friction

Materials required

Two identical paper clips, water, aluminum foil, measuring cylinder and sellotape.

Procedure

Step 1. Straighten one end of both the paper clips.

Step 2. Cut two aluminium sheets of 10 cm x10 cm.

Step 3. Wrap one of the aluminum foils around the stretched end of the paper clip as shown in Figure 9.4. Name it as clip A.

Step 4. Wrap another aluminum foil into the shape of a disc and fix it on the stretched end of the other paper clip using sellotape as shown in Figure 9.4. Name it as clip B.

Step 5. Fill the cylinder with water .

Step 6. Slowly drop both the paper clips in the cylinder at the same time.

Step 7. Observe what happens.

A B

Figure 9.4. Aluminium on clip.

Questions

1. What is different between Clip A and Clip B?
2. Which paper clip drops faster in water?
3. Why are the paper clips not moving with the same speed?
4. What can you conclude from this activity?

A body moving through a fluid experiences a **drag force** called **fluid friction.** Fluid friction is a force acting opposite to the relative motion of any substance moving in a fluid. It exists between two fluid layers, or a fluid and a solid surface. This is mainly caused by the **viscosity** of the fluid. The fluid which is thick and resists its flow is said to be viscous fluid. For example, honey is more viscous than water.

Fluids offer resistance that oppose the motion of a body moving through them. As a result, friction is produced between the moving body and the surface of the fluid in contact. The degree of friction due to fluid is determined by the shape of the moving body and the viscosity of the fluid. Therefore, the bodies moving through fluids have special shape to reduce fluid friction. These bodies are called **streamlined bodies**. Streamlined bodies gradually taper to a point or sharp edge, and are roughly aligned with the flow direction of fluid. For example, fish and aeroplane have streamlined bodies. Thus, streamlined bodies overcome friction and move faster in fluids. On the contrary, blunt shaped bodies are called non-streamlined bodies or **bluff bodies**. For example, a brick which has rectangular shape, has bluff body and it experiences more friction.

Reprint 2024

Questions

Aeroplane

Shark

Racing car

Jelly fish

Truck

Rocket

Boat

Can

Figure 9.5.

1. Study the picture in Figure 9.5 and sort them as per their shape in Table 9.7.

Table 9.7

Streamline	Bluff

2. Give two examples of bodies that you see in daily lives, which are streamlined to reduce friction.

WEBLINK

http://www.infoplease.com/encyclopedia/science/friction-the-nature-fluid-friction.html
http://physics.tutorvista.com/forces/fluid-friction.html
http://petrowiki.org/Fluid_friction
http://www.darvill.clara.net/enforcemot/friction.htm

Reprint 2024

3. Force and Pressure

Learning Objectives

On completion of this topic, you should be able to:

- explain the term pressure.
- calculate pressure using the expression $P = \frac{F}{A}$.
- explain the applications of pressure in our daily lives.

Pressure is the amount of force acting perpendicular on a unit area of a surface. When a body is placed on a surface, it exerts a force equal to its weight. The force acting on the floor when you stand or lie down is equal to your weight.

Carefully, hold a ballpoint pen in between your two index fingers. Gradually, press from both ends. Do not press it too hard!

Which end of the pen causes more pain on your fingers? Why?

Activity 9.5. Investigating pressure

Tshering carried out two experiments to see how weight and surface area of a body affect pressure. He took ply boards of equal size and thickness, and bricks of equal masses. He arranged them as shown in Figure 9.6 and Figure 9.7.

Investigation 1

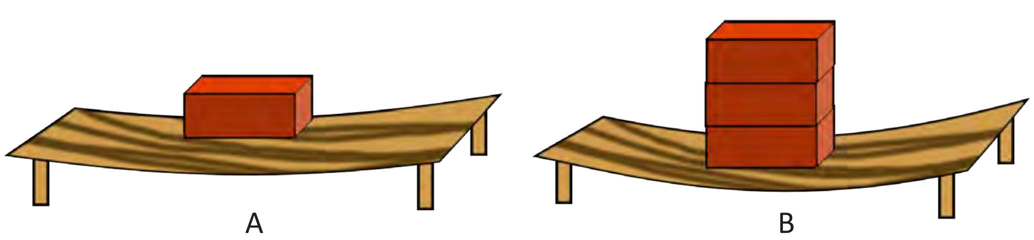


Figure 9.6. Bricks on ply boards (Horizontal).

Reprint 2024

Investigation 2

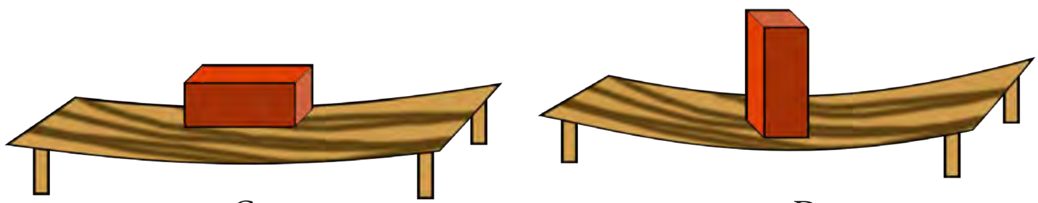


Figure 9.7. Bricks on ply boards (Vertical).

Help Tshering to fill up the following sentences as per your observation.

1. In Investigation 1, _ _ _ _ _ _ remains same whereas _ _ _ _ _ _ changes.
2. Why does the ply board in Figure 9.6 B bend more than the ply board in Figure 9.6 A?
3. In Investigation 2, _ _ _ _ _ _ remains same whereas _ _ _ _ _ _ changes.
4. Why does the ply board in Figure 9.7 D bend more than the ply board in Figure 9.7 C?
5. How is pressure related to weight of the object?
6. How is pressure related to surface area of the object in contact?
7. Define pressure using the conclusion drawn from this activity.

From Activity 9.5, we can conclude that pressure exerted on a surface can be increased by increasing the weight, or by decreasing the surface area where the force is applied. Therefore,

i. pressure is directly proportional to force (weight).
ii. pressure is inversely proportional to surface area of contact.

Mathematically,

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

The unit of pressure is Nm^{-2} or pascal (Pa).

Reprint 2024

Example 9. 2

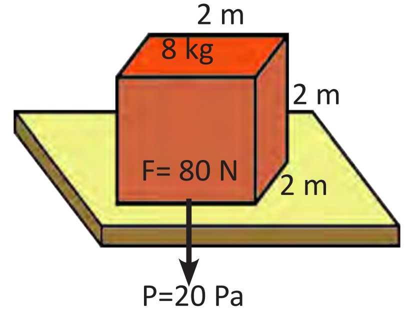


Figure 9.8.

Consider a block of mass 8 kg on a surface as shown in Figure 9.8.

The force on the surface is the weight of the block, i.e, = 80 N

The area it is pressing on is the base area of the block: 4 square metres

So the pressure on the surface is

$80 \div 4 = 20$ Pa

Examples of pressure in our daily lives

Figure 9.9. Example of low pressure.

1. People carry loads by hanging them using a flat rope resting on their heads. (Figure 9.9) The surface area of the point of contact is flattened to reduce the pressure exerted on the head due to heavy load. For the same reason, school bags and shopping bags have broad straps or belts.
2. Animals adapt to their environment to survive. For instance, camels have broad hooves that apply less pressure on sand, and thus can walk easily on sand.
3. Nails are pointed (less surface area), and can be easily drawn into surfaces with less amount of force.
4. Head of drawing pins have large surface area so that it can be pinned easily.
5. Snow shoes have broad soles to increase surface area to avoid sinking while walking on snow.
6. Sharp knife cuts better than blunt one.

WEBLINK

https://www.oercommons.org/authoring/3490-8th-standard-science-force-pressure/view
http://www.excellup.com/classeight/scienceight/forcepressure3.aspx

Reprint 2024

Questions

1. Write three applications of pressure in our daily lives.
2. A block with length, l = 1.5 m, width, w = 1 m, height, h = 0.5 m has a mass m = 300 kg and is placed on a table.

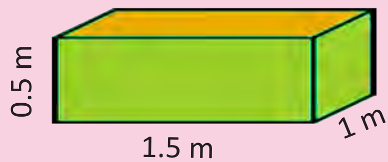


Figure 9.10.

What is the pressure exerted by the block?

3. Given in Figure 9.11 are the four bodies of 100 kg each.

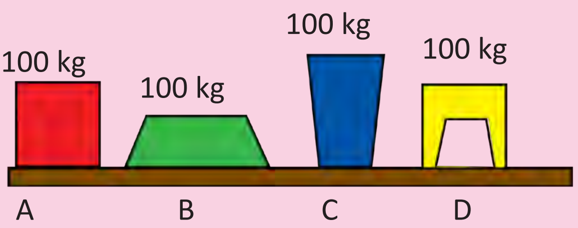


Figure 9.11.

i. Write a hypothesis for the above experiment.
ii. Which body exerts the minimum pressure? Why?
iii. Which body exerts the maximum pressure? Why?
iv. How will the pressure exerted by the bodies change if they are placed on the ground?
v. Draw a new position for body C, so that the pressure exerted by it is minimum.

Exercise

Fill in the blanks.

1. A quantity, which has both magnitude and direction is called ___________ quantity.
2. The amount of matter contained in a body is called ___________.
3. The weight of a body ___________ as the altitude increases, and ___________ as the latitude decreases.
4. Fluid friction is the ____________ force exerted by air and water on a moving body.
5. Frictional force ___________ with the decrease in viscosity of the fluid.
6. Flying bodies and aquatic animals are ___________ to reduce friction.
7. Pressure is directly proportional to ___________

Match the following.

Column A	Column B
1. Shooting an arrow towards north	A. Scalar quantity
2. Measurement of pressure in tires	B. 9.8 ms^{-2}
3. Speed of a moving car	C. Vector quantity
4. Acceleration due to gravity of the Moon	D. ms^{-2}
5. Acceleration due to gravity of the Earth	E. pascal
	F. 1.6 ms^{-2}

Check whether the following statements are True or False. Correct the false statements.

1. The ship has streamlined body to reduce fluid friction.
2. The rate of change of distance in a particular direction is called speed.

Reprint 2024

3. Weight of an object remains same whereas, mass of an object varies from place to place on the surface of the Earth.
4. For a given force, pressure is directly proportional to the surface area.
5. The value of 'g' is minimum at the equator and maximum at the poles.

Multiple Choice Questions

1. The value of 'g' near the poles will be
   A. less than 9.8 ms^{-2}.
   B. more than 9.8 ms^{-2}.
   C. equal to 9.8 ms^{-2}.
   D. equal to 1.6 ms^{-2}.
2. Which one of the following is an example of a vector quantity?
   A. Speed.
   B. Distance.
   C. Velocity.
   D. Mass.
3. A boy rides a bicycle on 300 m circular track three times. The displacement of the boy when he completes one round will be:
   D. 0 m.
   E. 100 m.
   F. 300 m.
   G. 900 m.
4. The person in Figure 9.12 is crossing the river using a thin plank. He is sliding over the plank instead of walking because he:
   A. likes sliding over the plank.
   B. is afraid of walking on the plank.
   C. feels that more pressure will be exerted on the plank if he slides over.
   D. feels that less pressure will be exerted on the plank if he slides over.

Figure 9.12.

Answer the following questions.

1. Table 9.8 represents the distance travelled by a car and time taken to travel, in a fixed direction.

Table 9.8

Time (s)	0	1	6	10	12
Distance (m)	0	10	30	40	60

Plot a displacement-time graph.

2. From figure 9.13, find:
   i. the velocity of the car.
   ii. the displacement of the car at the end of 2.5 s.

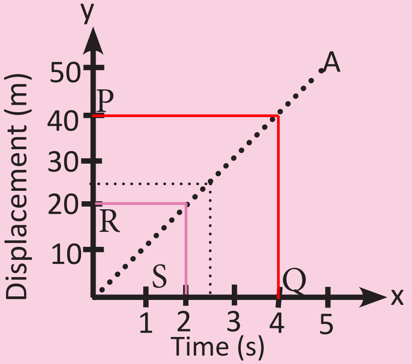


Figure 9.13.

3. A bus takes 2 hours to reach from station A to station B, and then 3 hours to return from station B to station A. Find the average velocity of the bus, if the distance between station A and station B is 50 kilometres.

4. Identify scalar and vector quantities:
   a. The volume of a petrol tank.
   b. A length measured in meters.
   c. The jet taking off against the gravity.
   d. The work done by a force.

5. Define
   a. Pressure
   b. Acceleration due to gravity
   c. Fluid friction

6. If a stone and a pencil are dropped simultaneously in vacuum from the top of a tower, which of the two will reach the ground first? Why?

Reprint 2024

7. A wooden cube is weighed at the North Pole by a beam balance and then by a spring balance. The reading on the beam balance is 6000 g and the reading on the spring balance is 60 N. At a point on the equator, the beam balance gives the same value while the spring balance records 59.8 N. Explain this difference.

8. Give reasons for the following:

   a. Trucks have double rear wheels, while cars do not have.

   b. It is easier to drive in sharp nails in a piece of wood than the blunt ones.

   c. The foundation of a Dzong is broad.

   d. A camel can easily walk on the desert but a horse cannot.

   e. Aeroplanes, missiles and space ships are pointed.

9. Dorji weighs 1500 N. If the total surface area of the soles of his feet is 0.5 m^2, what is the pressure exerted by his body on the ground?

10. Tshewang is sitting on the floor and drawing. His weight is 1000 N. If he exerts a pressure of 100,000 Pa on the floor, calculate the area of contact with the floor.

11. A bicycle covers a distance of 36 km towards east in 1 hour. Calculate

    a. velocity of the bicycle.

    b. time taken by the bicycle to cover a displacement of 500 m at the same velocity.

12. A girl of mass 50 kg is standing on pencil heels, each of cross-sectional area of 1cm^2, and another girl of same mass on wide heels, each of cross-sectional area of 5 cm^2. Compare the pressure exerted by them on the floor. [Take value of 'g' = 10 ms^{-2}]

13. "The fluid friction increases with the viscosity of the liquid". Design an experiment to prove the above hypothesis. Write the complete procedure and the materials used for your experiment.

Reprint 2024

Chapter 10

Work, Power, and Energy

In lower classes, you have learnt that when a force displaces an object, work is said to be done. Whenever work is done, energy is used. Hence, work and energy are related. For example, when a force of 20 N moves an object through a distance of 5 m in a straight line, the work done is 100 J. In other words, 100 joules of energy is spent to do 100 joules of work.

1. Power

Learning Objectives

On completion of this topic, you should be able to:

- define power and its unit.
- calculate power and apply it in different situations.

Activity 10.1. Measuring power

Work in Groups

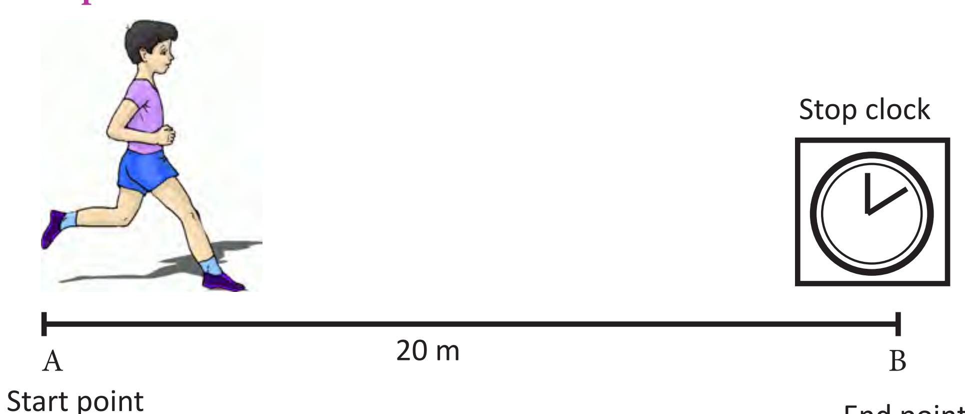


Figure 10.1. Measuring power.

Reprint 2024

Materials Required

Metre rule or measuring tape, stop clock, and weighing machine.

Procedure

Step 1. Measure the mass of body of your group members and record in Table 10.1.

Step 2. Convert your mass into weight (force in newton) by multiplying the mass by acceleration due to gravity of the Earth (10 m/s^2).

Step 3. Measure a length of 20 m on a ground and mark the start point as A and finish point as B.

Step 4. Ask your group members to run from point A to point B in turn. Record the time taken in Table 10.1.

Step 5. Calculate the amount of work (in joules) done by each person by multiplying their weight (in newton) and the displacement.

Step 6. Calculate the power (in watt) using the formula: $Power = \dfrac{Work\ done}{Time\ taken}$

Step 7. Use spreadsheet to fill Table 10.1

Table 10.1 *Calculating Power*

Name	Mass (kg)	Weight (N)	Displacement (m)	Time (s)	Work (J)	Power (W)
1.						
2.						
3.						
4.						
5.						

Answer the following questions.

1. Who has done more work in your group?
2. Who has done the work in least time?
3. Who is the most powerful member in group?
4. What can you conclude about power in terms of work done and time?

When we run for a same distance, the amount of work done by our body

Reprint 2024

depends on the force (weight). We can do same amount of work in shorter time or a longer time, or different amount of work may be done in the same time. Therefore, power depends on the amount of work done and the time taken to complete the work. The amount of work done in unit time is called **power**. Therefore, power is defined as rate of doing work.

That is,

$$Power = \frac{Work\ done}{Time\ taken}$$

The rate of doing work is equal to the rate of using energy, since one unit of energy (1 J) is used to do one unit of work (1 J). Unit of time can be 1 second, 1 minute, 1 hour, etc.

$$Power = \frac{Work\ done}{Time\ taken} = \frac{Force\ X\ Displacement}{Time\ taken}$$

$$Power = \frac{Force\ X\ Displacement}{Time\ taken} = Force\ X\ Velocity$$

The unit of power is watt (W). A power of 1 W is developed when a work of 1 J is done in 1s.

That is, 1 watt=(1 joule)/(1 second)=1J/s

Other units of power are kilowatt (kW), megawatt (MW) and gigawatt (GW)

1 kW=10^3 W

1 MW=10^6 W

1 GW=10^9 W

Horsepower (hp) is another unit of power, which is commonly used to calculate the power of motors and engines.

1 hp = 746 W = 746 J/s

WEBLINK

https://phet.colorado.edu/en/simulations/category/physics/work-energy-and-power
http://www.physics.ucla.edu/k-6connection/forwpsa.htm

Example 10.1

A box is pushed across 5 metres by a force of 30 N in 10 seconds. Calculate the power.

Solution:

Work done = force x displacement
= 30 N x 5 m
= 150 J

$$Power = \frac{Work\ done}{Time\ taken}$$

$$Power = \frac{150J}{10s} = 15W$$

Example 10.2

A box is pushed 15 m across a room with a force of 50 N.

a. What is the work done?

b. If it takes 20 seconds to push the box across the room. What is the power?

Solution:

a. Work done = Force x displacement
= 50 N x 15 m = 750 J

Energy used = 750 J

b. $$Power = \frac{Work\ done}{Time\ taken}$$

$$= \frac{750\ J}{20\ s}$$

$$= 37.5\ W$$

Questions

1. Sherab notices the power rating on a water pump as 200 W. In this context, fill in the following blanks.
    a. The power of the pump is ………….J/s.
    b. The work done by the pump in 1 minute is ………… kilojoules.
2. Convert 10 kilowatt into watt.
3. A bull pulls a plough with a constant force of 2000 N along a field through a distance of 10 m in 50 s. What is the power of the bull?

Reprint 2024

2. Energy

Learning Objectives

On completion of this topic, you should be able to:

- define energy and its unit.
- calculate potential energy and kinetic energy.
- discuss the relevance of energy in our day to day life.

Think of all the activities that you have performed from the time you got out of bed till the time you are sitting for this lesson. You must have done lots of work. What made it possible for you to do all this work? It is due to energy that you possess. Energy enables us to do work. Therefore, **energy** is the ability to do work.

The common units of energy are joule (J) and calorie (cal). The other bigger units of energy are watt hour (Wh) and kilowatt hour (kWh). These bigger units are used to measure the consumption of electrical energy.

All bodies in the state of rest or in motion possess **mechanical energy**. Mechanical energy is of two types namely **potential energy** and **kinetic energy**.

a. Potential Energy

Potential energy is the energy due to the position of the body. Potential energy is of two types:

i. gravitational potential energy and
ii. elastic potential energy.

Gravitation potential energy is defined as the amount of work done in lifting a body against the force of gravity. Higher the position of the body from the surface of the Earth, more is the gravitational potential energy stored. The other factors that affect gravitational potential energy are mass of the body and acceleration due to gravity.

Reprint 2024

A body of mass "m" is raised from ground to a vertical height "h". The gravitational potential energy of the body is calculated as

Potential energy = mass (m) x acceleration due to gravity (g) x height (h)

$$PE = mgh$$

For example, if an object of mass 12 kg is lifted to a height of 25 m, then the potential energy is given by

Potential energy = mgh (Take $g = 10\ m/s^2$)

Potential energy = $12\ kg \times 10\ m/s^2 \times 25\ m = 3000\ J$

Example 10.3.

A pumpkin of mass 7 kg grows at a height of 4 m from the ground. Taking the value of 'g' as $10\ m/s^2$, calculate its potential energy.

Solution:

The pumpkin will have potential energy due to its height.

So, PE = mgh, i.e. $PE = 7\ kg \times 10\ m/s^2 \times 4\ m = 280\ J$

Activity 10.2. Comparing potential energy

Materials required

An object, pan balance, measuring tape.

Procedure

Step 1. Measure the mass of the object.

Step 2. Place the object at 3 different heights (For example, on a chair, on a table, on the stair case, etc) and measure the height from the ground.

Step 3. Draw an observation table and record your measurements.

Step 4. Calculate the gravitational potential energy for the object at the 3 heights. Take the value of $g=10\ m/s^2$.

i. Where was the potential energy of the object maximum?

ii. Where was the potential energy minimum?

iii. What is the relationship between the potential energy and height of the object?

Reprint 2024

b. Kinetic Energy

Kinetic energy exists in a body when the body is in motion. Kinetic energy depends on the mass and the velocity of the body. The relationship of kinetic energy with the mass and the velocity of the body is:

$$Kinectic\ Energy\ (KE) = \frac{1}{2} mass\ X\ (velocity)^2$$

$$KE = \frac{1}{2} mv^2$$

For example, if a person throws a mass of 4 kg at a velocity of 15 m/s, the kinetic energy possessed by the body is

$$KE = \frac{1}{2} mv^2$$

$$KE = \frac{1}{2} \text{ x } 4 \text{ x } 15^2$$

$$= 450 \text{ J}$$

Example 10.4

Yonten serves a volleyball at a velocity of 10 m/s. If the mass of the ball is 0.25 kilograms, calculate the energy of the ball.

Solution:

Here, the energy possessed by the ball is kinetic energy.

i.e.

$$KE = \frac{1}{2} mv^2$$

$$KE = \frac{1}{2} \times 0.25 \text{ x } (10)^2 = 25 \text{ J}$$

WEBLINK http://www.physicsclassroom.com/class/energy

Reprint 2024

Questions

1. Write the difference between power and energy.
2. The formulae to find the mechanical energy are:

   PE = mgh and $KE = \frac{1}{2} mv^2$

   a. What is the common factor that affects both forms of energy?

   b. How does height affect the potential energy of a body?

   c. Kinetic energy of person who is running will be more than a person who is walking. Justify.
3. Copy and complete Table 10.2. Read the statements and write the correct state of energy by writing kinetic energy (KE), potential energy (PE) or both (B).

Table 10.2.

KE, PE or B	Statement
	1. If a ball is at rest, it certainly does NOT possess this form of energy.
	2. Depends upon mass of the body and height of the body from the ground.
	3. The energy of a moving car.
	4. The quantity is expressed using the unit joule.
	5. The energy stored in an object due to its position or height.
	6. Depends upon mass of object and velocity of object.
	7. A boulder rolling down the slope.

4. Disaster mitigation practices suggest not to store heavy object at a greater height at your home. Justify.

Reprint 2024

3. Heat Energy

Learning Objectives

On completion of this topic, you should be able to:

- differentiate between heat and temperature.
- explain transfer of heat energy by conduction, convection, and radiation.
- relate the conceptual ideas of heat energy transfer to everyday life.

Till the end of eighteenth century, people considered heat as fluid that flows from a warm body to a cold body. The imaginary fluid was called 'caloric' (Greek word for heat). In the nineteenth century, Count Rumford and James Prescott Joule established heat as a form of energy.

The Earth would be cold and barren without heat. Heat energy is used for cooking, warming, running automobiles, and for many other purposes. Like any other forms of energy, heat can be transformed into other useful forms of energy. For example, a car engine converts heat energy to mechanical energy. Similarly, heat energy from natural gas is converted to electrical energy. These conversions mainly take place through transfer of heat.

a. Heat Transfer and Temperature

If we get into a bath tub containing warm water, we feel warm due to the transfer of heat from the warm water to our body. This shows that heat flows from hot body to cold body. **Temperature** is a physical quantity which measures the degree of hotness or coldness. It is measured in degree Celsius (°C) or kelvin (K).The flow of heat energy from a body of higher temperature to the body of lower temperature is called **transfer of heat**. The transfer of heat can also take place within the same object, if the two parts are at different temperatures. If bodies are at the same temperature, then the transfer of heat will not take place. They are said to be in **thermal equilibrium**.

Heat energy is measured in calorie or kilo calorie, which is related to joule as:

$$1 \text{ cal} = 4.2 \text{ J}$$

Transfer of heat energy takes place in three ways namely: conduction, convection, and radiation.

Reprint 2024

i. Conduction

Activity 10.3. Demonstration of conduction in a solid

Materials required

Three pieces of candle (approximately of 2 cm long each), retort stand, matches, and spirit lamp.

Procedure

Step 1. Attach three pieces of candles at equal distance from each other, on the metal rod of the retort stand as shown in Figure 10.2.

Step 2. Heat the metal rod from the free end as shown in Figure 10.2.

Step 3. Observe carefully.

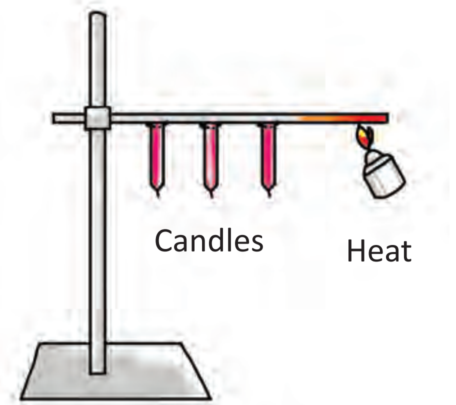


Figure 10.2. Investigating conduction.

Answer the following questions.

1. What do you observe after a few minutes?
2. Why do you think this happens?
3. What can you conclude from the experiment?
4. Give a few examples of this phenomenon from everyday lives.

ii. Convection

Activity 10.4. Demonstration of convection

Materials required

A carton box, transparent plastic sheet, sellotape, candle, matches, incense sticks, and scissors.

Procedure

Step 1. Cut one side of the box and stick transparent plastic sheet on it. Cut out two equal circles on the top and mount the chimneys, as shown in Figure 10.3.

Step 2. Light a candle and place it below chimney 1.

Step 3. Predict the path of the smoke, if a lighted incense stick is brought near the opening of chimney 2.

Step 4. Light an incense stick and place it near the opening of chimney 2.

Step 5. Observe the path of the smoke carefully.

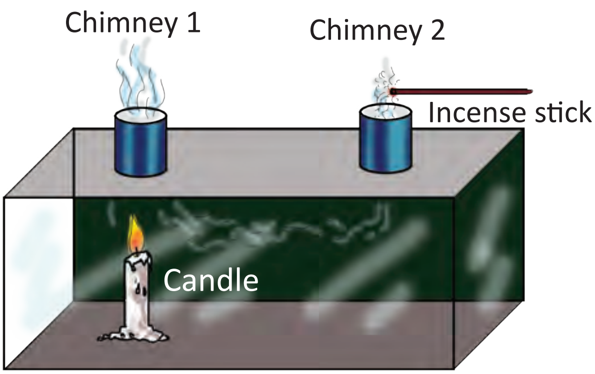


Figure 10.3. Investigating convection.

Answer the following questions.

1. Describe the path of the smoke.
2. Explain your observation.
3. Will the observation be the same, if the candle is not burning? Why?
4. Give a few examples of this phenomenon from everyday lives.

WEBLINK http://www.edinformatics.com/math_science/how_is_heat_transferred.htm

ii. Radiation

Activity 10.5. Investigating Radiation

Materials required

A cardboard, some butter or candle wax, a spirit lamp, and a match box.

Procedure

Step 1. Light the candle.

Step 2. Place the butter or wax near the flame of the candle as shown in Figure 10.4.

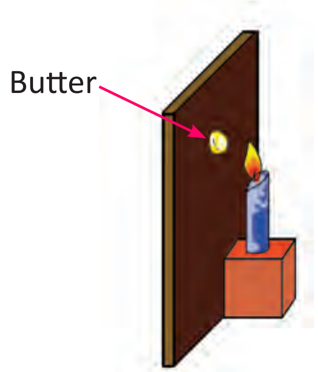


Figure 10.4. Investigating radiation.

Step 3. Observe the butter or wax carefully.

Answer the following questions:

a. What happens to the butter or the wax?

b. What makes it happen?

c. How does heat reach the wax or butter?

Activity 10.6.

Discuss and prepare a PowerPoint presentation on conduction, convection and radiation with illustrations and few examples.

Questions

1. Figure 10.5 shows two identical containers with equal volume of hot oil at the same temperature. One of the containers is covered with a lid.

   a. In which container will the oil cool faster? Why?

   b. In the container with the lid, how is the heat lost?

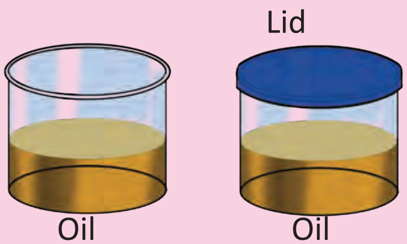


Figure 10.5.

2. A red-hot iron ball is suspended from the cork by a thin metallic wire (See Figure 10.6).

   Name the process by which heat is transmitted from the ball to the wall of the glass. Give reasons.

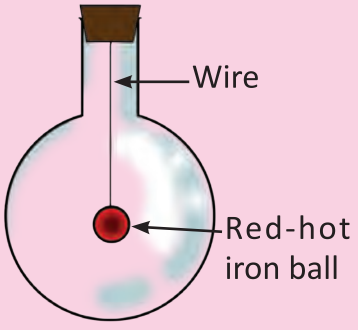


Figure 10.6.

Reprint 2024

4. Dissipation of Energy

Learning Objectives

On completion of this topic, you should be able to:

- define dissipation of energy with examples.
- explain how dissipation of energy reduces the efficiency and availability of energy resources.

According to the law of conservation of energy, energy can neither be created nor be destroyed, but can be transformed from one form to another form. Therefore, the total amount of energy in the universe remains the same.

When we light an ordinary bulb, most of the electrical energy is converted into the light energy, while the rest is converted to heat and other radiations that are not used for lighting purposes. Similarly, when LPG is used for cooking, chemical energy is converted into heat and light energy. Only heat energy is used, while the light energy is not used for cooking. The phenomenon of transformation of energy, from useful form to undesirable form is called **dissipation of energy**.

Activity 10.7. Identifying dissipated energy

Materials required

Work sheet (Table 10.3).

Procedure

In pairs, discuss and fill up Table 10.3 in the worksheet provided by your teacher. The first one is done for you.

WEBLINK
http://www.eschooltoday.com/energy/kinds-of-energy/energy-stored-transferred-dissipation.html

Reprint 2024

Table 10.3 *Identifying and Reducing Dissipated Energy*

Sl No	Activity	Energy Conversion	Name the Dissipated Energy	Ways to Minimize Dissipation
1.	Lighting a bulb.	Electrical to light	Heat	Use of CFL bulbs, LED bulbs or tube rods
2.	Rotating a prayer wheel manually.	Chemical to ……….....		Lubricate the prayer wheel from time to time.
3.	Using a car.	Chemical to kinetic		
4.	Cooking using LPG.	Chemical to …………....		Carry out servicing of stoves from time to time
5.	Generation of electricity in hydro electric plants.	Kinetic to …………......		

Answer the following questions.

1. Can you give an example of any energy transformation where there is no dissipation of energy?
2. How does the dissipation of energy affect energy resources?

Exercise

Multiple Choice Questions

1. The velocity of a car is tripled. Its kinetic energy will increase by
   A. 2 times.
   B. 3 times.
   C. 5 times.
   D. 9 times.
2. Which one of the following statements is FALSE?
   A. Energy is the capacity to do work.
   B. Work can be expressed as product of force and displacement.
   C. Power is the amount of work done in unit time.
   D. The unit of power is joule.
3. Two paths lead to the top of a hill. The first path is steep and short while second path is twice the length of first path but not steep. How much of potential energy would you gain if you take the second path?
   A. Gain in potential energy is same.
   B. Twice as much.
   C. Four times as much.
   D. No gain in potential energy in either case.
4. Which would be TRUE for an object possessing a kinetic energy of 0 joules?
   A. Its mass is zero.
   B. It is at rest.
   C. It is moving on the ground.
   D. It is accelerating.
5. The fastest mode of transfer of heat is:
   A. conduction.
   B. convection.
   C. radiation.
   D. same in all the three modes.

Reprint 2024

6. Which statement is NOT TRUE about heat transfer?
   A. Heat in liquids is transferred by convection only.
   B. Heat transfer in gases occurs due to radiation.
   C. In solids, heat transfer is only by conduction.
   D. Heat in liquids is transferred by conduction only.
7. Which one of the events describes kinetic energy?
   A. Falling of an apple from a tree.
   B. Apple on the ground.
   C. Water in a dam.
   D. Stretched rubber.
8. The physical quantity which is equal to the product of force and velocity is
   A. work.
   B. energy.
   C. power.
   D. acceleration.

Answer the following questions.

1. Explain dissipation of energy. Give an example.
2. Why is it important to use the energy resources judiciously?
3. A body of mass 14 kg is raised vertically through a distance of 1.8 m. Find the increase in potential energy. (Take $g = 10\ m/s^2$)
4. A 5 kg cart is pushed with a force of 30 N to a distance of 10 m in 5 seconds. Determine the power needed to move the cart.
5. A force of magnitude 750 N pulls a car up along a slope at a constant speed of 9 m/s. Given that the force acts parallel to the direction of the motion, find the power developed in kW.
6. An object is thrown as shown in Figure 10.7. Study the figure and answer the following questions.

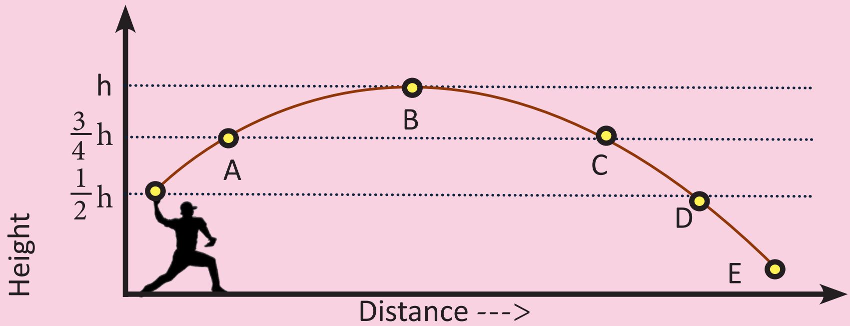


Figure 10.7.

i. At what point is the potential energy maximum? Why?
ii. At what point is the kinetic energy minimum?
iii. At what point is the kinetic energy maximum?

7. A particle of mass 0.25 kg is moving with a speed of 7 m/s due North. Find its kinetic energy.
8. What is the potential energy of an object with a mass of 10 kg, when kept at a height of 100 m above the surface of the Earth? [Take g = 10 m/s^2]
9. A coin is dropped from a height of 80 m. How fast will it fall, just before it hits the ground? [Take g = 10 m/s^2, Hint: For a falling body, the total PE at the greatest height will be equal to the K.E., just before it touches the ground]
10. Figure 10.8 shows the different modes of heat transmission. Fill in the labels for A, B, and C, and write a brief description for each in the Table 10.4.

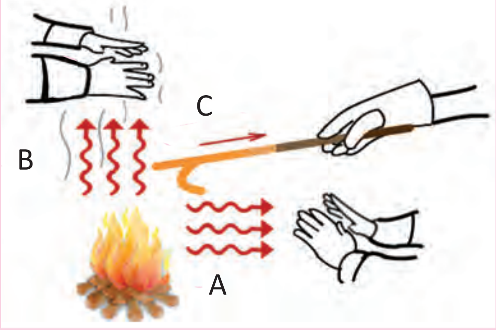


Figure 10.8.

Table 10.4

Label	Description
A - …………………	
B - …………………	
C - …………………	

11. The tips of two steel rods are heated as shown in Figure 10.9. In this regard, state whether it is True (T) or False (F) in the following.

Figure 10.9.

a. Heat is conducted only along rod A. __________

b. Heat is conducted only along rod B. __________

c. Heat is conducted along both the rods. _________

d. The idea that "heat rises" is relevant to transfer of heat by convection and not conduction. ________

12. Match the following.

Column A	Column B
1. Potential energy	a. heat transfer
2. Degree of hotness and coldness	b. convection
3. Land breeze	c. temperature
4. Temperature difference	d. mechanical energy
5. 1 hp	e. 1 calorie
	f. 746 J/s

13. Copy and complete Table 10.5.

Table 10.5

Point of Comparison	Conduction	Convection	Radiation
Medium			Material medium is not necessary.
Mode of transmission	No actual movement of particles of material medium.		The particles of medium are not involved.
Speed of transmission			Very fast process since heat transfer is at the speed of light (3 x 10^8 m/s).

WEBLINK

http://www.alchemical.org/thermo/img/TransmissionHeatWksht.jpg
http://www.physicsclassroom.com

Reprint 2024

Chapter 11
Electricity and Magnetism

Electricity is an important source of energy. Electrical energy is used in our homes, schools, industries, and in many other places.

In 1820, Hans Oersted, a Danish physicist and chemist found that electricity and magnetism are related. In 1830, Michael Faraday and Joseph Henry discovered that a changing magnetic field produces current in a coil of wire. This idea ultimately led to the making of dynamos. The discovery of the relationship between magnetism and electricity is one of the greatest achievements in science.

1. Circuits

Learning Objectives

On completion of this topic, you should be able to:

- define current, resistance, voltage, and state their units and symbols.
- state Ohm's Law and derive the relationship between current and voltage.
- calculate the resistance and voltage using Ohm's Law.
- explain the transfer of energy in a battery.
- explain how a battery discharges.

a. Potential Difference and Electric Current

An atom is made up of protons, neutrons and electrons. Protons carry positive charges, while electrons carry negative charges. Neutrons are neutral particles. The protons and neutrons lie inside the nucleus, and electrons revolve around the nucleus. The valence electrons of metal atoms are free to move. These electrons are called **free electrons**.

The metal conductors contain large number of free electrons, which can move from one end of the conductors to the other end. When we put on switch in the

Reprint 2024

circuit, an electric current flows through the wires which is the flow of charges.

The water flows from higher level to lower level, till the level becomes equal. Similarly heat flows from a body at a higher temperature to a body at a lower temperature. Likewise, the flow of electric current depends on the difference in the concentration of electrons across the two regions of a conductor.

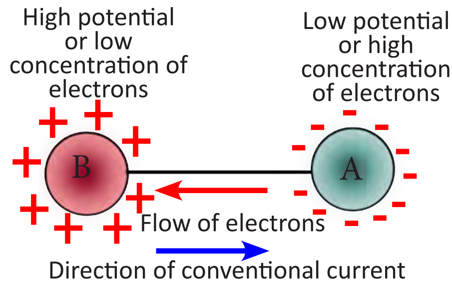


Figure 11.1. Direction of flow of current and electrons.

The region having excess of electrons is negatively charged and is said to be at a **lower potential**. The region having the deficiency of electrons is positively charged and is said to be at a **higher potential**. The difference in concentration of charges is called **potential difference**. The electrons flow from lower potential to higher potential. Keeping the convention of flow of water and heat from the higher to the lower level, the electric current from higher potential to lower potential. The rate of flow of electrons or electric charge is called **electric current**. Electric current is denoted by 'I' and measured in ampere (A).

Figure 11.2 shows a bulb glowing when connected to the terminals of a cell. The glowing of bulb indicates the flow of electric current. The electric current flows from positive terminal (higher voltage) to negative terminal (lower voltage) of a cell.

The term potential difference is also called voltage or electro motive force (emf). Potential difference is denoted by 'V', and measured in volt (V).

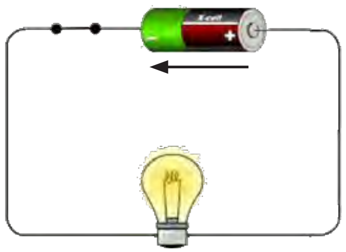


Figure 11.2. An electric circuit.

Figure 11.3 shows the movement of electrons through a conductor. When the electrons move from one part of the conductor to the other part, they collide with other electrons and with the particles (positive ions) present in the conductor. These collisions tend to slow down the flow of the electrons. This obstruction offered by the conductor to the flow of current is called **electrical resistance**. It is denoted by 'R' and measured in ohm (Ω).

Reprint 2024

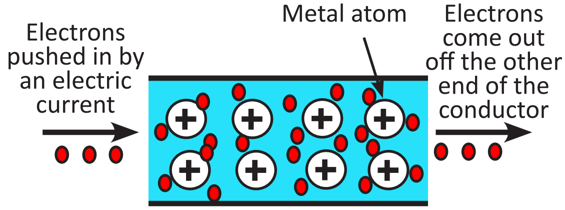


Figure 11.3. Flow of charge.

b. Ohm's Law

Activity 11.1 a Studying relationship between voltage (V) and electric current (I)

Observe the demonstration of the experiment by your teacher.

Materials required

Insulated wire, an ammeter, a voltmeter, five dry cells and a plug key.

Procedure

Step 1. Set up the apparatus as shown in Figure 11.4.

Step 2. Note down the least counts for the voltmeter and the ammeter.

Step 3. Note the potential difference of the dry cell.

Step 4. Plug in the key to complete the circuit.

Step 5. Record the readings in the voltmeter and ammeter in Table 11.1.

Step 6. Repeat Step 4 and Step 5 with two cells, three cells, four cells, and five cells.

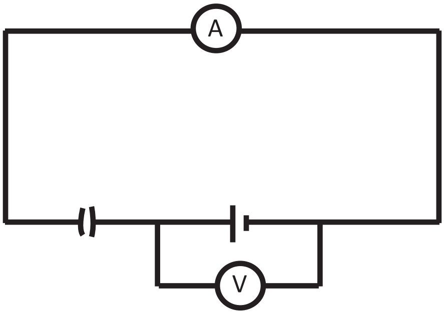


Figure 11.4. Verifying Ohm's law.

Precaution

- *Voltmeter is always connected in parallel with cells.*
- *Ammeter is always connected in series with cells.*

Table 11.1 *Observation Table*

Number of Cells Used	Total Voltage of Dry Cells	Voltmeter Reading	Ammeter Reading
1			
2			
3			
4			
5			

Answer the following questions.

1. What happens to the voltmeter and ammeter readings, when the number of cells is increased? Why?
2. How did we increase the voltage?
3. The reading in the voltmeter is always less than the total voltage supplied by the cells. Give reasons.
4. Plot a graph of voltage (V) against the current flowing in the circuit (I). What can you say about the relationship between them?

Activity 11.1 b Verifying Ohm's law

Use the simulation using the URL (https://phet.colorado.edu/sims/html/ohms-law/latest/ohms-law_en.html) and record voltage and resistance in Table 11.2.

Use data from Table 11.2 to plot a graph on spreadsheet for voltage versus current.

Table 11.2 *Relation Between Voltage and Current*

Sl.	Voltage (V) in volt	Current (I) in ampere
1	5	
2	10	
3	15	
4	20	
5	25	

Reprint 2024

i. What happened to the current when the voltage is increased?

ii. What happened to the current when the resistance is increased by keeping the voltage constant?

iii. Identify independent, dependent, and controlled variables in the experiment.

In Activity 11.1 b, the current flowing in the circuit increases with increase in the potential difference across the two ends of the conductor. This phenomenon was first established by a German physicist called George Ohm in 1826. He further established the relationship between the electric current (I), the potential difference (V) and the resistance (R) offered by the conductor in an electric circuit. The relationship is known as Ohm's Law. According to this Law, the electric current (I) flowing through a conductor is directly proportional to the potential difference (V) across its ends at constant temperature and pressure.

i.e. **V α I** (at constant physical conditions)

The equation for Ohm's law is given by **V = IR,** where R is the resistance offered by the wire.

The above equation can also be written as:

$$R = \frac{V}{I} \text{ or } I = \frac{V}{R}$$

Example: 11.1.

A conductor carries a current of 1.2 A, and offers a resistance of 5 Ω. Calculate the potential difference across the conductor.

Solution

I = 1.2 A   R = 5 Ω V =?

V = I x R = 1.2 A x 5 Ω = 6.0 V

Example: 11.2.

What is the ammeter reading in Figure 11.5?

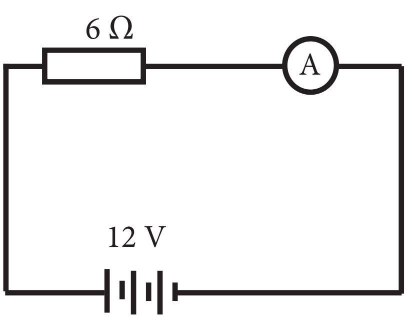


Figure 11.5.

Solution

$$V = IR$$

$$I = \frac{V}{R} = \frac{12V}{6\,\Omega} = 2\,A$$

The ammeter reading is 2 A.

Example: 11.3.

A resistance of 4 Ω is offered by a conductor when a potential difference of 6 V is applied across it. Calculate the current flowing through it.

Solution

V = 6V   R = 4 Ω I = ?

$$I = \frac{V}{R} = \frac{6V}{4\,\Omega} = 1.5\ A$$

Questions

1. Figure 11.6 shows two circuits: Circuit X and Circuit Y. Which circuit offers greater resistance to current flow? Explain the relationship between the current and the resistance, in these circuits.

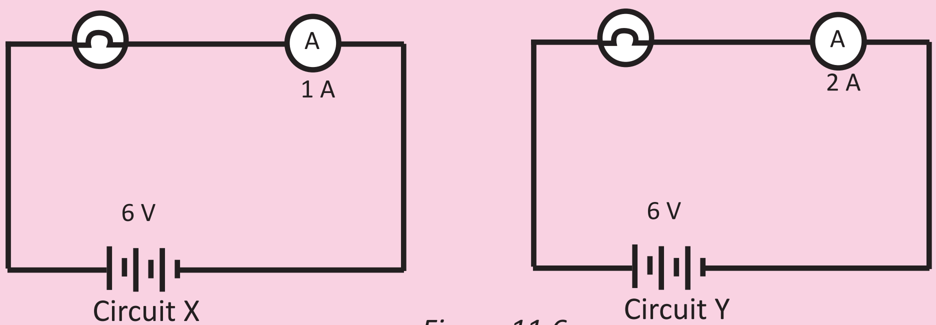


Figure 11.6.

2. Calculate the potential difference required for the flow of a current of 7.5 A through a conductor of resistance 12 Ω.

c. Energy Transfer in Battery

A large number of appliances used in our daily lives which need an electric current to work. For example, dry cells are used in torch as the source of electric current. Chemical energy in the cell converts to electrical energy. Figure 11.7 shows electro chemical cells and Figure 11.8 shows storage cells commonly known as battery. Two or more cells combined together is called a **battery**.

Figure 11.7. Dry cells.

Reprint 2024

The potential difference in a cell is created due to chemical reactions. Electric current is produced due to potential difference between two terminals of the cell. When a cell is used continuously, the potential difference decreases. Eventually, the potential difference becomes zero and the flow of current stops. At this stage, the cells are exhausted.

Figure 11.8. Car battery.

The cells can no more be used. They have to be either disposed or recycled.

Precaution

Do not dispose the used batteries into the fire or streams.

Activity 11.2. How does a cell exhaust?

Materials required

250 mL beaker, dilute sulphuric acid, a piece of granulated zinc, a piece of copper wire, connecting wires, and galvanometer.

Procedure

Step 1. Set up the apparatus as shown in Figure 11.9.

Step 2. Observe the magnitude of deflection in the galvanometer (by counting the number of divisions) as soon as the reaction starts.

Step 3. Keep the setup undisturbed for about 20 minutes.

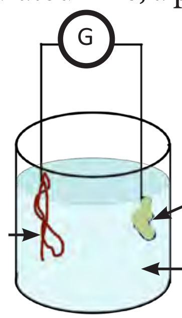


Figure 11.9. Making a cell.

Step 4. Observe the magnitude of deflection in the galvanometer after every 5 minutes.

Answer the following questions.

1. When is the deflection maximum? What does it indicate?
2. What happens to the magnitude of deflection in the galvanometer with the passage of time? What does this indicate?
3. What is your conclusion from this experiment?

Reprint 2024

Figure 11.10 shows the construction of a simple cell.

The cell consists of two different metal plates called **electrodes**, immersed inside a liquid called **electrolyte**. One of these metal plates is zinc and the other is copper. The liquid is dilute sulphuric acid.

The chemical reaction in the cell makes the copper plate to become positively charged (**anode**), and the zinc plate to become negatively charged (**cathode**). Anode is electron deficit area and cathode is electron rich area. As a result, a potential difference develops between the anode and the cathode. This potential difference results in the flow of electrons from cathode to anode, and the electric current flow anode to cathode when connected by a conducting wire. The potential difference gradually decreases and finally becomes zero. At this state, there is no flow of electric current, and we say that the cell is discharged.

The two types of cells commonly available in the market are primary and secondary cells. A primary cell can be used once and cannot be recharged. Secondary cells are also called rechargeable cells as they can be used again by recharging.

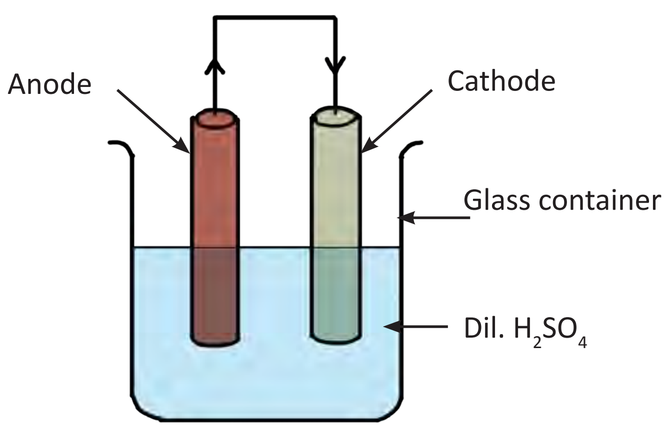


Figure 11.10. Electrolytic cell.

2. Mains Electricity

Learning Objectives

On completion of this topic, you should be able to:

- state the difference between direct current (DC) and alternating current (AC).
- describe the functions of live, neutral, and earth wires in the domestic mains supply.
- explain the function of insulation of domestic mains supply.
- explain the functions of earthing, fuse, and circuit breaker.
- calculate the cost of energy consumed by household appliances.

There are two types of electric current:

i. direct current (DC)

ii. alternating current (AC)

Direct current is the current that flows in one direction only. A cell or a battery and DC generator are the sources of direct current. Generally, power of DC is less than that of AC.

Figure 11.11 shows a circuit in which the current flows from the positive terminal to the negative terminal of the battery.

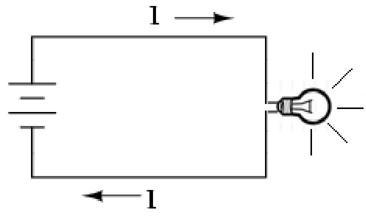


Figure 11.11. DC circuit.

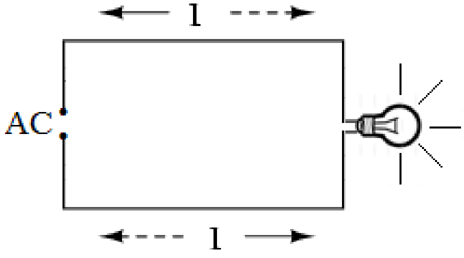


Figure 11.12. AC circuit.

Alternating current is the current with varying magnitude and direction, which reverses at regular intervals. The sources are AC generator and mains electricity.

Figure 11.12 shows a circuit in which current flows in both directions alternately.

a. Domestic Electric Supply

Figure 11.13. Pylon.

The electricity from the power station is brought to our homes through an aluminium cable with the help of overhead pylons (Figure 11.13) and poles, or through underground cables.

The cable (wires) which forms circuitry in our homes is generally made of copper with plastic insulation. The wires are of three types, and are distinguished by the colour of the insulation as shown in Figure 11.14.

Live (L) – **brown** insulation

Neutral (N)- **blue** insulation

Earth (E)- **green** or **yellow** insulation

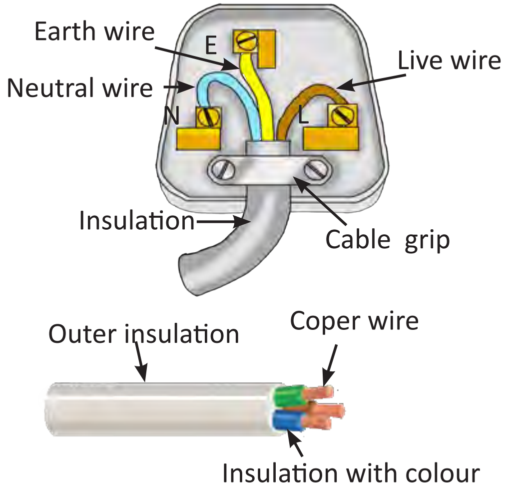


Figure 11.14. Colour code for wires.

The live wire carries the current from the source till the place of delivery, while the neutral wire provides the current path to complete the circuit. The earth wire provides a safety passage to leaked current to the ground.

Every electrical appliance is rated based on the electrical energy by which the appliance operates. The electrical energy that the appliance consumes is rated in watt (W). For example, a heater rated 2000 W-220 V consumes 2000 W when it is connected to 220 V mains supply. The total electrical energy consumed by the electrical appliance depends on the power of electrical appliance and the duration for which electrical appliance is used.

The old system of colour coding of wires used to be given as follows;

Live – Red, Neutral- Blue, Earth- Black

b. Electrical Safety

Connecting an electrical appliance to the earth by a wire or other conductor is called **earthing**. A copper wire (earth wire) connects the terminals for earth connection to a rod or a metal plate that is buried into the earth, as shown in Figure 11.15. The earthing is a safety device, which is used to safely transfer the excess or leaked current to the earth to prevent shocks. The earth wire is connected to the body of an electrical appliance.

Whenever there is short circuit or leakage of current in the appliance, the earth wire drains out the leaked current from the appliance to the earth. During this, a large current suddenly flows to the Earth owing to its low potential. This large current causes the fuse in the circuit to melt and disconnect the appliance from the power supply.

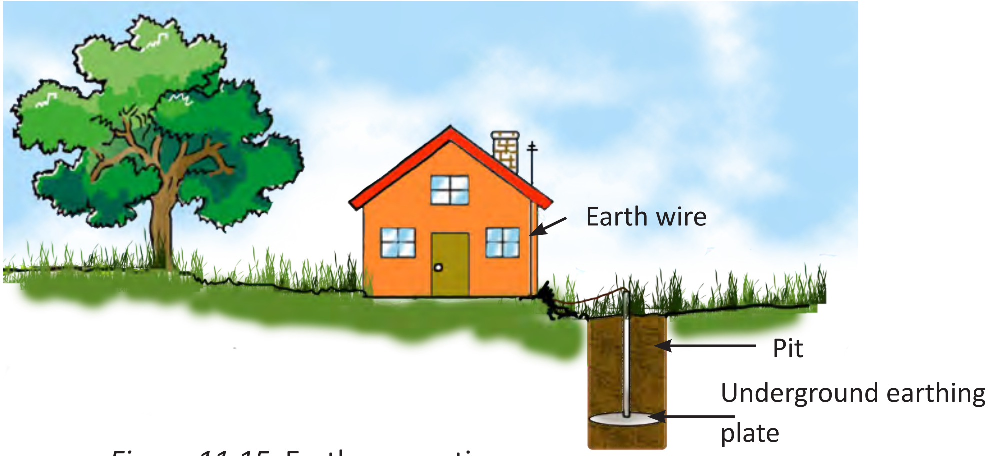


Figure 11.15. Earth connection.

c. Fuse

A **fuse** is a device which consists of a short and thin wire, which melts and breaks the circuit if the current exceeds a safe value. A fuse is always connected in series to the live wire. A fuse helps to prevent damage of electrical appliances.

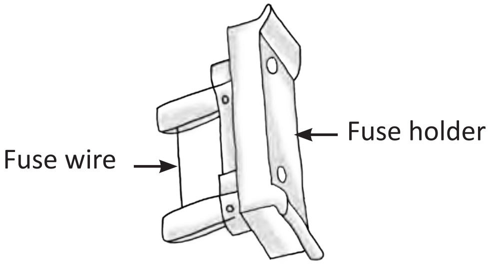


Figure 11.16. Fuse.

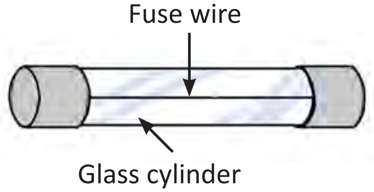


Figure 11.17. Cartridge fuse.

Reprint 2024

The current rating of the fuse used for an electrical appliance must be just above the current rating of the electrical appliance. When excess current flows through the circuit; the fuse melts preventing the current flow into the appliance, saving it.

The other safety device used is **miniature circuit breaker** (MCB), as shown in Figure 11.18. It is an automatic device that breaks circuit when excess current flows in the circuit. It is preferred over the fuse because the circuit breaker can be reset, whereas, a fuse wire has to be replaced in the fuse. Moreover, handling MCB is safer than a fuse.

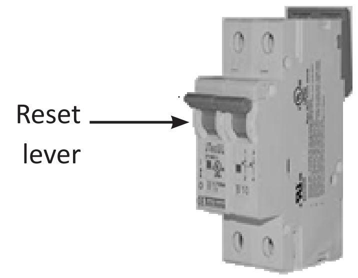


Figure 11.18. MCB.

d. Electrical Insulation

Electrical insulation is a way of restricting the flow of electrical current from the conductor with the use of insulators. As shown in Figure 11.19, wires have flexible plastic sheath which insulates electric current. The exposed wires in use with high voltage can lead to electric shock and electrocution. Therefore, insulation helps to prevent accidents.

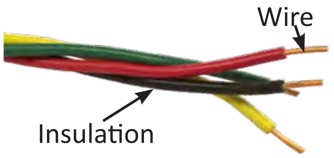


Figure 11.19. Insulated wires.

Figure 11.20. Ceramic and porcelain holders.

The ceramic or porcelain holders and using air are also used as insulation for high voltage. Figure 11.20 shows ceramic and porcelain holders used as insulator. The joints of wires in a circuit are also insulated by using an insulating tape as shown in Figure 11.21.

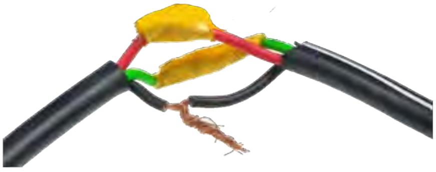


Figure 11.21. Wire junction insulated by insulating tape.

e. Electrical Heating for Domestic purposes

Electrical heating is a process of converting electrical energy to heat energy. Electrical heating appliances such as water heater, rice cooker, room heater, etc., have heating coils that convert electrical energy to heat energy.

Heating coils are made of metals with high resistance and high melting point that converts electric current to heat.

The use of electricity for heating, cooking, boiling, etc., consumes energy. We pay for every unit of the electrical energy consumed.

Figure 11.22. Heating coils.

A house, office or school connected by electricity supply has an electric meter (Energy Meter) to record the electrical energy consumed. There are two types of electric meter, analogue meter and digital meter, as shown in Figure 11.23.

(a) Analogue meter

(b) Digital meter

Figure 11.23. Types of electric meters.

WEBLINK

http://www.med.govt.nz/energysafety/consumer/safe-living-with-electricity/electrical-safety-devices
http://www.energysavingtrust.org.uk/Electricity/Products-and-appliances

Reprint 2024

Activity 11.3. How much electrical energy do you use?

Record all your readings and calculations and complete Table 11.3.

Table 11.2 *Electrical Energy Consumed*

Electrical Appliance	Power Rating (W)	Duration of Use Everyday	Electrical Energy (kWh)	Cost (Nu)

Procedure

Step 1. Select any five electrical appliances used at home or in school.

Step 2. Record the power ratings of the appliances.

Step 3. Record the approximate hours of use of each appliance in a day.

Step 4. Calculate the electrical energy consumed by each appliance every day, using the formula:

$$\text{Electrical energy consumed (kWh)} = \frac{\text{Power(watt)} \times \text{Time(hour)}}{1000}$$

Step 5. If a unit of electrical energy costs Nu 1.20, calculate the cost of energy consumed by each appliance, using the formula;

Cost (Nu) = Electrical energy consumed (kWh) × cost of 1 unit

Step 6. Find the total cost of electrical energy used in a day.

WEBLINK

http://www.rapidtables.com/calc/electric/electricity-calculator.htm
http://electricaltechnology.org/2012/03/lets-try-to-understand-calculation-of.html

Reprint 2024

Questions

1. Dhanay Ghalley had a bill from the electricity company. Unfortunately, his pet dog ravaged the bill before he could read it as shown in Figure 11.24. Can you calculate the bill amount which he must pay?

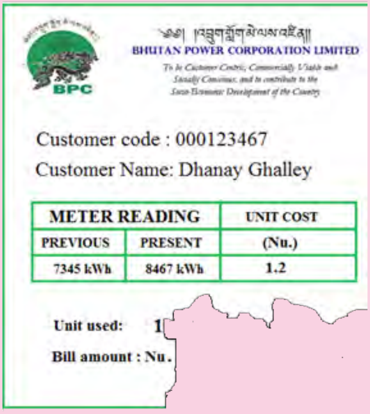


Figure 11.24.

2. Which statement is **true** about the direct current?
   a. It has varying direction.
   b. It is supplied by mains electricity.
   c. It is produced in hydro power stations.
   d. It is unidirectional.

3. Two tube lights of 40 watt each and an immersion heater of 1500 watt are connected to 220 V mains and operate on an average of 8 hours a day. If the cost of energy is Nu 2 per kWh, calculate the electricity bill for a day.

4. The wires have to be connected to the plug. Study Figure 11.25 and complete Table 11.4.

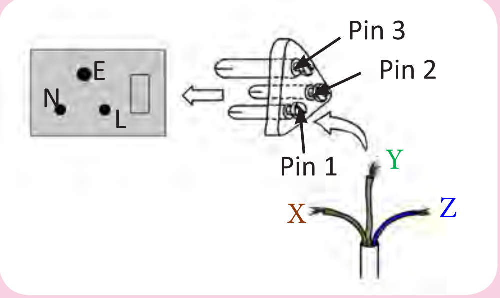


Figure 11.25.

Table 11.4

Wires	Plug pin
Wire X	....
Wire Y	....
Wire Z	....

5. Why would you choose MCB in place of a fuse?

3. Magnetism

Learning Objectives

On completion of this topic, you should be able to:

- explain natural magnets and horse shoe magnet.
- list the uses of electromagnets.
- describe the working of an electric bell.

a. Magnetisation

We have already learnt that a magnet is a substance which has a property to attract magnetic materials such as iron, steel, nickel, etc. Magnets can be both natural (lodestone) and human-made. Lodestone mainly consists of an oxide of iron called magnetite (Fe_3O_4). Many magnets of different shapes and sizes are made from natural magnet.

A horseshoe magnet is U-shaped. The strength of a horseshoe magnet is double the strength of a bar magnet because both the magnetic poles in horseshoe magnet point in the same direction. Horseshoe magnets have different sizes and strengths. They are either permanent or temporary. An electric bell uses a horseshoe electromagnet. Figure 11.26 shows a picture of horseshoe magnet.

Figure 11.26. Horseshoe magnet.

Reprint 2024

Activity 11.4. Making a simple magnet

Materials required

Bar magnets, paper pins, and nails.

Procedure

Step 1. Place a pin on a table.
Step 2. Take the nail closer to the pin. Observe.
Step 3. Now place a nail on a table.
Step 4. Stroke the nail several times with the bar magnet slowly in the direction as shown in Figure 11.27.
Step 5. Now take the nail closer to the pin. Observe.

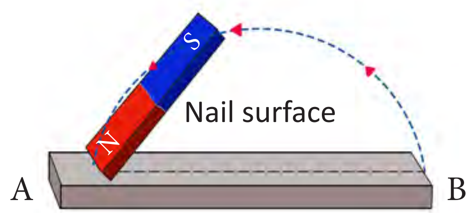


Figure 11.27. Stroking a nail with bar magnet.

Answer the following questions.

1. Is the pin attracted by the nail in step 2? Why?
2. Is the pin attracted by the nail in step 5? Why?

A simple way to magnetise a piece of iron is by stroking it several times with a strong permanent magnet, as shown in Figure 11.27. In the figure, the nail AB is stroked with a strong magnet in the direction shown by the dotted line. In the process, the end B of the nail becomes south pole and end A becomes north pole. This method is called a **single touch method**.

Figure 11.28 shows the orientation of molecular magnets inside the iron piece before magnetisaton. The molecular magnets do not have any particular orientation. Therefore, the iron piece does not show net magnetic effect.

Figure 11.28. Orientation of molecular magnets.

When the iron piece is stroked several times by a strong magnet as shown in Figure 11.29, the molecular magnets are aligned in line with the magnetic field of the magnet.

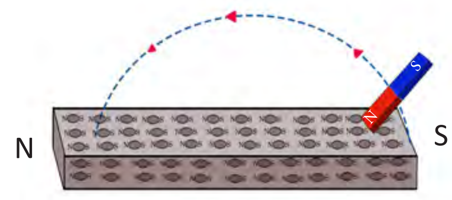


Figure 11.29. Single touch method.

Magnetisation can also be done by using two bar magnets to stroke the iron piece as shown in Figure 11.30. It is called **double touch method**.

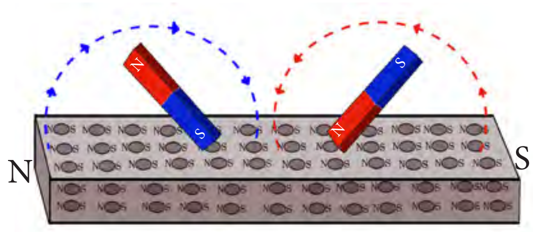


Figure 11.30. Double touch method.

Another way to magnetise a piece of iron is by using electricity. Figure 11.31 shows a soft iron piece like a nail put inside a coil of insulated wire. The ends of the coil are connected to the positive and negative terminals of a battery. A coil of insulated wire in which electric current flow is called a **solenoid**. The soft iron solenoid acts as a magnet as long as electric current flows in it. Such magnet is called electromagnet.

The polarity of an electromagnet is determined by the direction of current flow. If the direction of the current at the end of solenoid in the coil is clockwise, then the end is south pole. In Figure 11.31, the end A behaves as south pole. If the direction of the current flow in the coil is counter clockwise, then that end is north pole. In the same figure, the end B behaves as north pole.

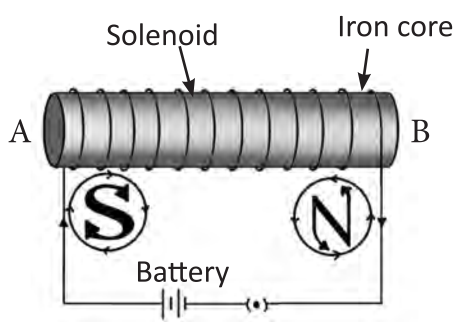


Figure 11.31. Electromagnet.

The magnetic field of an electromagnet can be altered by changing the strength of current flowing and by increasing or decreasing the number of turns of coil.

Electromagnets are used in many appliances.

1. Electromagnet is used in electrical devices such as the electric bell, telephone, loud speakers, electric motor, dynamo, etc.
2. Powerful electromagnet is used in cranes to lift and transfer containers, iron, steel, and their scraps in shipyards and factories.
3. Electromagnet is used to separate magnetic materials from non-magnetic ones.
4. Electromagnet is used to remove bits of iron from eyes and wounds.
5. Some trains use electromagnets to levitate themselves from tracks. This way trains move with great speed.

b. Parts of an Electric Bell

Parts of an electric bell are:

1. **Electromagnet:** It is a solenoid with soft iron core, which gets magnetised when electric current flows through the coil.
2. **Armature:** It consists of a soft iron metal piece to which a striker is attached.
3. **Spring:** When the electric current does not flow in the circuit, the spring pulls back the armature to its initial position.
4. **Striker:** It is a small metallic sphere at the tip of the armature, which strikes the gong to produce sound.
5. **Gong:** It is a metallic hemisphere which is struck by the striker to produce sound.

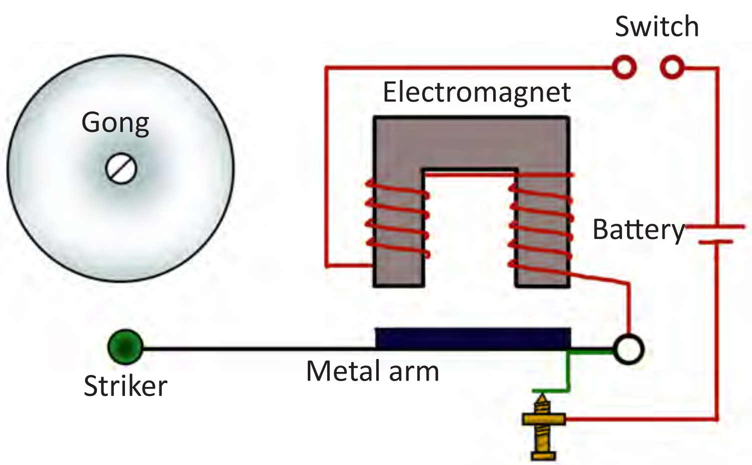


Figure 11.32. Parts of an electric bell.

Activity 11.5. Working of an electric bell

Use the google form to complete the following passage by referring Figure 11.32.

In an electric bell, when the switch is put on, the electric circuit is completed. The current flowing through the circuit makes an ………(1)……….. The electromagnet attracts the ……… (2)………. This makes the striker to hit the ……(3)..….. and produce sound. As soon as the striker hits the gong, the circuit is ……… (4)………. which will demagnetise the electromagnet. Hence, the electromagnet no longer pulls the armature, and it is pulled back to its ……(5)……. position by the spring. This makes the circuit …… (6)………… again. This process is repeated as long as the switch is on and the ……(7)..…. keeps on hitting the gong and sound is produced.

WEBLINK
http://www.coolmagnetman.com/magreview.htm
http://tutorvista.com/physics/10-uses-of-magnets

Exercise

Multiple Choice Questions

1. Figure 11.33 shows an experiment to test the property of a liquid.

   What is the property tested?

   A. Melting point.
   B. Conductivity.
   C. Volume.
   D. Density.

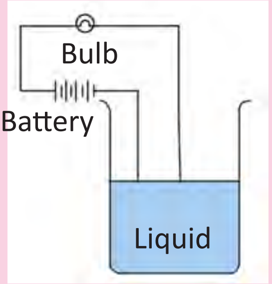


Figure 11.33.

2. Figure 11.34 shows magnetic field lines between the two poles of magnets.

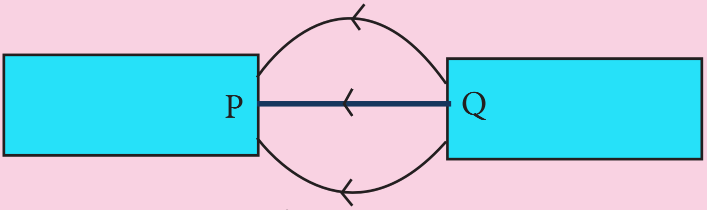


Figure 11.34.

   Which of the following statements

   A. P is north pole and Q is south pole.
   B. P is South Pole and Q is north pole.
   C. Both P and Q are north poles.
   D. Both P and Q are south poles.

3. Choose the suitable fuse rating for a circuit which has an appliance operating with 7 A of electric current.

   A. 3.5 A
   B. 6.5 A
   C. 7.5 A
   D. 8.0 A

Reprint 2024

4. Which of the following is a heating appliance?
   A. Water boiler
   B. Computer
   C. Bulb
   D. Washing machine
5. A device that breaks a circuit during the flow of excess current and can be reset is called
   A. fuse.
   B. earthing.
   C. miniature circuit breaker.
   D. switch.

Fill in the blanks.

1. The coil of insulated wire in an electromagnet is called ________
2. The directions of the flow of electric current and electrons in a circuit are ________
3. A calculator uses a ________ current.
4. An instrument used to detect an electric current is ________
5. Ohm's law describes how voltage, current and ________ are related.

State whether the following statements are **True or False**. Correct the false statements.

1. Earthing is a technique used for safety purpose.
2. Poles of a magnet always exist in pairs.
3. Ohm's law is true in all physical conditions.
4. Lodestone is a temporary magnet.
5. Wire with blue insulation is a live wire.

Reprint 2024

Answer the following questions.

1. Write two differences between alternating current and direct current.
2. List down two uses of an electromagnet.
3. Explain why the fuse is always connected to the live wire and not the neutral wire.
4. State the colour coding of live, neutral, and earth wires.
5. Calculate the potential difference across a 10 Ω resistor carrying a current of 2.5 A.
6. Calculate the current flowing through a 5 Ω resistor when a potential difference of 12 V is applied across it.
7. Calculate the resistance offered by a heater if the current flowing through it is 3 A when a potential difference of 15 V is applied across it.
8. An electric heater is rated 2500 watt. Calculate the energy consumed in 3 hours, if the cost of 1 kWh is Nu 2.
9. Two bulbs of 100 watt each and a geyser of 2000 watt are connected to a 220 V mains and are operated on an average of 6 hours a day. If the cost of energy is Nu 1.5 per kWh, calculate the cost of electricity consumed for a month.
10. 'Saving electricity in our homes is saving our money'. Mention five ways of saving energy.

Reprint 2024

Chapter 12
Light and Sound

Life on the Earth depends on light and sound. Light is important because it is a primary source of energy. Every living thing depends on plants for their source of energy, and the plants in turn depend on light. Sound is equally important in people's lives as it is used for communication. Seeing and hearing are the fundamental senses of life. Impressions obtained through these two senses are as much necessary as food and water.

1. Refraction of Light

Learning Objectives

On completion of this topic, you should be able to:

- describe refraction of light through glass slab, prism, and lenses.
- draw ray diagrams for the image formation by lenses.
- identify the uses of lenses in optical instruments and devices.

Light is a form of energy which gives us the sensation of sight. Velocity of light remains same in same medium, but it changes with change in density of the medium.

a. Bending Light Rays

One of the properties of light is that, it travels in a straight line in a homogeneous medium. When the light falls on the media of different densities, a portion of the light is reflected, some of it passes through the medium, while rest of it is absorbed by the medium. Those light rays passing through the media change their path and are called **refracted rays**. Refraction of light is the phenomenon in which the direction of the ray of the light changes when it travels from one medium to another medium of different densities. Refraction occurs at the boundary of two different media due to the change in the speed of light.

(a)

(b)

Figure 12.1. Refraction of light.

Activity 12.1. Observing the bending of light rays

Materials required

Plain paper, black marker, ruler, beaker, and water

Procedure

Step 1. Place plain paper on a table.

Step 2. Use ruler and marker to draw a line to divide the paper into two equal halves.

Step 3. Place the beaker on the line drawn on the paper.

Step 4. Look down into the beaker to adjust the position of beaker so that the line appears to divide the bottom of the beaker into halves.

Step 5. Pour water into the beaker, while you continue to look down into the beaker. Observe the line on the paper carefully.

Answer the following questions.

i. What happens to the line as water is added? Why?

ii. A fish you see in the water is not located in exact position and depth as it appears. Explain.

iii. Give an example of refraction of light that you see in daily lives.

b. Medium and Refraction of Light

The speed with which light travels from one medium to the other differs, depending on the optical density of the medium. The **optical density** of a medium is the measure of the extent to which the medium transmits light. The more optically dense a medium is, the slower will be the speed of the light through the medium. Therefore, light travels with different velocity through different media. The medium in which the speed of light is high is referred as **optically rarer medium**. Air is optically rarer medium compared to glass. The medium in which the speed of light is low is referred as **optically denser medium**. Water is optically denser medium compared to air.

The ratio of velocity of light in one medium to the velocity of light in the other medium is called its **refractive index** or **index of refraction**. It is represented by symbol "μ" (Greek letter pronounced as 'mu'). The refractive index of a medium represents the factor by which the velocity of light changes, when traveling through a refractive medium, such as glass or water compared to air or vacuum. As the light travels from a rarer medium to a denser medium, velocity of light decreases, and vice versa.

The refraction of light occurs in the following ways:

1. When light ray passes from denser medium to rarer medium, the refracted ray bends away from the normal as shown in Figure 12.2.
2. If ray is incident normally, it will travel without deviation whether light travels from rarer to denser medium, or vice versa, as shown in Figure 12.3.
3. When light ray passes from rarer medium to denser medium, the refracted ray bends towards the normal as shown in Figure 12.4.

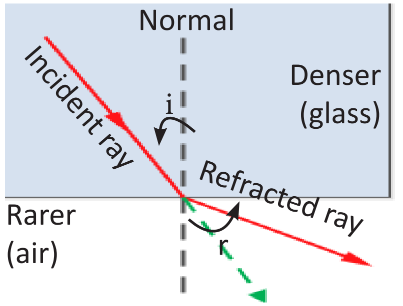


Figure 12.2. Refraction of light from denser to rarer medium.

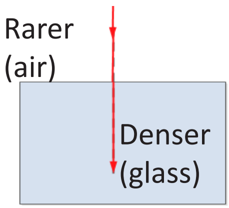


Figure 12.3. Light ray incident normally on a surface.

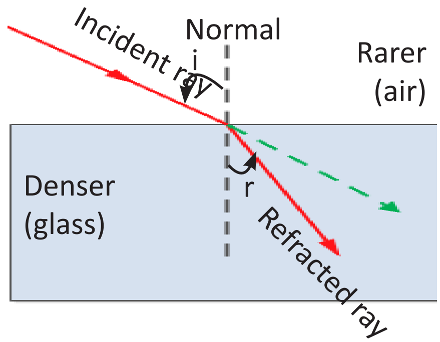


Figure 12.4. Refraction of light from rarer to denser medium.

Reprint 2024

c. Refraction of Light through a Glass Slab

Figure 12.5. shows a ray of light traveling from rarer medium (air) to denser medium (glass) and emerging out into the air again..

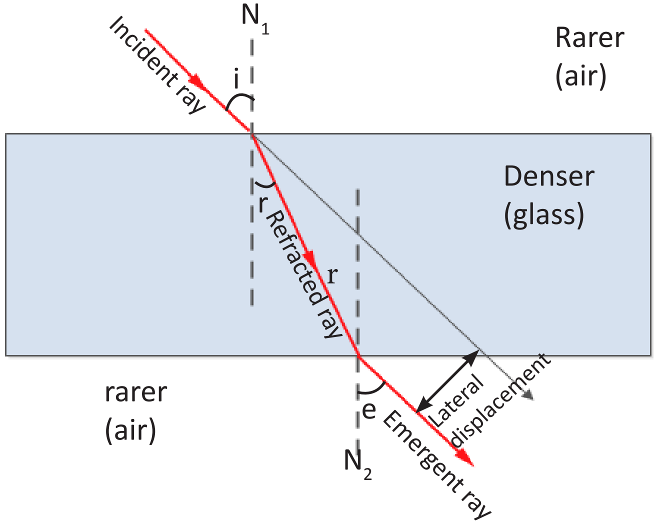


Figure 12.5. Refraction of light through a glass slab.

When a light ray travels from rarer (air) to denser (glass) medium, it bends towards the normal in the denser medium, and it bends away from normal as it goes out from denser to rarer medium.

If the incident ray is produced forward, it forms a line along the direction of the emergent ray. The perpendicular distance between the path of the incident ray and the emergent ray is called **lateral displacement**.

Activity 12.2. Investigating refraction of light through glass slab

Materials required

Drawing board, sheet of paper, pencil, glass slab, pins, and geometry box.

Procedure

Step 1. Place glass slab on a white sheet of paper fixed on the drawing board.
Step 2. Draw a boundary ABCD of the glass slab using a pencil.
Step 3. Remove the glass slab.
Step 4. Select a point of incidence on the line AB.
Step 5. Draw IO to represent the incident ray.

Reprint 2024

Step 6. Draw a normal NN′ at the point of incidence O.

Step 7. Fix two pins P_1 and P_2 vertically on the incident ray IO.

Step 8. Place the glass slab within its boundary ABCD.

Step 9. Look through the glass slab from the opposite side of incident ray and fix two pins P_3 and P_4 such that they are in a straight line with P_1 and P_2. In this condition the pins are in 'No parallax' positions.

Step 10. Remove the glass slab and the pins.

Step 11. Join the points of pin P_3 and P_4 and extend it to line CD to represent the emergent ray O′E.

Step 12. Join OO′ to represent the refracted ray.

Step 13. Draw a normal N_1N_2 at the point of emergence O′.

Step 14. Extend the line IO along the emergent ray O′E.

Step 15. Label and measure angle of incidence, angle of refraction, angle of emergence, and the lateral displacement.

Answer the following questions.

i. What is the angle of incidence and angle of refraction?
ii. Why is the angle of incidence greater than angle of refraction?
iii. What is the difference between angle of incidence and angle of emergence?
iv. What is the relationship between the angle of incidence and the angle of emergence?
v. What is the value of lateral displacement?
vi. Identify the pair of angles which are equal.

d. Refraction in Nature

Figure 12.6. Sunset.

There are several natural phenomena around us that occur due to refraction of light.

We see the Sun before the actual sunrise and after the sunset. This is because of the refraction of the light from the Sun by the Earth's atmosphere. The Earth's atmosphere bends the path of the sunlight so that we see the Sun above the horizon, a position slightly different from where it really is.

Due to the changes in the density of air, the magnitude of refraction of light rays

Reprint 2024

from the stars also changes continuously. Therefore, the apparent positions of images of the stars and its brightness change continuously with time. Hence, the stars appear to twinkle.

Figure 12.7. Twinkling of star.

e. Refraction through Lenses

A **lens** is a transparent medium with spherical surfaces, which refracts light. There are several types of lens. The basic types of lens are the concave lens and the convex lens.

i. Concave Lens

A concave lens is thinner in the middle and thicker at the edges. As light passes through the concave lens, it is refracted in such a way that light diverges out of the lens. Therefore, it is also called **diverging lens**. A concave lens will disperse light and an image produced is always virtual, erect (upright) and smaller than the real object.

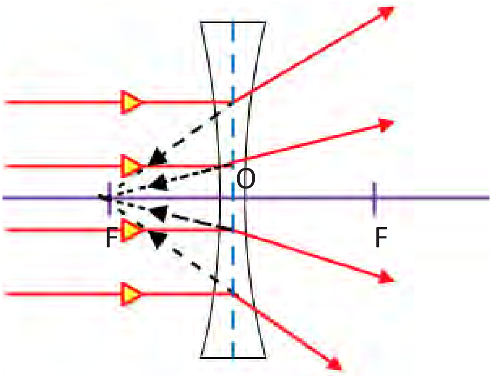


Figure 12.8. Concave lens.

ii. Convex Lens

A convex lens is thicker in the middle and thinner at the edges. As light passes through the convex lens, it is refracted in such a way that light converges to a point. Hence, it is also called **converging lens**. The image formed by a convex lens is generally real and inverted. When convex lens is used as a magnifying glass, the image formed will be virtual and erect. The image can be smaller, bigger or of same size as that of the object. The nature of image depends on the position of the object from the lens.

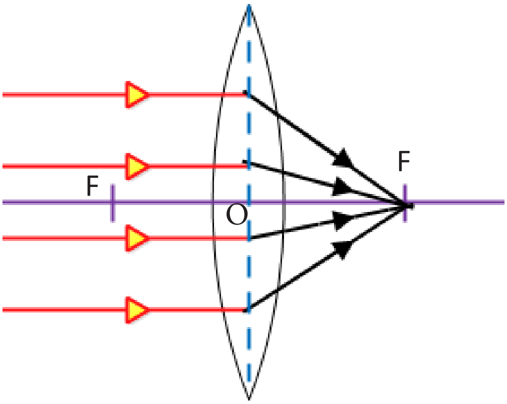


Figure 12.9. Convex lens.

Activity 12.3. Identifying the types of lenses

Materials required

Lens A and Lens B

Procedure

Step 1. Take Lens A and observe the features of the Lens A and fill in Table 12.1.

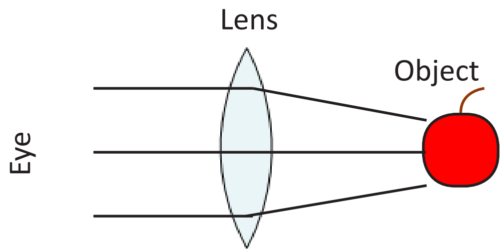


Figure 12.10. Image formation by lens.

Step 2. Look at an object through Lens A as shown in Figure 12.10. Observe the size of the object through lens (Image size) and compare with the original size of the object (Object size). Record your observation in Table 12.1.

Step 3. Repeat Step1 and Step 2 for Lens B.

Table 12.1 *Identifying Lenses*

Lens	Description of Lenses Based on your Observation		
	Thin/Thick Edges	Thin / Thick in Middle	Smaller/ Bigger than Object
A			
B			

Answer the following question.

i. Which lens is convex? Why?

Questions

1. Look at Figure 12.11 and answer the following questions.
   i. Name the type of lenses A and B.
   ii. How did you identify the lenses?
   iii. Give two differences between lens A and lens B.
2. Write two examples of refraction in our daily life.

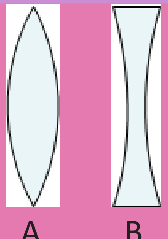


Figure 12.11.

f. Formation of Image by Lens

i. Terms related to lens:

Centre of curvature is the centre of the sphere of which a lens is a part. It is denoted by 'C'.

Radius of curvature is the radius of the sphere of which a lens is a part. It is denoted by 'R'.

Principal axis is an imaginary line passing through the centre of the lens.

Optical centre is a point on the principal axis at the centre of the lens. A ray passing through the optical centre goes un-deviated. It is denoted by 'O'.

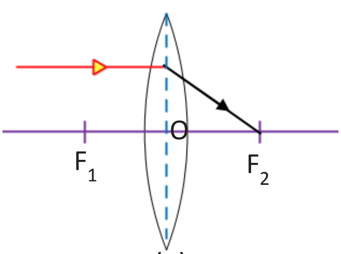
Principal focus is a point on the principal axis. The light ray parallel to the principal axis converges or diverges after passing through the lens. It is denoted by symbol 'F'.

Focal length is the distance between the principal focus F and the optical centre O of the lens. It is denoted by an 'f'.

ii. Convex lens

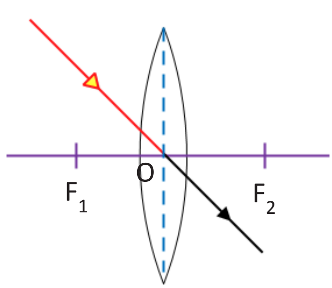
(a) Rules for construction of ray diagrams

1. Ray of light travelling parallel to the principal axis converges at principal focus after passing through the lens.

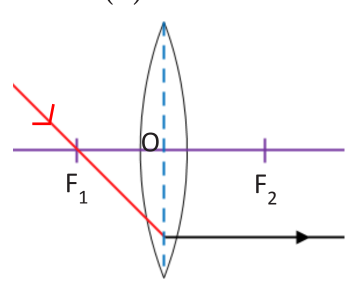


(a)

2. Ray of light passing through the optical centre of the lens emerges from the lens without deviation as shown in Figure 12.12 (b).



(b)



(c)

Figure 12.12. Construction of ray diagrams.

3. Ray of light passing through the principal focus travels parallel to the principal axis as shown in Figure 12.12 (c).

(b) Formation of image in convex lens– Ray diagrams

The type of image formed by a convex lens depends on the position of the object as shown in Figures 12.13 to 12.18.

1. When object is at infinity, the image formed is
   a. at the principal focus F_2
   b. real
   c. inverted
   d. highly diminished

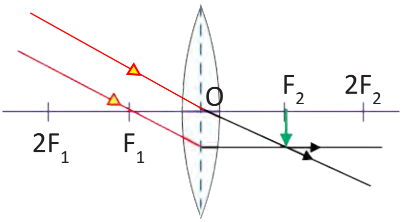


Figure 12.13. Object at infinity.

2. When the object is beyond $2F_1$, the image
   a. in between F_2 and $2F_2$
   b. real
   c. inverted and
   d. diminished

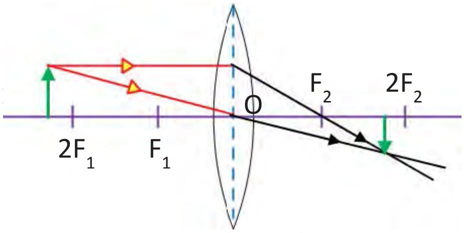


Figure 12.14. Object beyond $2F_1$.

3. When the object is on $2F_1$, the image formed is
   a. at $2F_2$
   b. real
   c. inverted
   d. same size as the object

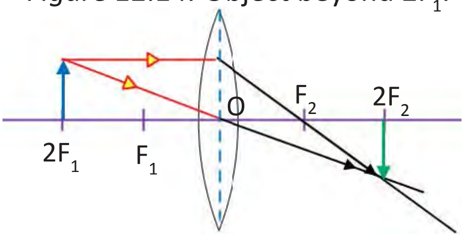


Figure 12.15. Object at $2F_1$.

4. When the object is in between $2F_1$ and F_1, the image formed is
   a. beyond $2F_2$
   b. real
   c. inverted
   d. magnified

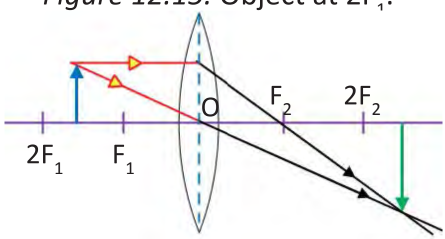


Figure 12.16. Object between F_1 and $2F_1$.

5. When the object is at F_1, the image formed is
   a. at infinity on the other side of the lens
   b. real

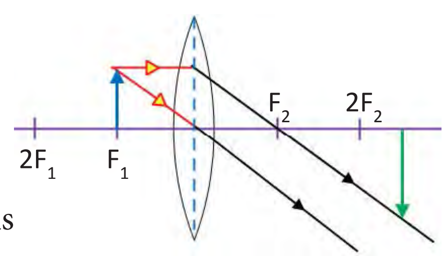


Figure 12.17. Object at F_1.

c. inverted
d. highly magnified

6. When the object is between F_1 and optical centre O, the image formed is
   a. beyond F_1, on the same side of the lens
   b. virtual
   c. erect
   d. magnified

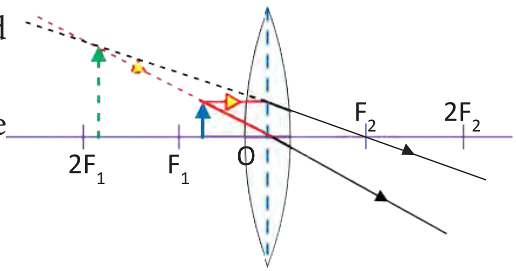
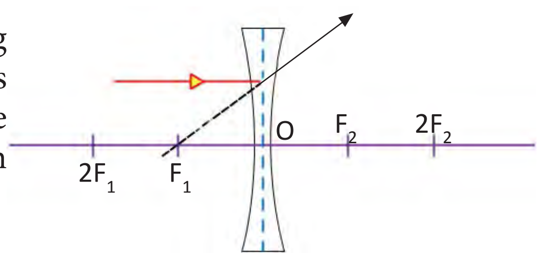


Figure 12.18. Object within focus.

iii. Concave Lens

(a) Rules for construction of ray diagrams

1. An incident ray of light travelling parallel to the principal axis diverges from the lens after refraction. The refracted ray appears to come from the principal focus.



2. Ray of light passing through the optical centre of the lens emerges from the lens without deviation as shown in Figure 12.19 (b).

3. Ray of light that appears to pass through the principal focus travels parallel to the principal axis after the refraction as shown in Figure 12.19 (c).

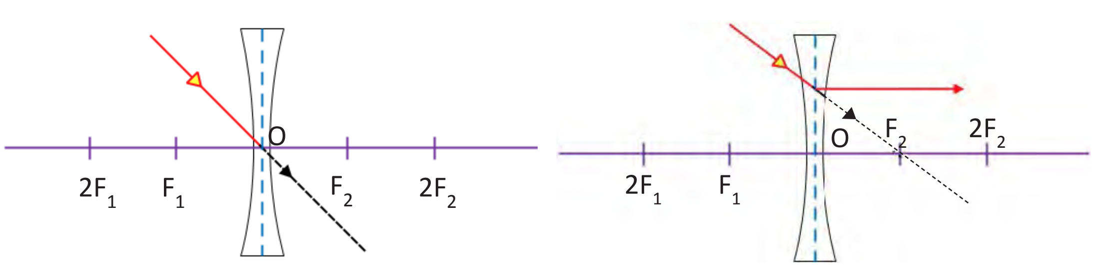


Figure 12.19. Construction of ray diagrams.

Activity 12.4. Formation of image in concave lens– ray diagrams

Using the rules for the formation of image by the concave lens, draw the ray diagrams for the formation of image of an object at two different positions. Use graph paper for the diagrams.

i. Write the characteristics of the image formed.
ii. What is the location of the image?
iii. What conclusion can you draw about the nature of image formed from your ray diagrams?

g. Lenses Everywhere

Table 12.2 gives the uses of lenses at various places and devices. In some places we use the combination of both the type of lenses.

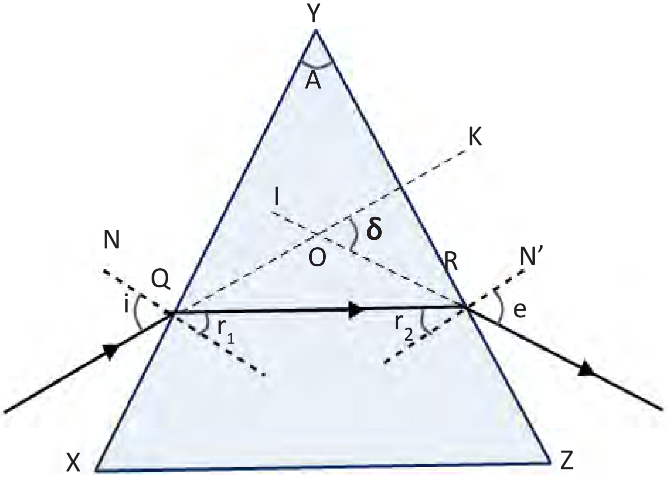
Table 12.2 *Uses of Lens*

Device	Name of the Device	Lens Used
	Binocular	Convex lens
	Projector	Convex lens
	Magnifying glass	Convex lens
	Flash light	Convex lens and concave lens
	Camera	Convex lens and concave lens
	Overhead projector	Convex lens

Device	Name of the Device	Lens Used
	Microscope	Convex lens
	Spectacles	Convex lens and concave lens
	Spy holes in the door	Convex lens
	Telescope	Convex lens and concave lens
	Contact lens	Convex lens and concave lens

h. Refraction of Light through a Prism

Prism is a transparent medium enclosed by two plane refracting surfaces, XY and ZY, inclined at certain angle supported by a base XZ as shown in Figure 12.20. The angle between the two refracting surfaces of prism is called angle of prism. The angle of prism is represented by 'A'.



i = angle of incidence

r = angle of refraction

e = angle of emergence

δ = angle of deviation

A = angle of prism

Figure 12.20. Refraction through a prism.

When the ray of light is incident at Q on the face of the, it undergoes refraction. The refracted light ray bends towards the normal as it travels from air (rarer medium) to glass (denser medium). The refracted ray strikes the inner face of the other refracting surface of the prism at R and emerges out of the prism as shown in Figure 12.20.

If incident ray is produced forward as QK and the emergent ray is extended backward as RI, they meet at point O. ROK is the angle of deviation that measures the amount of deviation of incident ray from the normal path after refraction through the prism. It is denoted by the 'δ' (delta).

Do you know?

Sir Isaac Newton was the first to investigate the colour bands formed by white light passing through a prism.

Activity 12.5. Investigating refraction through a prism

Materials required

Drawing board, drawing pins, prism, plain white paper, ruler, pencil, and protractor

Procedure

Step 1. Place the prism on the plain white paper on the drawing board and draw its outline.

Step 2. Remove the prism and mark the outline as X, Y, and Z, such that XY and ZY are the two refracting surfaces.

Step 3. Draw an incident ray DE inclined at a certain angle on the surface XY of the prism.

Step 4. Place the drawing pins P and Q on the line DE, 3 cm apart.

Step 5. Place the prism back exactly on its outline marked X,Y, and Z.

Step 6. Now observe the pins P and Q from the other refracting surface ZY.

Step 7. Fix pin R and pin S such that they are in a straight line with P and Q. In this condition the pins are in 'No parallax' positions.

Step 8. Remove the prism and the pins.

Step 9. Join the points of the pins R and S and extend it to G on the surface ZY to construct the emergent ray FG.

Reprint 2024

Step 10. Complete the refracted ray by connecting point E and G.

Step 11. Label and measure the angle of incidence, angle of emergence and angle of deviation.

Answer the following questions.

1. What are the values of angle of incidence, angle of emergence, angle of prism, and angle of deviation?
2. Why are the incident ray, refracted ray and emergent ray not in a straight line?
3. Why is the angle of incidence greater than the angle of refraction on surface XY?
4. What is the difference between angle of incidence and angle of emergence?
5. What is the relationship between the angle of incidence and the angle of emergence?

i. Dispersion of White Light

The light coming from the Sun is not colourless, but white light consists of seven colours: violet, indigo, blue, green, yellow, orange, and red. This sequence can be remembered by 'VIBGYOR'.

White light incident on refracting surface of a prism splits into seven different colours. The splitting of white light into seven different colours is called **dispersion**. The band of colours obtained by dispersion is called **spectrum**.

Activity 12.6. Formation of spectrum by using prism

Materials required

Drawing board, plain white paper and prism.

Procedure

Step 1. Place a plain white paper under a prism on a drawing board.

Step 2. Position the prism such that sunlight falls on one of the refracting surfaces.

Step 3. Turn and adjust the angle of the prism to obtain a band of spectrum on paper.

Answer the following questions

1. Observe and write all the colours that you see.
2. Are you able to see all the colours clearly? Why?

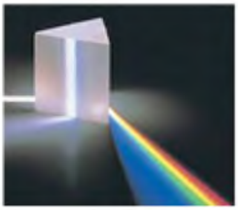


Figure 12.21 Dispersion of light.

Different coloured light are deviated at different angles. The red colour is deviated the least as it moves with higher velocity inside the glass prism and violet is deviated the most as its velocity is the least among the colours as shown in Figure 12.21.

The seven different colours obtained after dispersion of white light in Figure 12.22 are visible to our eyes therefore, it is called **visible spectrum**. There are also ranges of spectrum beyond red and violet, which are not visible to our eyes, they are called **invisible spectrum**.

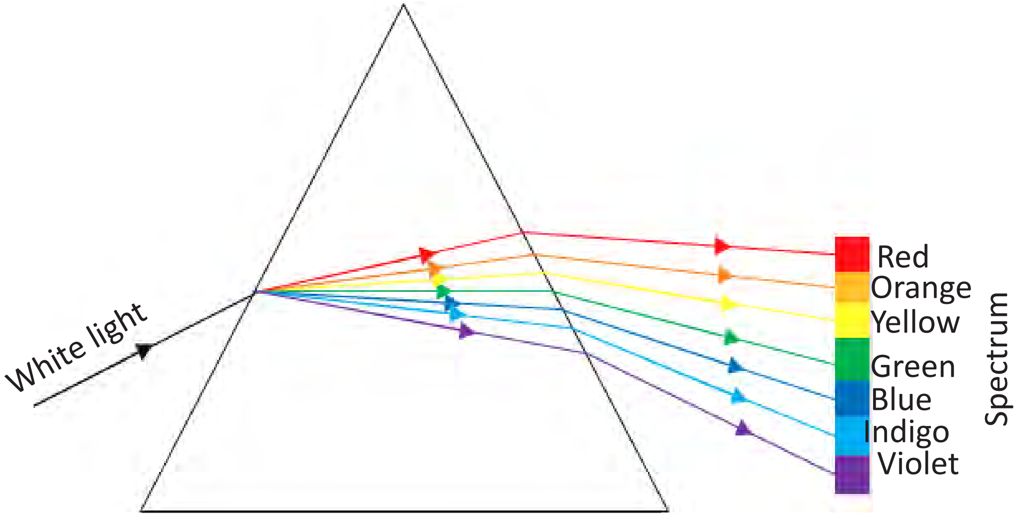


Figure 12.22. Visible spectrum.

2. Colours

Learning Objectives

On completion of this topic, you should be able to:

- identify primary colours and secondary colours of light and pigments.
- describe how coloured objects appear in white light and in other colours of light.
- describe the effect of colour filters on white light and in other colours of light.

The set of colours of light, which cannot be obtained by mixing any other colours are called **primary colours**. They are red, blue, and green. However, primary colours can be mixed to obtain other colours. The colours obtained by mixing any two primary coloured light are called **secondary colours**. Secondary colours are cyan, magenta and yellow. A pair of colours which gives white light is called **complimentary colours**, as shown in Figure 12.23.

Red light	+	Cyan light	=	White light
Green light	+	Magenta light	=	White light
Blue light	+	Yellow light	=	White light

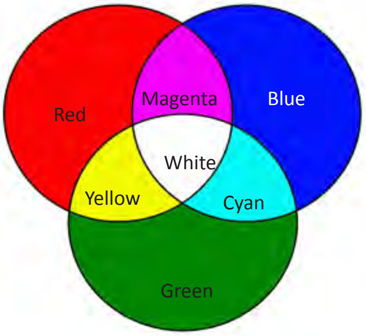


Figure 12.23. Colour combination of light.

Pigments are substance used for colouring objects. Pigments selectively absorb and reflect lights of different colour. The primary pigments are magenta, cyan and yellow. The secondary pigments are red, blue and green. Primary spectral colours are secondary pigments, whereas secondary spectral colours are the primary pigments. Pair of pigments which gives black colour is called complementary pigments, as shown in Figure 12.24

Example:	Magenta	+	Green	=	Black
	Cyan	+	Red	=	Black
	Yellow	+	Blue	=	Black

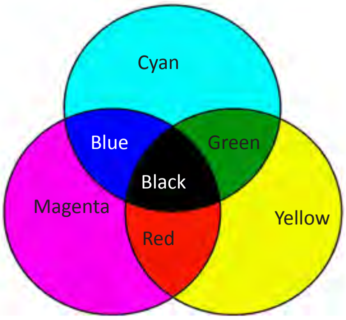


Figure 12.24. Colour combination of pigment.

Reprint 2024

a. How do we See Things

Light is a form of energy, which helps us to see things. For a person to see any object, light reflected by the object must enter the eye of the viewer. When light falls on opaque objects, they reflect a certain portion of incident light and absorb the rest. The colour of the object depends on the colours of the light reflected by the objects. For example, in Figure 12.25 a rose appears to be red under white light because it absorbs all the six colours and reflects only the red light.

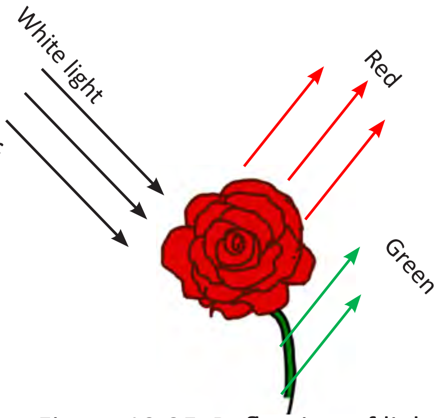


Figure 12.25. Reflection of light from an object.

Table 12.3 shows the appearance of different coloured objects under different coloured light.

Table 12.3 *Colour Matrix*

Objects Light	White Objects	Red Objects	Green Objects	Blue Objects	Yellow Objects	Cyan Objects	Magenta Objects	Black Objects
White Light	White	Red	Green	Blue	Yellow	Cyan	Magenta	Black
Red Light	Red	Red	Black	Black	Red	Black	Red	Black
Green Light	Green	Black	Green	Black	Green	Green	Black	Black
Blue Light	Blue	Black	Black	Blue	Black	Blue	Blue	Black
Yellow Light	Yellow	Red	Green	Black	Yellow	Green	Red	Black
Cyan Light	Cyan	Black	Green	Blue	Green	Cyan	Blue	Black
Magenta Light	Magenta	Red	Black	Blue	Red	Blue	Magenta	Black

WEBLINK http://mathbabe.org/2012/07/01/mixing-colors-pigment-vs-light/

Reprint 2024

Activity 12.7. Seeing coloured objects under white light

Figure 12.26 shows the colours reflected by various coloured balls under white light.

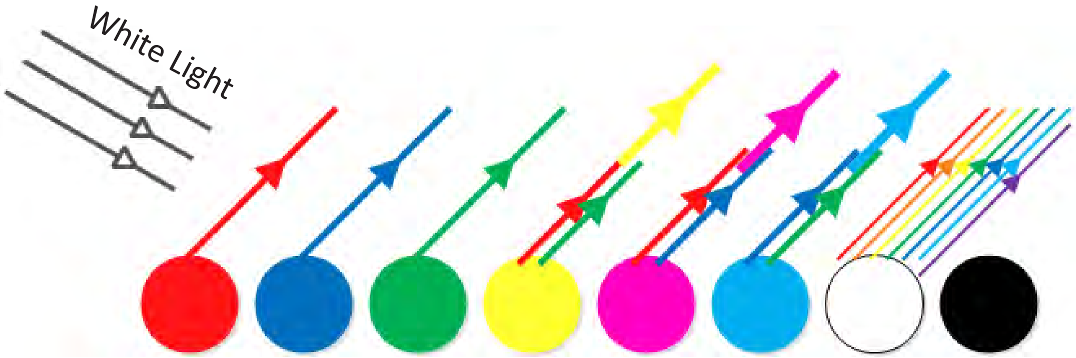


Figure 12.26. Reflection of light by coloured balls.

Answer the following questions.

1. Which colour is reflected by the blue ball in white light?
2. Which colours are absorbed by the blue ball?
3. Name the colours absorbed and reflected by cyan ball.
4. Why does black ball appear black in white light?
5. Why does white ball appear white in white light?

Question

A fruit bowl in Figure 12.27 is observed under three different colours of light i.e., red, blue and green.

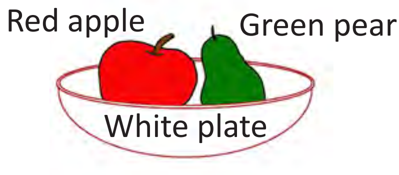


Figure 12.27.

i. What will be the colour of an apple, a pear and the plate in red light?
ii. What will be the colour of an apple, a pear and the plate in blue light?
iii. What will be the colour of an apple, a pear and the plate in green light?

Reprint 2024

b. Colour Filter

A transparent medium which allows light of certain colours to pass through and absorb the rest is called **colour filter**. Filters usually transmit the light of its own colour and absorb the rest.

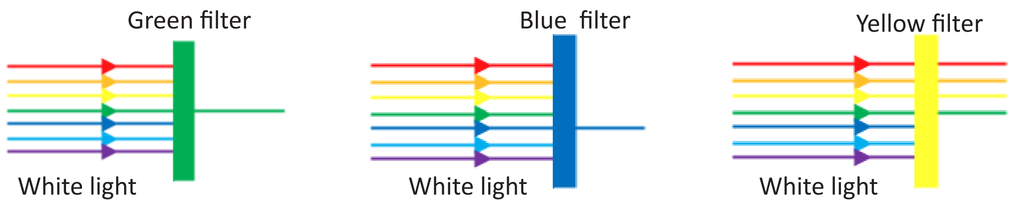


Figure 12.28. Transmission of light through filters.

When white light is incident on a green filter, the orange, yellow, red, blue, and violet components of the light are absorbed by the filter, allowing only the green component of the light to pass through it. Likewise, blue filter will transmit only blue light and absorb the rest. A filter which allows only a single colour of light to pass through is called **pure filter**. Most filters are not pure as they allow more than one colour to pass through them.

Activity 12.8. Investigating the transmission of light through different colour filters

Materials required

Yellow colour filter, blue colour filter, red colour filter and source of white light (torch).

Procedure

Observe the torch light through the colour filters and complete Table 12.4

Table 12.4.

Colours Filter	Colour Seen through the Filter	Colour of Light Passing through the Filter
Red		
Blue		
Yellow		

Reprint 2024

Red + Blue		
Blue + Yellow		
Yellow + Red		
Red + Blue + Yellow		

i. Draw a diagram to illustrate the observation you made from the experiment.

ii. During a birthday, if you wish to have blue dim light, how will you modify your normal bulb light into blue light?

Question

Study Figure 12.30 and fill Table 12.5 with the colours transmitted by each filter.

White light is passed through a yellow filter. Light coming out of yellow filter is again passed through green filter which is further passed through blue filter.

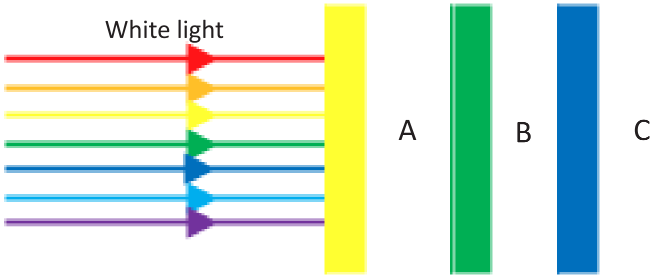


Figure 12.30.

Table 12.5.

Colours Obtained at 'A'	Colour Obtained at 'B'	Colour Obtained at 'C'

http://www.education.com/science-fair/article/colored-lights-effect/
http://everythingscience.co.za/grade-10/10-sound/10-sound-03.cnxmlplus
http://www.physicsclassroom.com/class/sound/Lesson-1/Sound-is-a-Mechanical-Wave

Reprint 2024

3. Sound

Every day we hear different types of sound. The sound is produced by animals, birds, human beings, automobiles, aeroplanes, etc. Sound is a form of energy that is produced by a vibrating body. It requires medium for propagation and travels in the form of waves. The velocity of sound is not constant. It varies in the same medium at different temperatures and in different media.

The sound from a source is characterised by loudness, pitch and the timbre. Sounds from different sources can be distinguished from each other by these characteristics. The properties of each sound wave is described by its wavelength, frequency, and amplitude.

Learning Objectives

On completion of this topic, you should be able to:

- explain the relationship between the loudness and amplitude of the sound.
- explain the relationship between pitch and frequency.
- explain why sound travels with different speed in different media.

Sound waves are generated by any vibrating body. For example, when a drum is hit, the membrane of the drum vibrates about its initial position. These vibrations transfer energy to nearby air particles, producing sound waves in air. Similarly, when a guitar string is plucked, it vibrates, i.e, the string moves back and forth about its initial position. This initial position is called **mean position**. The two positions A and B on the either side of the mean position O, as shown in Figure 12.31, are called **extreme positions**. If the string moves from mean position O to A and then to B and back to O, then the string is said to complete one vibration or **oscillation**.

Vibrations can be represented in the form of waves. A **wave** is a disturbance that moves through a matter or a space. Waves carry energy from one place to another.

Reprint 2024

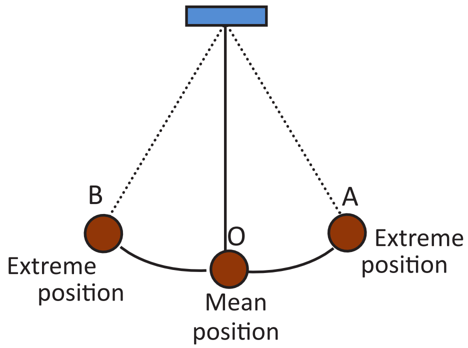


Figure 12.31. Oscillation of a simple pendulum.

Activity 12.9. Drawing sound waves

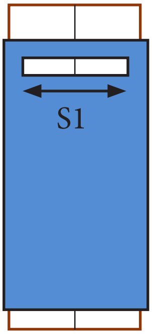


Figure 12.32. Wave device.

Materials required

Card board, paper cutter, sellotape, paper, and pencil.

Procedure

Step 1. Make a paper tape of width 5 cm and length of 30 cm.

Step 2. Draw a centre line along the length of the paper tape.

Step 3. Cut the card board to make a wave device as shown in Figure 12.32.

Step 4. Cut a thin slot S1 of 3.6 cm, on the wave device card board so that slot is exactly divided by the centre line. Label mean position and the extreme positions A and B.

Step 5. Make sure the paper tape slides easily through the wave device.

Step 6. Similarly, make another thin slot S2 of 2.6 cm just below the first slot.

Step 7. Insert the paper tape into the wave machine.

Step 8. "Vibrate" your pencil in slot S1 back and forth once, i.e, from mean position O to A and then to B and back to O inside the slot while your friend slowly pulls the paper tape. Name it tape 1.

Step 9. "Vibrate" your pencil in slot S1 back and forth rapidly inside the slot while your friend slowly pulls the paper tape. Name it tape 2.

Step 10. Repeat Step 8 with slot S2. Name it tape 3.

Step 11. Repeat Step 9, but "vibrate" your pencil back and forth rapidly. Name it tape 4.

Reprint 2024

Answer the following questions

1. What is the shape of one complete vibration in tape 1?
2. What is the common feature of the lines in all the tapes?
3. How are the waves in tape 2 and tape 3 different?
4. How are the wave in tape 2 and the wave in tape 4 different?
5. How can you relate vibration and the form of the waves?

The type and the properties of the waves depend on the vibrations that produce them. Each wave can be plotted graphically as shown in Figure 12.33.

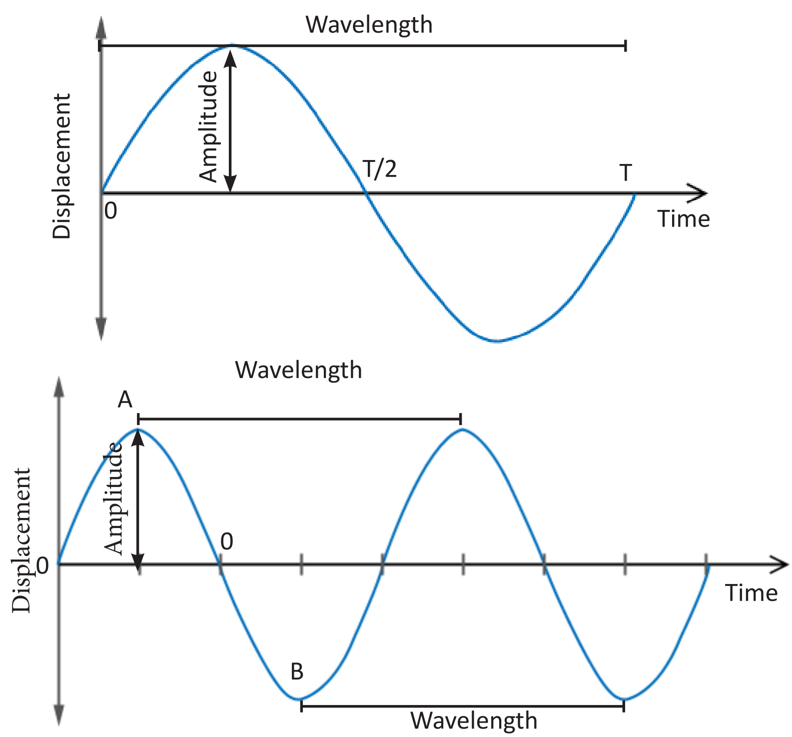


Figure 12.33. Graphical representation of waves.

Sound waves are described by using the following terms.

Wavelength

The distance between start point and the end point of a wave for one complete vibration of same speed and direction is called **wavelength**. It is represented by symbol λ (lamda). It is measured in metres.

Frequency

The **frequency** of a wave is the number of wavelengths that pass through a point in one second. It is also described as the numbers of vibrations a body makes in one second. It is denoted by '*f*'. It is measured in hertz (Hz).

Amplitude

Amplitude is the measure of displacement of vibrating body on either side about its mean position. Amplitude is measured in metre and generally denoted by 'a'. Greater the energy a wave carries, the larger is its amplitude.

Period

The **period** of a wave is the time it takes for one complete oscillation. The unit of period is second. It is denoted by 'T'.

a. The Loudness of Sound

What makes a sound loud or soft? A loud sound can be produced by striking the cymbals hard and a soft sound can be produced by striking them gently.

Loud sounds have more energy than soft sounds.

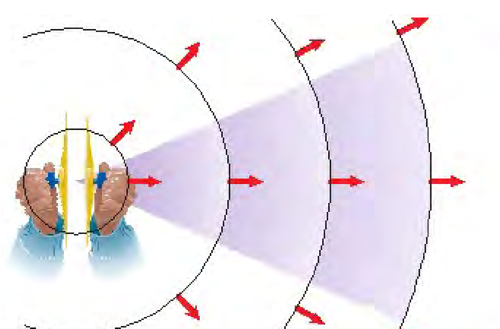


Figure 12.34. Sound from striking cymbals.

The amount of energy that a wave carries across a unit area in each second is the **intensity** of the sound. Figure 12.34 shows how the intensity of sound from the cymbals decreases with distance. The intensity of sound waves is related to the amplitude. Sound with greater amplitude has a greater intensity as shown in Figure 12.35.

Reprint 2024

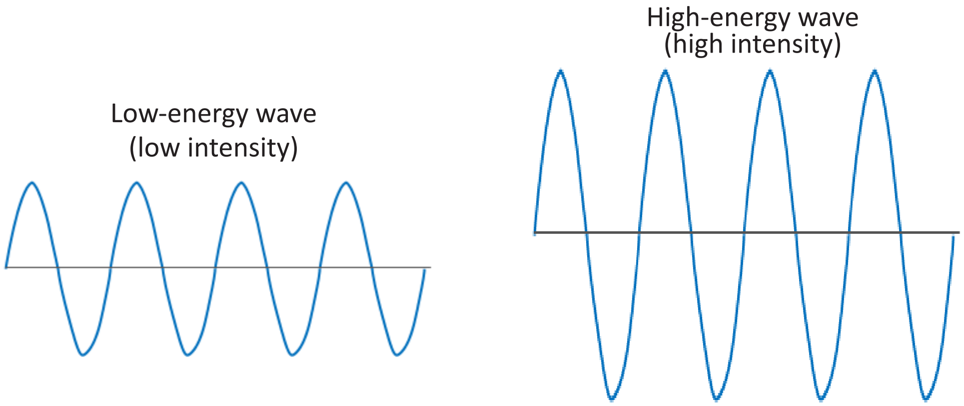


Figure 12.35. Intensity of sound.

The intensity of sound waves is measured in **decibels** (dB), as shown in Figure 12.36.

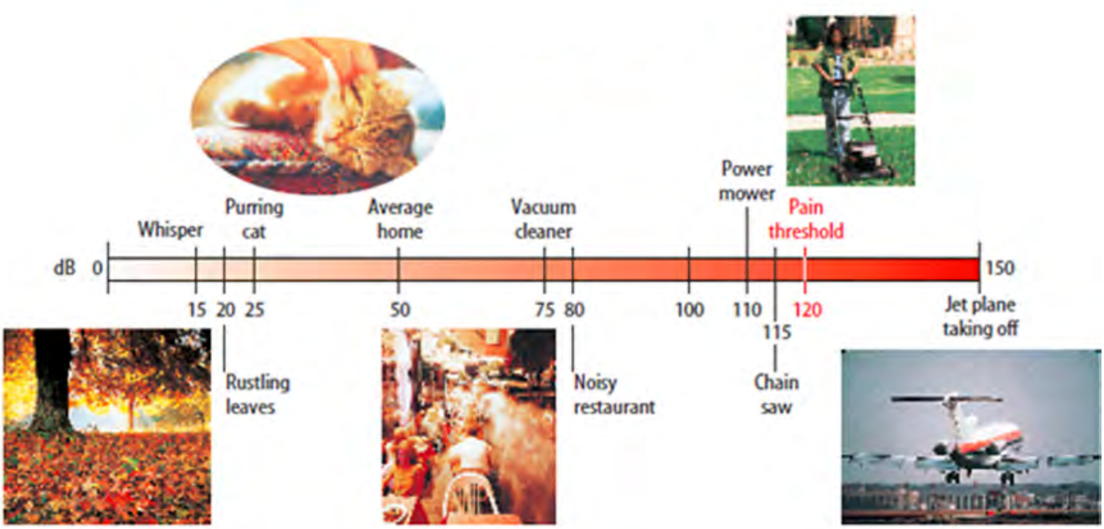


Figure 12.36. Loudness in decibels.

The softest sound a person can hear has an intensity of 0 dB. A normal conversation has an intensity of about 50 dB. Sound with intensities of about 120 dB or higher are painful to hear. Loudness is the human perception of the intensity of sound waves. Prolonged exposure to sounds above 85 dB can damage your hearing.

b. Frequency and Pitch

The **pitch** of sound waves is determined by the frequency of the vibrations that produce the sound. Wave frequency is measured in hertz (Hz). People are usually able to hear sounds with frequencies between about 20 Hz and 20,000 Hz.

Pitch is the shrillness of the sound. The sounds from a drum have low frequencies, therefore, are low pitched while the sound from a flute have high frequencies resulting in high pitched sound.

Examples:

1. In a guitar, a thin string vibrates with high frequency than a thick string. Therefore, a thin string produces high pitch sound.
2. The frequency of a flute can be changed by closing different holes in the flute. For high pitch note, all the holes are closed.
3. High pitch sound can be produced by tightening the membrane of the drum, or by increasing the tension of the strings in a guitar.

Figure 12.37 shows a sound of high and low frequency.

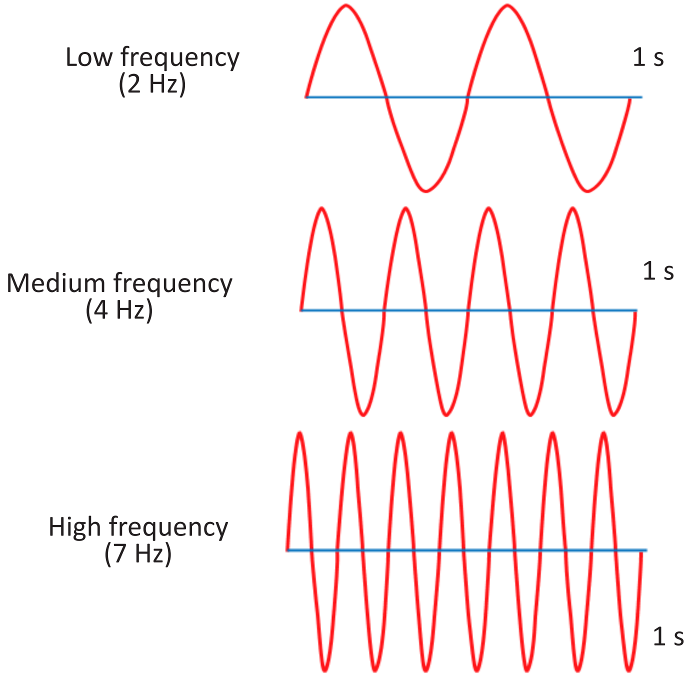


Figure 12.37. Sound waves of different frequencies.

Reprint 2024

Activity 12.10. Investigating the sound produced by the different tuning forks

Materials required

Set of tuning forks and striking pad.

Procedure

Step 1. Copy Table 12.6 in your note book.

Step 2. Take a tuning fork and gently strike the tuning fork on the pad.

Step 3. Listen to the sound carefully.

Step 4. Repeat Step 2 and Step 3 with 2 other tuning forks with greater frequency differences.

Step 5. Complete Table 12.6 in your notebook.

Table 12.6 *Identifying Sound*

Sl No	Frequency of Tuning Fork	Type of Sound (Tick)		
		Sharpest Sound	Sharp Sound	Dull Sound
1				
2				
3				
4				

1. Which tuning fork produced the sharpest sound?
2. Which tuning fork produced the dull sound?
3. How is frequency related to the shrillness of the sound?

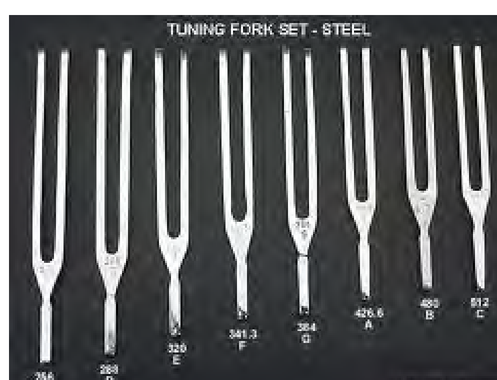


Figure 12.38. Tuning forks.

Reprint 2024

d. The Speed of Sound

Activity 12.10. Investigating the variations in sound

Materials required

4 number of 150 mL beakers, honey, water, pencil, and vegetable oil.

Procedure

Step 1. Fill one beaker with 140 mL water, another beaker with 140 mL vegetable oil and a third beaker with 140 mL honey. Leave the fourth beaker empty.

Step 2. Tap the side of the beaker containing water using a pencil, about halfway down from its rim.

Step 3. Listen carefully to the pitch of the sound that you hear. Observe whether the sound is prolonged or momentary one. Tap the beaker several times to be sure you heard the sound well.

Step 4. Construct an observation table to record the descriptions of the sound.

Step 5. Repeat Step 2 and Step 3 for the remaining beakers. Write the description of the sound in the observation table.

Answer the following questions.

1. List the materials in the beakers in order of increasing density.
2. How does the pitch of the sound change with the change in the density of the material?
3. How does the density of the material affect the duration of the sound?
4. What can you conclude from the experiment?

Speed of sound is not same in every medium. It is because of the following factors:

1. Nature of medium: It is easier for sound waves to travel through solids than through liquids because the molecules in solids are closer together and more tightly bonded. Similarly, it is easier for sound to pass through liquids than through gases, because molecules in gases are farther apart.
   Therefore, the speed of sound is faster in solid materials than in liquids or gases.

Reprint 2024

2. Elastic Properties and Density: An **elastic property** is the ability of a material to maintain or regain its original shape after the impact of a force. Steel is more elastic than rubber. A material such as steel undergoes a smaller deformation than rubber when a force is applied. Steel is rigid material because atoms or molecules have strong force of attraction between them. This attractive force helps the steel particles to restore their initial positions quickly, and thus, can vibrate at higher speed. Therefore, sound can travel faster through medium with higher elastic properties, than through solids, which have lower elastic properties.

   Density describes the mass per volume of the substance. A denser substance has more mass per volume. If a substance is more dense due to larger molecules, it takes more energy to make large molecules vibrate than to make smaller molecules vibrate. Thus, sound will travel at lower speed in the denser object.

3. Temperature: Molecules at higher temperatures have more energy, thus they vibrate faster. The speed of sound in air at room temperature is 346 m/s and the speed of sound in air at freezing temperature is 331m/s.

4. Wind: If the wind blows in the direction of the sound propagation, the speed of the sound increases. If the direction of the sound propagation is in the opposite direction of the wind, the speed of sound decreases. This is mainly because air offers resistance to the sound propagation.

Table 12.7 *Speed of Sound in Different Media at 25°C*

State	Substance	Speed in m/s
Solids	Aluminium	6420
	Nickel	6040
	Steel	5960
	Iron	5950
	Brass	4700
	Glass	3980

State	Substance	Speed in m/s
Liquids	Water (Sea)	1531
	Water (distilled)	1498
	Ethanol	1207
	Methanol	1103
Gases	Hydrogen	1284
	Helium	965
	Air	346
	Oxygen	316
	Sulphur dioxide	213

Questions

1. Study Figure 12.40. Indicate the interval that represents one full wavelength.
   A. A to C
   B. B to D
   C. A to G
   D. C to G

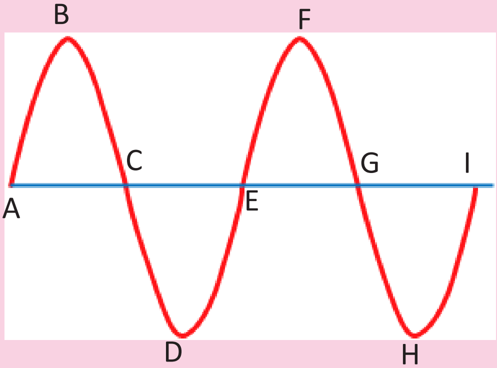


Figure 12.40.

2. Which of the following is not a characteristic of a musical sound?
   A. Pitch
   B. Wavelength
   C. Quality
   D. Loudness

Reprint 2024

Exercise

Fill in the blanks.

1. Angle of refraction is the angle between the _________ and the _________ .
2. A magnifying glass is a _________ lens.
3. The light travels at different _________ in different _________ .
4. A straight stick will appear to_________ when placed in a glass of water.
5. The speed of light in air is _________ than the speed of light in water.
6. The splitting up of white light into seven colours is called _________ .
7. Study Figure 12.41 and answer questions (a) and (b).

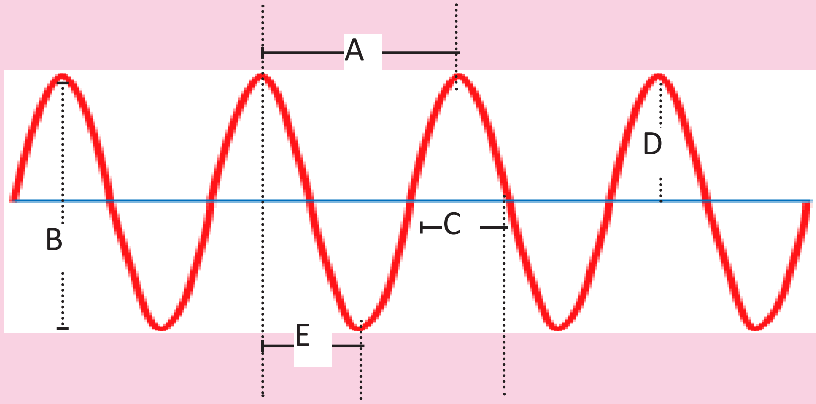


Figure 12.41.

   a. The wavelength of the wave in the diagram above is given by letter _________.
   b. The amplitude of the wave in the diagram above is given by letter _________.

8. The _________ of a wave is the maximum distance moved by the medium particles on either side of the mean position.

Match the following.

Sl.No	Column A	Column B	
1.	Concave lens	a.	Converging lens
2.	Convex lens	b.	Visible spectrum
3.	Prism	c.	Primary spectral colours
4.	Magenta, cyan and yellow	d.	Diverging lens
5.	Red, blue and green	e	Primary pigments
		f	Complementary colours

Check whether the following statements are TRUE or FALSE. Correct the false statements.

1. A concave lens is thicker at the center and thinner at the edges.
2. Yellow filter transmits yellow, orange, red, and green light.
3. In a vacuum, different colours of light travel at different speeds.
4. The density of the medium affects the speed of the sound.
5. When blue and yellow spectral colours are mixed, it gives white colour.

Multiple Choice Questions

1. The refraction of light is caused by

   a. dispersion.
   b. change in frequency.
   c. bending of light.
   d. change in speed.

Reprint 2024

2. If an object is located between the focal point and optical centre of a converging lens, the image formed will be
   a. real.
   b. upside down.
   c. larger than the object.
   d. smaller than the object.

Use Table 12.8 to answer question 3.

Table 12.8

Substance	**Speed in m/s**
Aluminium	6420
Brass	4700
Glass	3980

3. Which of the following statements is true?
   a. Aluminium is more elastic than brass.
   b. Aluminium is less elastic than brass.
   c. Glass is more elastic than aluminium.
   d. Brass is more elastic than aluminium.
4. Assume that the following colours of light pass through a prism. Which colour of light bends the most?
   a. Red.
   b. Blue.
   c. Green.
   d. Yellow.
5. The part of the lens through which the ray of light passes without deviation is called
   a. optical centre.
   b. focus.
   c. centre of curvature.
   d. pole.

Reprint 2024

6. An object reflects red light and absorbs all the other colours. The object appears:
   a. white.
   b. black.
   c. red.
   d. orange.
7. Where should an object be placed so that a real and inverted image of the same size is obtained, using a convex lens?
   a. Between O and F_1.
   b. At F_1.
   c. At $2F_1$.
   d. At infinity.
8. The image produced by a concave lens is
   a. always virtual and magnified.
   b. always virtual and diminished.
   c. always real.
   d. sometimes real, sometimes virtual.
9. Mr. Nidup found a ball lying in his bedroom at night. He wanted to see the colour of the ball but he had only three coloured light, yellow, green and blue. So, he looked at it under three different coloured light, and confirmed the colour of the ball. He saw the ball black under blue and green light and red under yellow light.

Figure 12.42.

The actual colour of the ball in Figure 12.42 is
   a. green.
   b. red.
   c. yellow.
   d. white.

10. When a wave travels through a medium,
    a. particles are transferred from one place to another.
    b. energy is transferred in a periodic manner.
    c. energy is transferred at a constant speed.
    d. energy is not at all transferred.
11. The loudness of a sound wave is determined by
    a. amplitude.
    b. frequency.
    c. period.
    d. wavelength.
12. Consider the waves on a vibrating guitar string and the sound waves the guitar produces in the surrounding air. The string waves and the sound waves have the same
    a. amplitude.
    b. wavelength.
    c. frequency.
    d. velocity.
13. What is the angle of incidence if an incident ray of light is normal to the surface separating the two media?
    A. 0^{o}
    B. 45^{o}
    C. 90^{o}
    D. 180^{o}

Answer the following questions.

1. Define the following terms:
   i. Refraction.
   ii. Dispersion of light.
   iii. Lens.
   iv. Colour filter.

2. Draw diagrams to trace the path of light as it passes from
   i. Air to glass.
   ii. Glass to air.
3. State two consequences of refraction of light.
4. Write two uses each of convex lens and concave lens.
5. The cover of a book appears to have a magenta colour. What colours of light does it reflect and what colours of light does it absorb?
6. Explain the characteristics of sound produced by a woman in terms of loudness, pitch and quality.
7. What are the factors that affect the speed of sound in different media?

Reprint 2024

Chapter 13

The Earth and Beyond

You have already learnt that luminous bodies produce their own light, whereas non-luminous bodies do not. The Sun's family is known as solar system. The major objects that form the solar system are comets, meteors, Sun, satellites, eight planets, and asteroids. The heavenly bodies that round around the Sun, though they do not have light of their own. They have the ability to reflect the light of Sun that falls on them. All of these round in different orbits around the Sun and rotate on their own axis.

1. Visibility of Heavenly Objects

Learning Objectives

On completion of this topic, you should be able to:

- explain that planets and other bodies are seen because they reflect light from the Sun.
- identify the factors that enable object to be seen in the sky from the Earth.

The light from a source spreads in all directions. When it falls on a non-luminous object, the object reflects light in all direction which makes the object visible. For example, a flower is a non-luminous object. It does not emit light of its own. We see it because it reflects the light falling on it.

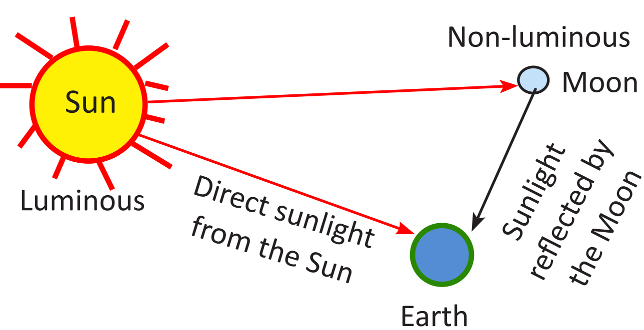


Figure 13.1. Reflection of light by non-luminous bodies.

The Sun and the stars are luminous bodies as they produce their own light.

Reprint 2024

The planets and other satellites do not produce any light of their own. However, they shine and are visible since they reflect light from the Sun and the stars.

The Sun and the stars emit large amount of light. The Moon is very close to the Earth therefore, it is the brightest object seen in the night sky though it only reflects about 7% of the sunlight. Similarly, all the planets and other non-luminous heavenly bodies are visible to us with different brightness. The brightness of the planets and the satellites depends upon the factors like distance from the Sun, its apparent size, the amount of cloud cover, the reflectivity features on its surface, and the relative position of the bodies from the Earth.

Figure 13.2 shows the photographs of four planets and the Moon as seen from the space. Three-fourth of the surface of the Earth is covered with water. Water reflects good amount of light that falls on it. Therefore, the Earth appears the brightest amongst other bodies in the space.

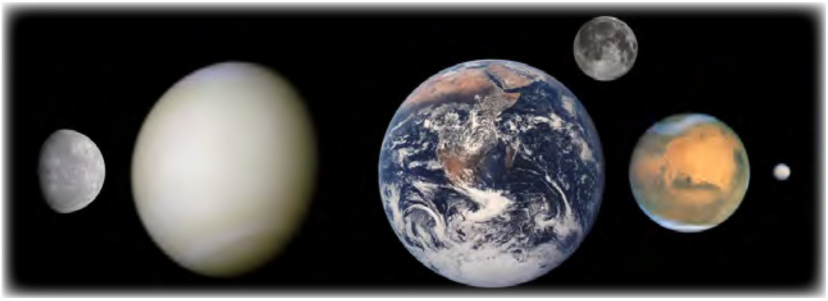


Figure 13.2. Planets seen from the space.

Questions

1. How is the Moon visible to us?
2. Why do we see stars of different brightness in the sky?
3. The Moon is very small compared to Jupiter, but the Moon is seen as the largest object in the night sky. Why?
4. Why is Venus seen brighter than Mercury?
5. What are the factors on which the visibility of heavenly objects from the Earth depend?

Reprint 2024

2. The Planetary Motion

Learning Objectives

On completion of this topic, you should be able to:

- understand centripetal force and centrifugal force.
- explain the movements of planets in relation to gravitational force.

Activity 13.1. Investigating forces in circular motion

Materials required:

A small bucket, water, and rope.

Procedure

Step 1. Tie the rope on the handle of the bucket.

Step 2. Half fill a bucket with water.

Step 3. Swing the bucket from front to back, gradually higher and higher, then smoothly and speedily all the way around in a circle.

Step 4. Make the bucket of water swing in circle several times.

Step 5. Lower the speed of swing gradually and bring it to stop.

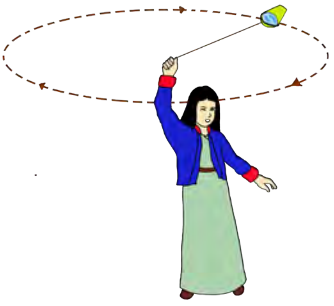


Figure 13.3. Swinging a bucket of water.

Answer the following questions.

1. What type of motion is shown by the bucket of water?
2. Where is the centre of this rotation?
3. What would happen if the bucket is released?
4. What is the direction of the force applied to keep the bucket of water in motion?
5. Even though the water is momentarily upside down, it does not spill out of the bucket. Why?

The force that causes an object to follow a circular path by pulling the object towards the center of the path is called **centripetal force** (Center seeking force).

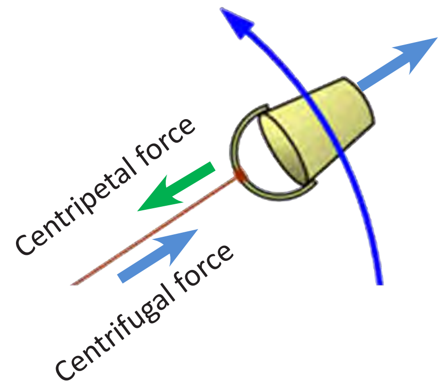


Figure 13.4. Centripetal force and centrifugal force.

Centripetal force exerted on a spinning object like the bucket of water also leads to an equal and opposite force called **centrifugal force** (Centre fleeing force). It is an apparent force that draws a rotating object away from the center of rotation. Centrifugal force is a consequence of inertia of motion. As we swing a bucket of water, the water tries to continue travelling in a straight line, but rope constantly redirects the water in a circular motion. Inertia of water resists the redirection, leading to the centrifugal force that pulls the water to the bottom of the bucket.

Centrifugal force describes the tendency of an object following a curved path to fly outward, away from the centre of the curve. It is due to inertia i.e., the tendency of an object to resist any change in its state of rest or motion. Centripetal force counteracts the centrifugal force and prevents the object from flying out, keeping it along a circular path.

There are several places where centripetal and centrifugal forces play an important role. The principles of centripetal and centrifugal forces are applied in the construction of banked turns on roads, tracks of a roller coaster, separating chemicals in centrifuges in science laboratory, rotation of satellite around the Earth and so on.

Activity 13.2. Case study

Read this article extracted from a website and answer the following questions.

First of all, saying the planets go around the Sun is just another way of saying the planets are in orbit around the Sun. A planet orbiting the Sun is like the Moon or a NASA satellite orbiting Earth. Now, why does a planet orbit the Sun and not the Sun orbit the planet? The lighter object orbits the heavier one, and the Sun is, by far, the heaviest object in the solar system. The Sun is 1000 times heavier than the largest planet, Jupiter and it is more than 300,000 times heavier than Earth. In the same way, the Moon and satellites we launch orbit Earth because they are so much lighter than our planet.

But now we still have the question of why one body orbits another. The reasons are complicated but the first good explanation was provided by one of the greatest scientists ever, Isaac Newton, who lived in England about 300 years ago. Newton realized that the reason the planets orbit the Sun is related to why objects fall to Earth when we drop them. The Sun's gravity pulls on the planets, just as Earth's gravity pulls down anything that is not held up by some other force and keeps you and me on the ground. Heavier objects (really, more massive ones) produce a bigger gravitational pull than lighter ones, so as the heavyweight in our solar system, the Sun exerts the strongest gravitational pull.

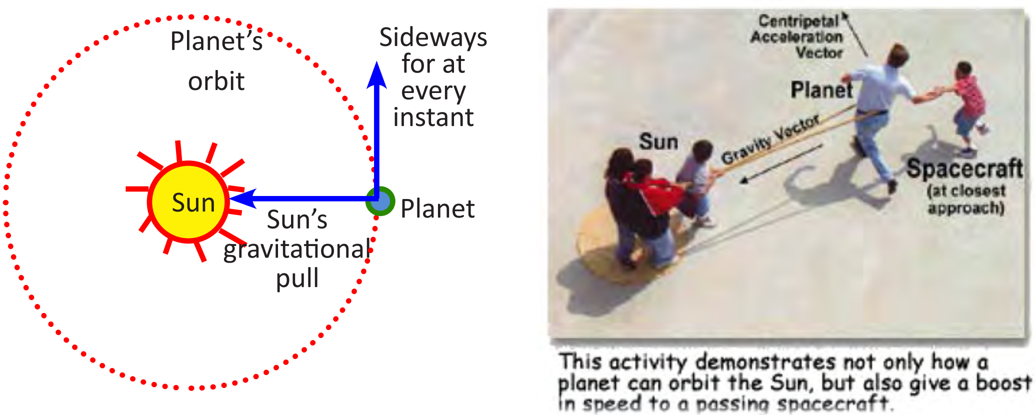


Figure 13.5. Movement of planet on orbit.

Now if the Sun is pulling the planets, why don't they just fall in and burn up? Well, in addition to falling toward the Sun, the planets are moving sideways. This is the same as if you have a weight on the end of a string. If you swing it around, you are constantly pulling it toward your hand, just as the gravity of the Sun pulls the planet in centripetal force, but the motion sideways keeps the ball swinging around. Without that sideways motion, it would fall to the center; and without the pull toward the center, it would go flying off in a straight line, which is, of course, exactly what happens if you let go of the string.

(Source: http://spaceplace.nasa.gov/review/dr-marc-solar-system/planet-orbits.html)

1. What keeps the planets in orbit around the Sun?
2. What is centripetal force? Explain it with an example.
3. Why do planets not collapse into the Sun?
4. What affects the gravitational pull of heavenly bodies?
5. Do all communication satellites revolve around the Earth? Why?

WEBLINK

http://www.physicsclassroom.com/class/circles/Lesson-1/The-Forbidden-F-Word
http://www.beckstromobservatory.com/whats-up-in-tonights-sky/
http://www.space.com/16149-night-sky.html

Exercise

Fill in the blanks with correct word (s).

1. The force acting between two heavenly bodies is called ___________.
2. The gravity on the Moon is ___________ than the gravity on the Earth.
3. The force that keeps the planets from collapsing into the Sun is _____.
4. Star produces its own light. Star is an example of ___________.
5. An object is visible due to ___________ light.

Multiple Choice Questions

1. Which statement about the force of gravity is **true**?
   A. The smaller the masses of two objects, the larger the force of gravity between them.
   B. The shorter the distance between two objects, the greater the force of gravity between them.
   C. Force of gravity depends only on distance.
   D. Force of gravity depends only on mass
2. What does the Earth's gravity do?
   A. Allows ships to sail smoothly.
   B. Keeps things from floating away from the Earth.
   C. Pulls the Earth closer to the Sun each year.
   D. Causes volcanoes to erupt.
3. The mass of the Moon is six times lesser than the mass of the Earth. The gravitational pull on the Earth will be
   A. twice the force of gravity on the Moon.
   B. six times the force of gravity on the Moon.
   C. twelve times the force of gravity on the Moon.
   D. three times the force of gravity on the Moon.

Reprint 2024

4. Although the planet Mercury, the Moon and the dwarf planet Pluto are of similar sizes, the Moon is distinctly visible from the surface of the Earth. This is because
   A. gravity on the Moon is more.
   B. Moon is closer to the Earth.
   C. Mercury is closer to the Sun.
   D. Pluto has the least gravity.
5. Which of the following sets contains only objects that shine as a result of reflected light?
   A. Moons, planets, and comets.
   B. Moons, comets, and stars.
   C. Planets, stars, and comets.
   D. Planets, stars, and Moons.

Check whether the following statements are TRUE or FALSE. Correct the false statements.

1. Moon has no gravity.
2. Gravity is a contact force.
3. No stars in the universe have planets orbiting around them.
4. Centripetal force is a force that makes an object move along a curved path.
5. The heavenly object orbits the Sun because the Sun is the heaviest object in the solar system.

Answer the following questions.

1. Observe Figure 13.6 carefully and answer the following questions.
   a. What does the figure show?
   b. Why do planets move around the Sun?

Figure 13.6.

c. The gas in the Sun is continuously burning and the energy is getting dissipated. One day, millions of years later, the Sun might vanish. Predict what would happen to the solar system considering the size of the planets?

2. Jupiter has sixteen moons and the largest moon is as big as the Earth. Why is it not visible from the Earth?
3. Table 13.1 shows the mass of the planets in kilograms.

Table 13.1

Planets	**Mass in Kg**
Mercury	0.33×10^{24}
Venus	4.87×10^{24}
Earth	5.98×10^{24}
Mars	0.65×10^{24}
Jupiter	1900×10^{24}
Saturn	570×10^{24}
Uranus	87×10^{24}
Neptune	100×10^{24}

a. Name the planet that exerts the maximum gravitational pull.
b. Name the planet that exerts the minimum gravitational pull.

5. Sonam jumped 5 m during school sports day competition. How high can Sonam jump on the Moon?

Reprint 2024

Annexture - A

Assessment

Assessment in science involves testing of scientific knowledge, skills, values and attitudes. The assessment should be able to diagnose the learning progress or gap of the learner in terms of expected core competencies and learning outcomes. Consequently, it is imperative to use appropriate assessment techniques and tools to provide relevant feedback to the learners and to assess the impact of teaching learning processes.

Holistic assessment entails assessing all the three domains of learning: cognitive, psychomotor and affective. Thus, the assessment practice in science assesses Scientific Knowledge (SK), Working Scientifically (WS), Scientific Values and Attitudes (SV) of the learners.

Purpose of Assessment

Assessment is used to:

i. inform and guide the teaching and learning process.

ii. gauge the efficacy of the teaching and learning process.

iii. assess the relevance of curriculum materials.

iv. help learner's set learning goals.

v. monitor learner's progress in achieving learning outcomes.

vi. generate reports on learner's performance.

Areas of Assessment

The assessment in science focuses on the three domains of learning reflected as scientific knowledge (cognitive), working scientifically (psychomotor) and scientific values and attitudes (affective) as detailed below:

i. **Scientific Knowledge (SK):** The learner meets the requirement reflected in the learning objectives and expected learning outcomes under each unit, chapter, and topic. The learner is able to provide expected scientific information through various ways as asked.

ii. **Working Scientifically (WS):** The learner demonstrates scientific skills such as observing, predicting, inquiring, questioning, investigating, experimenting, measuring, classifying, recording, analyzing, inferring, communicating, etc. and explain how science works.

iii. **Scientific Values and Attitudes (SV):** The learner exhibits interest, curiosity, intellectual drive, creativity, exploring possibilities, inquisitiveness, finding facts, coherent presentation of ideas, reasoning

Reprint 2024

skills, collaborative skills, respect and concern for all, etc.

Assessment Modalities

The assessment focuses on diagnosing the learning gap through Continuous Formative Assessment (CFA), Continuous Summative Assessment (CSA) and Summative Assessment (SA) using appropriate assessment tools.

Specifically, the assessment is carried out in the following ways:

i. **Home work:** The extended activities given to students encourages independent learning and responsibility to complete the task. The task is assigned only on important topics that require extra time and energy, and to be assessed using appropriate assessment tools such as rubrics, rating scale, and checklist.

ii. **Class work:** The learning activities such as group discussion, presentation, individual work, etc. are assessed using appropriate assessment tools.

iii. **Journal:** A journal is an informal written record of personal thoughts, experiences, and observations. The students are free to express their ideas related to science and the entries can be simple and short, written or sketched based on their observation. You have to observe carefully and write down your observations. Therefore, the science journal probes students to document their observations about the scientific concepts, events and phenomenon that they observe and experience in their daily lives.

    This activity shall be carried out throughout the academic session with periodical assessments. An exercise book can be maintained by each student to make a minimum of 15 entries in their science journal. While maintaining journal, students are expected to explain the concept with the use of appropriate scientific language and scientific processes. The journal must be well organised and have the reflection of the learner. Teacher must assess each entry and may use the sample rubrics to assess the students' work.

iv. **Project work:** It is an opportunity for the learner to learn and explore the basics of science through the scientific process of observation, investigation, analysis, and synthesis to generate scientific knowledge and understanding. The project work is given based on the topic of the learner's choice and assigned at the beginning of the academic session. It is mandatory to assess both process and product of the project work. The learner must select the topic based on their interest in the beginning of class VII and complete the project work by the end of class VIII. Therefore, teacher shall assess some components in class VII and remaining in class VIII as reflected in rubrics of project work. The product of the project work must be inclusive of write ups, illustrations, models or collection of real objects.

Reprint 2024

The format for the project work write-up must include observation, questioning, hypothesis, background information, design, data collection, analysis, conclusion and sharing as explained in the scientific processes. The teacher may use the given sample rubrics to assess the students' project work.

v. **Practical work**: It is a hands-on experience given to the learner to test, develop, and apply the scientific theories learnt in the class. It enhances the deeper understanding of scientific ideas which culminates in the development of scientific skills, temper and positive attitudes and values. A practical work is conducted based on the requirement of the topic and concept.

vi. **Test and Examination**: It is a procedure intended to establish the quality, performance, or reliability of learner's learning. It is used to test the conceptual understanding and competencies of students in subject matters. Tests are generally administered at the end of every chapter while the examinations are conducted at the end of each term.

Assessment Matrix

Assessment Matrix									
		CFA	**CSA**					**SA**	**Grand Total**
		Domains	**Domains**						
		SK WS SV	**SK WS SV**	**SK**	**WS**	**SV**	**Total**	Examination	**CSA+Exam**
Areas of Assessment	Term I	Home Work	Home Work	1	1	1	3	25	40
		Class work	Class Work	1	1.5	1.5	4		
		Practical work	Test	1		1	2		
		Journal	Journal	0.5	1	1.5	3		
		Project work	Project work	0.5	1	1.5	3		
	Term II	Home Work	Home Work	1	1	1	3	45	60
		Class work	Class Work	1	1.5	1.5	4		
		Practical work	Test	2		1	3		
		Journal	Journal	0.5	1	1	2.5		
		Project work	Project work	0.5	1	1	2.5		
Grand Total				9	9	12	**30**	70	**100**

Topic-wise time allocation and weighting

Chapter Number	Chapter	Maximum time required (mins)	Weighting
1	Cell	400	5%
2	Human as Organism	950	13%
3	Green Plant	500	7%
4	Living Things and their Environment	600	8%
5	Classifying Material	915	12%
6	Materials and Change	470	6%
7	Separating Mixture	390	5%
8	Patterns in Chemistry	655	9%
9	Force and Motion	420	6%
10	Work and Energy	320	4%
11	Electricity and Magnetism	720	10%
12	Light and Sound	845	11%
13	The Earth and Beyond	240	4%
	Total	7425	100.00%

The total time required to complete the topics is 7425 minutes or 165 periods of 45 minutes in a period

Assessment Tool

It is important to use appropriate assessment criteria and tools to obtain the right information on the progress of the learners. This is because the quality of information acquired through assessment is determined by the tools and descriptors chosen for assessment. The assessment tools and samples are given below:

- **i.** **Checklist:** It offers 'yes' or 'no' format in relation to the achievement of specific criteria by a learner. It can be used for recording observation of an individual, a group, or the whole class.
- **ii.** **Rating scale:** It allows teachers to indicate the degree or frequency of the behaviours, skills, and strategies displayed by the learner. It has scale-based criteria to describe the quality or frequency of the work with precise and

Reprint 2024

reliable descriptive words. The teachers can use it to record observations and the learners can use it for self-assessment.

iii. **Rubric:** It presents a set of criteria with a fixed measurement scale and a detailed description of each level of performance. It helps to increase the consistency and reliability of scoring.

iv. **Anecdotal Record:** It helps to record specific observations of a learner based on behaviour, skills, and attitudes in relation to the expected learning outcome. It provides cumulative information and direction for further instruction. It can be used for the ongoing observations.

Sample Assessment Tools

i. **Checklist**

	Domains														**Teachers feedback**	**Remedial Actions**
	SK				**WS**						**SV**					
Name	Name everyday materials	Name some transparent and opaque materials	Categorize things into degradable and non-degradable things.	Classify things in our surroundings into natural and man-made things.	Observation	Experimentation	Recording	Analysis	Conclusion	Communication	Curiosity	Respect	Inquiry	Collaboration		
Dorji	✓	✓	✓	X	X	X	✓	✓	✓	X	✓	X	X	X	**SK**: 3 ticks **WS**: 3 ticks **SV**: 1 tick	

Reprint 2024

ii. Rating Scale

Domains	Key Areas	Performance Rating					
		Exceeding	Meeting	Approaching	Beginning	Feedback	Remedial Action
SK	Define living things						
	Define non – living things						
	Mention the characteristics of living things						
	Mention the characteristics of non-living things						
	Define habitat						
	State the importance of habitat						
	Define adaptation						
	Give example of the technique used by living things to adapt						
	State the importance of camouflage						
	Explain food chain						
WS	Observation						
	Experimentation						
	Recording						
	Analysis						
	Conclusion						
	Communication						
SV	Curiosity						
	Respect						
	Inquiry						
	Collaboration						

iii. Rubric

		Performance Rating				Remarks/ Feedback
Domains	Key Areas	Exceeding	Meeting	Approaching	Beginning	
Scientific Knowledge	Sources of light	Identify four or more sources of light	Identify three sources of light	Identify two sources of light	Identify only one source of light	
	Properties of light	Explain two properties of light in their own words	Explain one property of light in their own words but one as given in the book	Explain two properties of light as given in the book	Explain any property of light as given in the book	
	Properties of sound	Explain two properties of sound in their own words	Explain one property of sound in their own words but one as given in the book	Explain two properties of sound as given in the book	Explain any property of sound as given in the book	
Work Scientifically	Scientific skills	Demonstrate observation, experimentation, recording, and communication skills	Demonstrate any three skills	Demonstrate any two skills	Demonstrate any one skill	
Scientific values and attitudes	Scientific attitude and scientific inquiry	Demonstrate curiosity, respect, inquiry and collaboration	Demonstrate any three	Demonstrate any two	Demonstrate any one	

iv. Anecdotal Record

Anecdotal Records are detailed, narrative descriptions of an incident involving one or several learners. They are focused narrative accounts of a specific event. They are used to document unique behaviors and skills of a learner or a small group of learners. Anecdotal Records may be written as behavior occurs or at a later time and comprise of following components:

Anecdotal Record

Developmental Domain: ……………….

Learner's Name:……………………….. *Learner's Age:*…………..

Time: …………………………
Observer:…………………

Setting:……………………….

Anecdotal:

(Describe exactly what you see and hear; do not summarize behavior. Use words conveying exactly what a learner said and did. Record what the learner did when playing or solving a problem. Use specific language to describe what the learner said and did including facial expression and tone of voice; avoid interpretations of the learner's behavior).

Interpretation:

(What specific inferences can you make from this anecdotal record? What does it tell you about this learner's growth and development? The inferences must be directly related to the domain designated in the anecdote and refer to a specific aspect of the domain.)

Implication for Planning:

(Give a specific activity that you would incorporate into curriculum planning as a result of what you learned about this learner. Make sure that the plan is directly related to the area of development described in the anecdote and the activity is different from the one in the anecdote. Include a brief explanation of why you would create this specific activity.)

Rubric for Presentation

Domain	Key Areas	Criteria				Remarks
		Exceeding	Meeting	Approaching	Beginning	
SK	Preparedness	Demonstrate clear and logical flow of ideas supported by relevant visual aids.	Contains any three components.	Contains any two components.	Contains any one component.	
	Content	Present variety of ideas that are relevant to the topic.	Presents some ideas that are relevant to the topic.	Presents limited ideas that are relevant to the topics.	Presents ideas that are not relevant to the topic.	
WS	Presentation skills	Communicate the ideas, attains to all the audiences, uses proper gestures and completes within time.	Contains any three components.	Contains any two components.	Contains any one component.	
SV	Collaboration	Seek suggestions, responses to the queries and shows a positive learning attitude.	Contains any three components.	Contains any two components.	Contains any one component.	

Reprint 2024

Rubric for Homework

Domains	Criteria	Performance Rating			
		Exceeding	Meeting	Approaching	Beginning
SV	Completion	All of the assigned work is complete.	Most of the assigned work is complete.	Some of the assigned work is complete.	Little or a few of the assigned tasks are complete.
SK	Accuracy	All of the answers are correct.	Most of the answers are correct.	Some of the answers are correct.	Little or a few of the answers are correct.
WS	Presentation	Work is neat, error free and legible with relevant illustrations.	One component is missing.	Two components are missing.	Three or more components are missing.
WS	Originality	Display of original and creative ideas.	Partial display of original and creative ideas.	Little display of original and creative ideas.	No display of original and creative ideas.
SV	Submission date	Submitted on due date	Submitted one day after the due date	Submitted two days after the due date.	Submitted three days after the due date.

Reprint 2024

Rubric for Project Work

	Domains	Key Areas	Performance Rating: Exceeding (4)	Meeting (3)	Approaching (2)	Beginning (1)
Class VII	**SV**	Observe	Phenomena observed is systematic, objective and verifiable.	Phenomena observed is systematic, objective but not verifiable.	Phenomena observed is objective but not systematic and not verifiable.	Phenomenon observed is subjective and not verifiable.
	SV	Question	Clearly stated, focused, and relates to variables	Loosely stated, focused, and relates to variables	Loosely stated and relates to variables	Loosely stated and does not relates to variables
	SK	Hypothesize	Feature variables and predict the relationship between variables	Predict the relationship between variables	Feature the variables	Makes no sense
	SK	Background Information	Relevant, has adequate information, unbiased and concise.	Relevant, has adequate information, unbiased but not concise.	Relevant, has adequate information that is bi-ased and not concise.	Relevant but lack ade-quate information.
	WS	Design	Procedure is detailed and sequential.	Procedure is not detailed and sequential.	Lack detailed and sequential procedure	Procedure is not shown
	SV	Collect data	Appropriate method, relevant and sufficient data	Appropriate method, relevant but not sufficient data	Inappropriate method, sufficient but irrelevant data	Inappropriate method, insufficient and irrelevant data
Class VIII	**WS**	Analyse	Appropriate mathematical procedures or appropriate charts with clear interpretation	Appropriate mathematical procedures or appropriate charts but no clarity in interpretation	Inappropriate mathematical producers or charts but no clarity in interpretation	Inappropriate mathematical producers or charts and unclear no interpretation
		Conclusion	Restate the hypothesis, supports or refutes it, and explain the role of the test in making the decision.	Restate the hypothesis, supports or refutes it,	Supports or refutes the hypothesis	Restate the hypothesis
		Communication	Focus on communicating the central idea, using evidences in the logical format	Focus on communicating central idea with evidences	Focus on central idea	No focus on central idea

Annexture - B

Model Question Paper

Subject: Science **Full Marks: 100**

Class: VIII **Time: 2 Hrs**

Question 1

Direction: *Each question is followed by four possible answers. Choose the correct answer and write it down in your answer sheet.* [25×1 Marks]

1. The role of the cell organelle pointed out in Figure 1.1 is
   A. golgi bodies-secretes enzymes and hormones.
   B. mitochondrion- produces energy.
   C. nucleus-carries genetic material.
   D. lysosome-digests food.

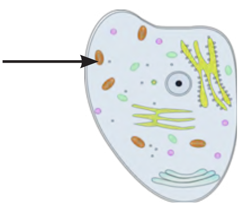


Figure 1.1.

2. A cell is best defined as the
   A. part of living being.
   B. body part that can be seen only under a microscope.
   C. starting point in the life of all organisms.
   D. structural and functional unit of life.

3. Which of the following sequence shows the correct levels of biological organisation?

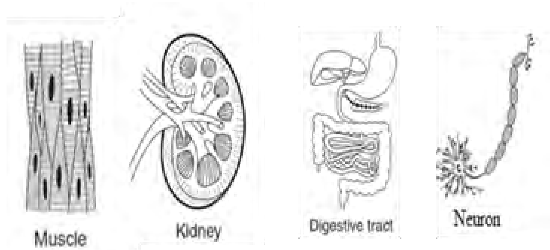


Figure 1.2.

   A. Neuron ⟶ Muscle ⟶ Digestive tract ⟶ Kidney
   B. Neuron ⟶ Muscle ⟶ Kidney ⟶ Digestive tract
   C. Digestive tract ⟶ Kidney ⟶ Muscle ⟶ Neuron
   D. Neuron ⟶ Digestive tract ⟶ Muscle ⟶ Kidney

4. Which of the following acids ionizes partially in water?
   A. HCl
   B. HNO_3
   C. H_2SO_4

Reprint 2024

D. CH_3COOH

5. The tissue that connects bone with bone is called?
   A. tendon.
   B. ligament.
   C. cartilage.
   D. muscle.
6. Which of the following describes the role of the oesophagus in digestion?
   A. It releases acid and mixes food.
   B. It aids in absorption of nutrients from food.
   C. It carries food from the mouth to the stomach.
   D. It carries food from the stomach to the intestines.
7. One can increase the number of sugarcane plants by?
   A. cutting.
   B. grafting.
   C. layering.
   D. budding.
8. The suitable outcome of mulching is?
   A. destroys harmful pests.
   B. maintains moisture and improves soil condition.
   C. increases the lifespan of crops.
   D. decreases crop yield.
9. The shape of the beak differ from one bird to another to
   A. produce different songs.
   B. adapt to a specific source of food.
   C. construct a different type of nest.
   D. protect the birds from different predators.
10. Carrots has a pH of 5.0. Therefore, carrot is
   A. acidic.
   B. neutral.
   C. basic.
   D. an alkaline.
11. Class VIII students performed an experiment using sulphuric acid and sodium hydroxide. Which environmental risks are associated with the disposal of used

Reprint 2024

acid and base in drainage?

I. It may dissolve in water and make the soil basic.
II. It may dissolve in water and make the soil acidic.
III. It may dissolve in water and cause acid rain.
IV. It may leak and contaminate soil and water.

A. I, II and III .
B. I, III and IV.
C. II, III and IV.
D. I, II and IV .

12. A farmer planted chillies in the first year. In the following year, he planted beans in the same field. This type of farming practice is referred as
A. mixed-cropping.
B. mulching.
C. crop-rotation.
D. organic farming.

13. Figure 1.4 shows the structures of four atoms. Identify a pair of atomic structures, which belongs to the same element.

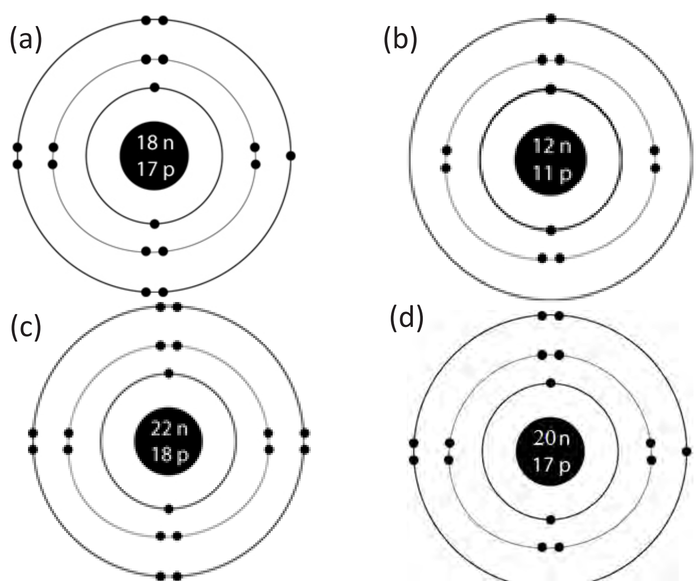


Figure 1.4.

A. (a) and (b)
B. (b) and (c)
C. (a) and (d)

D. (c) and (d)

14. A chemical compound is a pure substance formed by the chemical combination of two or more atoms of different element in a fixed proportion. Which of the following is a compound?

A. CO_3^{2-}

B. CO^2

C. O_2

D. O^{2-}

15. Chemical substances contain a positively charged part and a negatively charged part called radicals. Identify the substance containing only compound radicals from the following:

A. $CaCO_3$

B. NaCl

C. Na_2CO_3

D. NH_4NO_3

16. A balanced chemical equation, shows that the total mass is conserved during a chemical reaction. Which of the following chemical equations agree with the statement?

(a) $Na + Cl_2 \longrightarrow NaCl$

(b) $Na + H_2O \longrightarrow NaOH + H_2$

(c) $C + O_2 \longrightarrow CO_2$

(d) $CaCO_3 \longrightarrow CaO + CO_2$

A. (a) and (b)

B. (c) and (d)

C. (a) and (c)

D. (b) and (d)

17. Figure 1.5 models chemical reaction taking place when paper burns in oxygen to form carbon dioxide. The oxygen atoms are represented by ● and the carbon atoms are represented by ◆. Which of the models correctly represents the chemical reaction taking place?

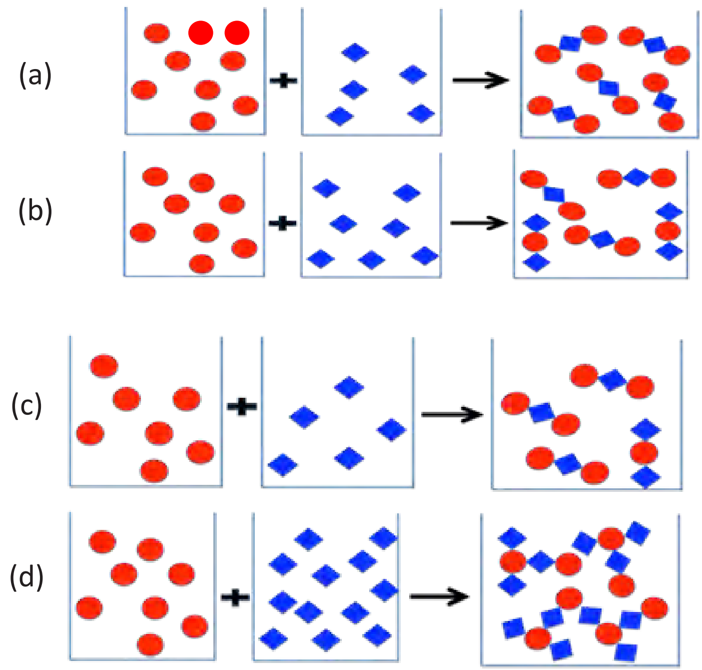


Figure 1.5.

A. (a).
B. (b).
C. (c).
D. (d).

18. A car has an oil drip. As the car moves, it drips oil at a regular rate, leaving a trail of spots on the road. Which of the diagrams in Figure 1.6 showing trail of spots shows the continuous decrease in velocity of the car?
A. (a) .
B. (b).
C. (c) .
D. (d) .

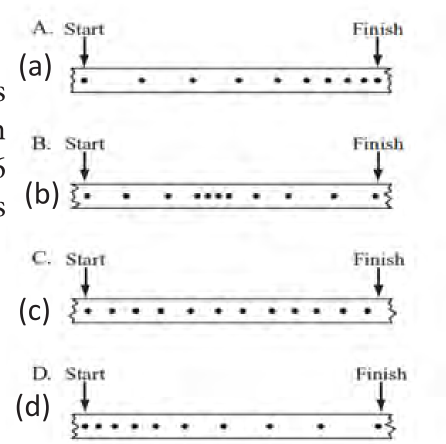


Figure 1.6.

19. Two shapes are made from the same material having equal mass as shown in the Figure 1.7.
The object A reaches the base of the pool faster than the object B when they are dropped from the same height at the same time. This is because

A. gravitational pull on object A is more.
B. gravitational pull on object B is more.
C. object A experiences less fluid friction.
D. object B experiences less fluid friction.

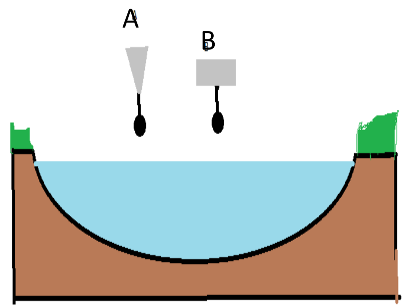


Figure 1.7.

20. Tshering and Wangchuk are attending a swimming lesson. Figure 1.8 shows their heights of diving. Which of the following statements best describes their initial potential energy?
    A. Wangchuk has more potential energy.
    B. Tshering has more potential energy.
    C. Both of them have same potential energy.
    D. Potential energy does not depend on height.

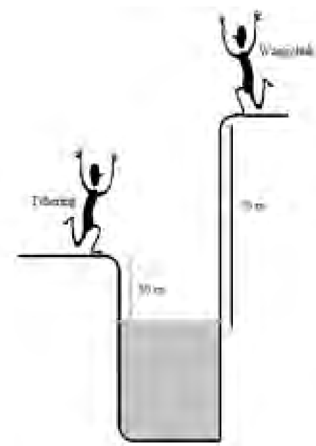


Figure 1.8.

21. Which of the following graphs best describes Ohm's law?

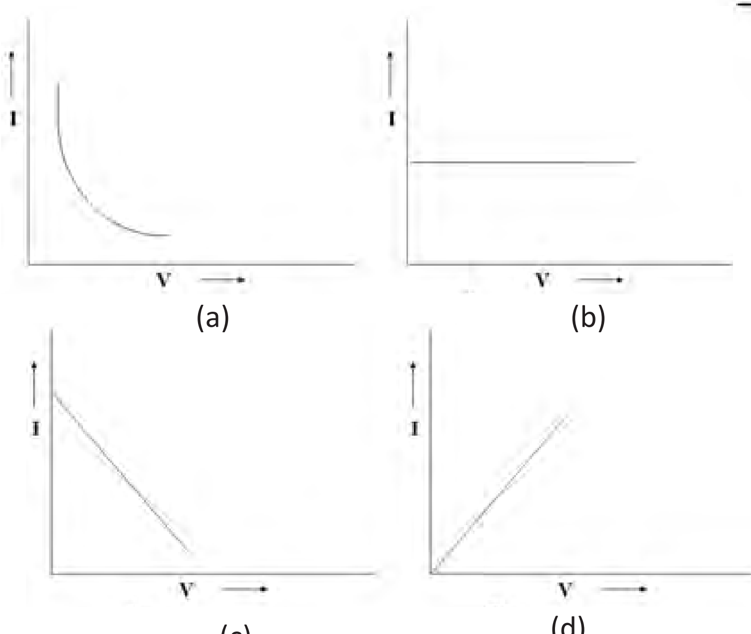


Figure 1.9.

A. (a) .
B. (b).
C. (c) .
D. (d).

22. Which statement best describes the property of light waves illustrated in Figure 1.10?
   A. Some materials absorb light waves.
   B. Some materials reflect light waves.
   C. Some materials refract light.
   D. Some materials emit light without any change.

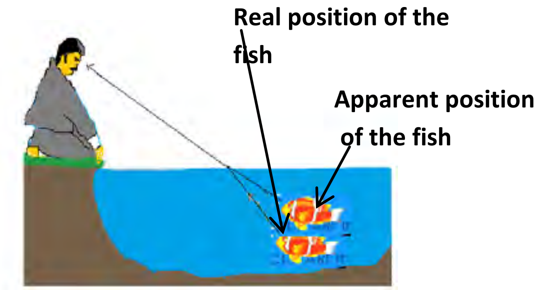


Figure 1.10.

23. White light is passed through various filter as shown in Figure 1.11. What colour will be seen by the observer?
   A. Black
   B. White
   C. Yellow
   D. Red

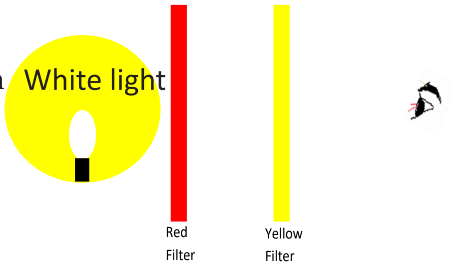


Figure 1.11.

24. Which of the following sets contains only objects that shine as a result of reflected light?
   A. moons, planets and asteroids.
   B. moons, comets and stars.
   C. planets, stars and comets.
   D. planets, stars and moons.

25. Which statement describes the flow of electron through a conductor, which has potential difference across its ends?
   A. Electrons flow from hot region to cold region.
   B. Electrons flow from high potential to low potential.
   C. Electrons flow from its low concentration to the region of its high concentration.
   D. Electrons flow from its high concentration to the region of its low concentration.

Reprint 2024

Question 2

Fill in the blanks. *[10×1 Marks]*

1. A base with a non-metallic ion is ....
2. The chemical formula of sodium carbonate is Na_2CO_3. The compound radical present in it is.................................
3. Ovulation takes place in ....
4. If a man weighs 600 N on the surface of the Earth, his approximate weight on the Moon will be ……………………
5. The protection, preservation, and careful management of natural resources is called…………………… .
6. ....solution is a solution that cannot dissolve any more solute at that given temperature.
7. The magnetic field of an electromagnet can be decreased by …………………… the number of turns of coil.
8. If you put a sharp object into your ear, it might rupture your……………… membrane.
9. The factor that determines the flow of heat from one body to another is ……………………
10. Petroleum products are separated by ....

Question 3

Direction: *Write TRUE or FALSE against the given statements. Correct the false statements.* *[10×1 Marks]*

1. All bases are alkalis.
2. Steel is an example of mixture.
3. With an increase in temperature, the solubility of a substance decreases.
4. Leaching of chemical fertilizers leads to eutrophication.
5. Protoplasm includes cytoplasm, cell organelles, and vacuoles.
6. Natural selection is a fast process.
7. A common characteristic of sound waves is that they are created by vibrations.
8. A cell gets exhausted when chemical reaction stops in it.
9. Electric current is due to the flow of protons.
10. Electric current flows in the same direction of the flow of electrons.

Question 4

Reprint 2024

Direction: *Match the items of Column I with correct answers of Column II [10 Marks]*

Column I	Column II
1. Light	A. determines the solubility of a solvent at a particular temperature.
2. Isotope	B. colour pigment
3. Refraction	C. determines the solubility of a solute at a particular temperature.
4. Chromatography	D. connects the foetus and placenta.
5. Eustachian tube	E. chlorine – 37
6. Pitch	F. depend on frequency
7. Solubility curve	G. bends away from the normal
8. Centripetal force	H. HCl
9. Umbilical cord	I. directed towards centre
10. Stomach	J. can travel through vacuum
	K. connects to throat

Question 5

(a) Karma often sees his mother cleaning off the white deposits from the inner wall of a water boiler using vinegar. Bubbles are formed when the vinegar is added. This helps her to remove the white deposits easily.

i. What do you think these white deposits are? [1]

ii. What is the gas that evolves in the above process? [1]

iii. Why do you think the white deposits are removed by the vinegar?[1]

(b) Peljor uses two tube lights of 60 W each and a bulb of 100 W in a room connected to 220 V mains. The appliances operate for 8 hrs in a day. The cost of energy is Nu. 1.9 per kWh.

i. Calculate the cost of electrical energy used in a day. [2]

ii. Name the energy lost in using the above appliances. [1]

(c) Study Figure 1.12 of a human eye and answer the following questions

a. Label the parts B, E, G and H. [2]

b. Write the function of part D. [1]

Reprint 2024

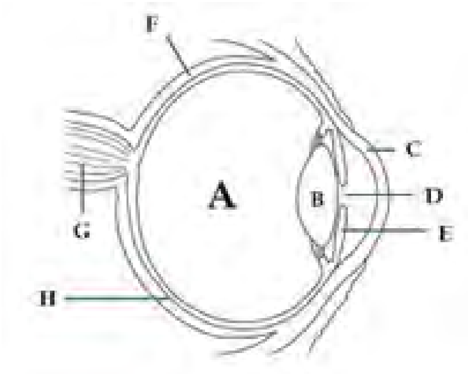


Figure 1.12.

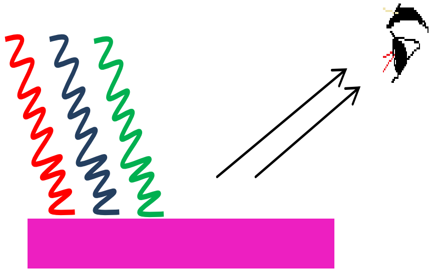


Figure 1.13.

Question 6

(a) Use Figure 1.13 to complete the following statements.

When white light is incident on the magenta object, it reflects the .... and................. light, but absorbs the ....light. If a red filter is placed in front of the observer, the object appears .... [2]

b) Define centrifugal force. [1]

c) Use the information given in Table 1.1 to answer the questions that follow.

Table 1.1

Element	Proton Number	Neutron Number	Electronic Configuration
A	3	7	2,1
B	20	40	2,8,8,2
C	18	40	2,8,8
D	8	18	2,6
E	17	18	2,8,7

i. Which element has valence electrons as 2? [1]

ii. What is the mass number of element A? [1]

iii. Draw the atomic structure of element E. [1]

d. Use Figure 1.14 to identify the feet of animals based on their environment. [3]

Reprint 2024

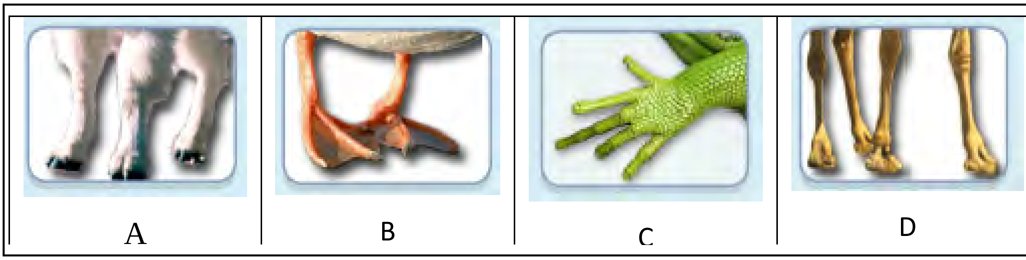


Figure 1.14.

(i) Sandy-

(ii) Aquatic -

(iii) Tree top-

(iv) Steep and rocky mountain-

Question 7

(a) An element X has an atomic number of 13 and a mass number of 27. Similarly, an element Y has an atomic number of 17 and a mass number of 35.

i. What are the valencies of elements X and Y? [1]

ii. Write down the chemical formula of the compound formed between the elements X and Y? [1]

iii. What will be the formula of the compound, if the element X combines with element Z with an atomic number 8? [1]

(b) Draw a ray diagram to show the refraction through prism. Label the following in the diagram. [4]

a. Incident ray

b. Refracted ray

c. Emergent ray

d. Angle of incidence

e. Angle of emergence

f. Angle of deviation

(c) Complete the table given below: [2]

Name of Cell Organelle	**Function**
Centrosome	……………………………….
…………………….	Provides shape and turgidity
Lysosome	………………………….
....	Controls the cellular activities and remove the full stop

Reprint 2024

Question 8

(a) Give two common applications of solubility. [1]

(b) Explain with an example how stirring helps the solubility of solute in a solvent? [2]

(c) Give reasons for the following.

(i) Sedentary life style leads to many health problems. [2]

(ii) Most of the grasshoppers are green. [2]

(d) Convection causes rainfall. Explain how this happens. [2]

Question 9

(a) Excessive use of chemical fertilisers in farming affects our environment. Explain. [2]

(b) A company builds an iron industry in your community. The company burns coal to run this industry.

i. Name some pollutant that will be released into the atmosphere from this industry.[1]

ii. Suggest two measures that can be taken by the industry to reduce the release of these pollutants into the atmosphere. [1]

iii. Explain one consequence, if large amount of these pollutants are directly released into the atmosphere. [1]

(c) Excavators have broad steel track chain, instead of normal wheels. Give reason. [1]

(d) Explain why the Moon is seen as the largest object in the night sky, although the Moon is very small as compared to the other heavenly bodies? [1]

(e) Figure 1.15 shows a small bar magnet suspended by a thin string, which is placed near a solenoid fixed at one point. What affect does the solenoid have on the bar.

(f) Differentiate between selective breeding and evolution. [1]

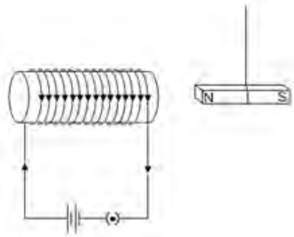


Figure 1.15.

****

Annexture - C

Writers

1	Wangpo Tenzin	M.SC	REC
2	Surjey Lepcha	M.SC	REC
3.	Mr. Chetnath Dhungyal	PGDE	Rangjung HSS
4	Mr. Adip Rai	B.Ed Phy	Damphu HSS
5	Mr Kishore Mongar	M.Sc. Botany	Samtse Col. of Education
6	Ms. Kesang Choden	M.Sc. Chem	Samtse Col. of Education
7	Mr. Jigme Tshering	PGDE, M Sc. Bio	Bayling HSS
8	Mr. Kezang Tshering	PGCE.	Trashigang MSS
9	Mr. Prem Prasad Timsina	B.Sc. Bio	Nangkhor HSS
10	Mr. Tshewang Namgyel	B.Ed Sec. Bio	Trashiyangtse LSS
11	Mr. Bhim Kumar Sharma	PGDE, Chem	Damphu HSS
12	Mr. Basant Pradhan	PGDE, MSc. Chem	College of Sc. & Technology
13	Mr. Choeda Phuntsho	B.Ed. Chem	Tshebar LSS
14	Mr. Sonam Dorji	B.Ed. Sec. Chem	Nanglam HSS
15	Mr. Shankar Lal Dahal	PGCE, Phy	Bajo HSS
16	Mr. Kinley Gyeltshen	M.Ed	Dashiding HSS
17	Ms. Sital Thapa	B.Ed Sec	Lango LSS
18	Mr Deepak Raj Chhetri	B.Ed Sec Phy	Meldregang MSS
19	Ms. Sonam Choden	B.Ed. Sec	Drujeygang HSS

Reprint 2024

Reviewers (Second Edition)

1	Wangpo Tenzin	REC	Writer
2	Bhoj Raj Rai	REC	Writer
3	Wangchuk	REC	Writer
4	Karma Dorji	REC	Writer
5	Phuntsho Norbu	REC	Writer
6	Khem Prasad Thapa	Minjiwoong CS	Writer
7	Tashi yangzom	Khasadrapchu MSS	Writer
8	Susma Pradhan	Kuzhugchen MSS	Writer
9	Singye Thinley	Phuntshothang MSS	Writer
10	Tahi Zangpo	Darla MSS	Writer
11	Pema Tshering	Katsho LS	Writer
12	Tsheltrim Pelzang	Trashigang MSS	Writer
13	Tashi Lhamo	Yangchengyatshel MSS	Writer
14	Kinga Chedup	Wangbama CS	Writer
15	Bal Bdr. Gurung	Loselling MSS	Writer
16	Tobgay	Wangbama CS	Writer
17	Tshering Zangmo	Shari HSS	Writer
18	Namgay Dorji	Shari HSS	Writer
19	Thinley Wangchuk	Taju PS	Writer
20	OM Tshering Lepcha	Norbuling CS	ICT and Art Work
21	Ugyen Tshomo	NECS	Writer
22	Krishna	Consultant, NECS	Writer
23	Chencho Thinley	Lungtenzampa MSS	Language Editor
24	Pratima Rai	Khangkhu MSS	Language Editor
25	Karma Wangmo	REC	Layout and Typesetting
26	Kinzang Peldon	REC	Layout and Typesetting

Reprint 2024