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General Science

Student Textbook

Grade 7

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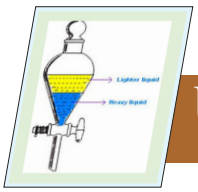
This book was developed by Addis Ababa city Administration Education Bureau and adapted by Southern Nations, Nationalities and peoples' Regional Education Bureau.

Southern Nations, Nationalities and peoples' Regional Education Bureau

Table of Contents



Unit - 7.....203

7. MOTION,FORCE, ENERGY AND ENERGY RESOURCES....203

UNIT - 1

1. BASIC CONCEPTS OF SCIENCE

Learning Outcomes

At the end of this unit, learners will able to:

- *define science as a body of knowledge and the processes and practices used to add to that body of knowledge*
- *describe the main branches of science and explain their relationship.*
- *describe positive and negative effects that result from applications of science and technology in their own lives, the lives of others, and the environment.*
- *appreciate the role and contribution of science and technology in the understanding of the world.*
- *Provide examples of Ethiopian scientists who have contributed to science and technology, and describe their contributions*
- *discuss the importance of scientific values in decision making and problem solving.*
- *Select and use tools to observe, measure, and construct. Including: microscope, concave and convex mirrors and lenses, chemical apparatus*
- *Show concern for their own safety and that of others in carrying out activities and using materials*
- *work collaboratively while exploring and investigating*

Main Conents

1.1. The Nature of Science and its Branches

Learning Competency

At the end of this section, learners will able to:

- *define science as a body of knowledge and the processes and practices used to add to that body of knowledge;*
- *describe the main branches of natural science and explain their relationship;*
- *describe positive and negative effects that result from applications of science and technology in their own lives, the lives of others, and the environment*
- *appreciate the role and contribution of science and technology in the understanding of the world.*
- *discuss the importance of scientific values in decision making and problem solving.*
- *provide examples of Ethiopian scientists who have contributed to science and technology, and describe their contributions*
- *discuss the importance of scientific values in decision making and problem solving; and*

Introduction

In the lower grades, you have learnt about science in general such as environmental science. In this middle level (grade 7and 8) you will learn about general science which deals with things related to our day to day life.

1.1.1. Definition of science (Conventional and Indigenous Science)

Activity 1.1

Form a group and discuss the following questions. Then share your ideas to the class

i) Describe science by your own words
ii) Investigate the ways in which the major areas of science are further divided. You can use reference books and the internet to augment your current ideas
iii) Differentiate Conventional Science and Indigenous Science

The word science comes from the Latin word '***Scientia***', which means' ***Knowledge'.*** But science is not just about having knowledge: **Science** is a systematic method of gaining knowledge about the physical and natural world and the social aspect of human society. It provides an ordered way of learning about the nature of things, based on observation and evidence. Through science, we explore our environment, gather knowledge and develop ideas that help us interpret and explain what we see. Science may be indigenous or conventional.

Indigenous science is process by which Indigenous people build their empirical knowledge of their natural environment. It is knowledge based on the social, physical and spiritual understandings.

Conventional science is the system of knowledge which relies on certain laws that have been established through the application of the scientific method to phenomena in the world around us.

Indigenous Science incorporating local people's knowledge and Indigenous perspectives, while conventional scientific approaches are commonly recognized as Western science.

Activity 1.2

Perform the following activities.

Find some practical indigenous knowledge in your community that solves community problems and present your finding to your class

Q. Why teach Indigenous Knowledge in science?

There are two main reasons to include Indigenous Knowledge in the science:

1. to increase awareness of original culture and identity
2. in modern day environmental problems have social and cultural dimensions which benefit from perspectives other than Western science.

Ethiopia is one of the countries where a wide variety indigenous knowledge practiced for a long time to solve practical problem that exist in different areas like:-

- Extractions of medicinal chemicals from plants to treat disease and fight infections. The common medicinal plants used for treating curing various disease are: *Hagenia Abyssinica* (Kosso tree) , *Eucalyptus globulus* (bahrzaf), *Ocimum lamiifolium* Hochst (Damakese) etc
- Preserving meat by adding a salt and smoke drying

1.1.2. Branches of science

Activity 1.3

Form a group and discuss the following questions. Then share your ideas to the class

1. What are the major branches of science?
2. Give short descriptions of physics, biology and geology.

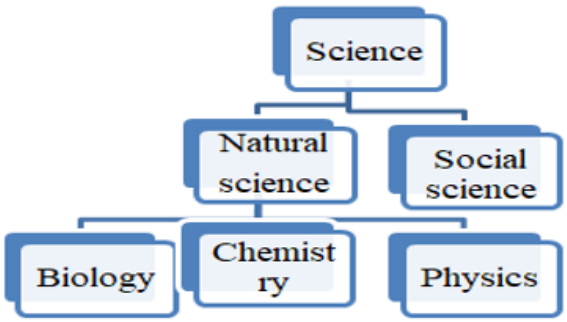


Figure 1.1 branches of science

Science has two major categories, which are natural science and social science. Again, natural science has three branches which are Biology, chemistry and physics

as shown in as shown in figure1.1. At higher levels/grades you will learn more branches of natural science.

Natural science is the study of nature and natural laws. It includes fields such as chemistry, biology, physics and geology. These fields of study in natural science are closely interrelated. There are no distinct boundaries between them.

- **Biology** is a branch of natural science which studies about living things.
- **Chemistry** is a branch of natural science which deals with the properties, composition, structure and transformation of substances.
- **Physics** is the branch of natural science. It is the study of the nature of matter, energy and their interactions.

There is no clear boarder line between the different branches of natural sciences. Knowledge of natural sciences overlaps with each other .For example, chemistry and physics knowledge are studied as a subject called physical science/physical chemistry. It is the study of properties of materials and their interaction.

- Biophysics: combination of biology and physics.

  Biophysics is the study of physical phenomena and physical processes in living things, on scales spanning molecules, cells, tissues and organisms.

- Biochemistry: combination of biology and Chemistry.

  Biochemistry is the branch of science that explores the chemical processes within and related to living organisms. It involves the study of chemical reaction in living things.

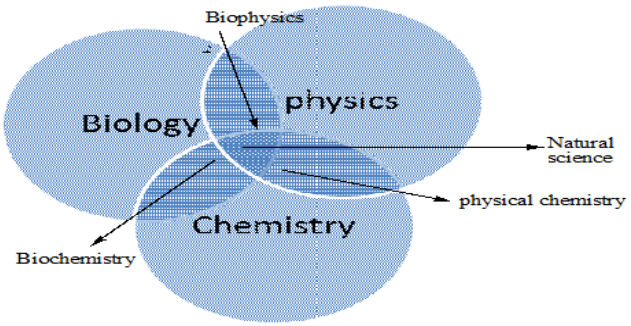


Figure1.2.The relationships between some fields of Natural Science

- Science: a systematic method of gaining knowledge about the physical and natural world.
- Technology: is the use of scientific knowledge to help human beings work easier and live better or putting scientific knowledge into practice.

Exercise 1.1

Give short answer for the followings questions

1. What is science?
2. List the three branch of natural science
3. Which field of science is study of matter and energy?

1.1.3. Science and technology

You have already seen what science is. Now, you will learn what a technology is.

Technology is the use of scientific knowledge to help human beings work easier and live better as well as enjoy their environment more. It includes the use of materials, tools, techniques, and sources of power to make life easier or more pleasant and work more productive. Things such as automobiles, TV sets, radio, bulb, microchip, computer, airplane and home tools (appliances) are the products of technology.

A person who studies technology is called **a technologist.**

Technologists apply Science and mathematical knowledge and skills to produce a very useful tools.

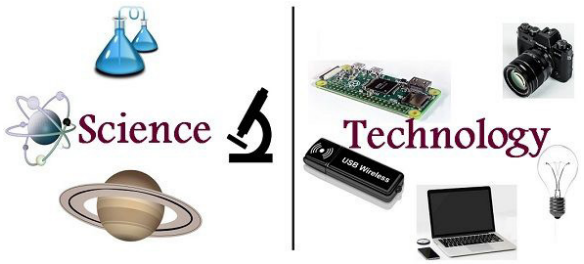


Figure 1.3 Relationship of science and technology

Science and technology is integrally connected; but they are different fields driven by different concepts and processes. Science generates knowledge for its own sake, proposing and testing explanations. Technology, on the other hand, develops human-made solutions to real-world problems. Of course, science uses technology to generate knowledge and technology uses scientific knowledge to generate solutions.

Uses of Science and technology for the society

Science and technology plays an important role in our daily life. It is mainly concerned with the production of new materials of desirable properties and qualities to satisfy social needs and plays an important role in agriculture, in the production of medicines and drugs, in environment and population control, in the construction industry, in manufacturing various products such as cosmetics, textiles, dyes, soaps and detergents, plastics, rubber and a variety of metals, non-metals, alcoholic beverages, dry cells and car batteries.

Activity 1.4

From their background information let them discuss in group about the importance of scientific values in decision making and problem solving.

Science can and should be important for all major decisions in life. Science is often used to support decisions that have profound economic, social and environmental impacts. Good decision-making follows from having clear favorites for what is to be achieved and using science to evaluate potential means of reaching those aims. Mostly decisions are or should be based on two pillars: beliefs and values. A decision maker's **beliefs** are a reflection of his or her perceptions of reality, including facts, opinions, and uncertainties surrounding them whereas its **values** reflect his or her

sense of what to strive for or to achieve, including goals, objectives, and associated negotiations.

Obviously, science can help identify unexpected consequences or causal relationships where ethical values or principles are relevant. In addition, individuals need reliable knowledge for making informed decisions. Science is valued by society because the application of scientific knowledge helps to satisfy many basic human needs and improve living standards.

At a more general level, science can and should be important for all major decisions in life. For example,

- Science can help us learn which products are safe to use or which foods are healthy to eat.
- Doctors use science to decide how to diagnose and treat disease(.Finding a cure for disease)
- Governments may use science to decide which rules to make and how to enforce them.
- Forecasting weather condition (rainy, cloudy, sunny) are some examples.

1.1.4. Famous scientists of the world and Ethiopia

A scientist is someone who systematically gathers and uses research and evidence, to make hypothesis and test them, to gain and share understanding and knowledge. Some of the world and Ethiopian scientists and their contribution are listed below.

Fig1.4 some world known scientist and their works

Activities 1.5

Form a group and the following activity

Choose one of the scientists and create a role-play for the press release following the news of his/her discovery. Various roles to consider would include: the scientist; media; fellow scientists; and the general public. Alternatively, you could choose an Ethiopian scientist and create a cartoon strip showing their discovery.

Dr. Aklilu Lemma(1935 -1997) made his most important scientific discovery very early in his career, in 1964, when he discovered a natural treatment to schistosomiasis, also known as snail fever disease or bilharzia. He found that berries from the endod plant, which is commonly used to make soap and shampoos in many parts of Africa, is a potent, inexpensive and safe molluscicide, to prevent the spread of the parasitic worm. This discovery made the plant an object of scientific research in many parts of the world.

Prof.Yalemtsehay Mekonnen was born in Asela, Ethiopia on May 30, 1955. She work on human physiology, the impact of pesticides on human health, the use of plants as medicinal against human and animal disease and as the first female professor of Addis Ababa university.

TewoldeBerhan Gebre Egziabher is an Ethiopian scientist, who has worked to ensure biodiversity and the rights of communities to their genetic resources.

Gebisa Ejeta (born 1950) is an Ethiopian plant breeder, geneticist and Professor at Purdue University. In 2009, he won the World Food Prize for his major contributions in the production of sorghum.

Fig1.5 some Ethiopia known scientist and their works

1.1.5. Ethical principle in science

Activity 1.6

Form a group and discuss on the following questions then present your opinion to the class

i) Do you think ethical discipline is important for science?
ii) List down same ethical disciplines in science

Ethics is an integral part of science. Like science, it requires being consistent and empirically justified in our interpretation the action of scientists. Things are always get in front of us either right or wrong, good or bad, but we have to decide that what we actually want to do through our ethical point of view.

The following are some of ethical principles that various codes address in science. Those are:

- Honesty
- Responsibility
- Objectivity
- Openness
- Legality
- Non-Discrimination
- Carefulness.
- Competence

Exercise 1.2

Give short answer for the followings questions

1. The natural science disciplines are

A. interacting
B. overlapping
C. Interrelated
D. all of the above

2. The branches of natural science studying the composition of compounds, and the processes taking place in organisms, respectively, are:

A. Chemistry and biology
B. Physics and geology
C. Biology and physics
D. Biology and geology

3. Which one of the following is true about Science?

A. It is the study of physical and natural world.
B. It comes from Latin word "Scientia meaning 'knowledge'
C. It is the system of acquiring knowledge based on scientific method
D. All

4. Which one of the following is true about Indigenous knowledge?

A. It is based on scientific method
B. The knowledge derived from western countries
C. It incorporates local people's knowledge's
D. It has universal perspective and commonly recognized as western science

5. Which one of the following is true about Indigenous knowledge?

A. It is based on scientific method
B. The knowledge derived from western countries
C. It incorporates local people's knowledge's
D. It has universal perspective and commonly recognized as western science

6. World famous scientists who discover law of motion and gravity

A. Michael Faraday
B. Marie Curie
C. Isaac Newton
D. Albert Einstein

1.2. Common Laboratory Equipment, Uses, Safety Rules and Procedures in Science Laboratories

Learning Competency

At the end of this section, learners will able to:

- *identify different laboratory tools*
- *select and use tools to observe, measure, and construct. Including: microscope, concave and convex mirrors and lenses, chemical apparatus*
- *show concern for their own safety and that of others in carrying out activities and using materials*
- *work collaboratively while exploring and investigating*

1.2.1. Common Laboratory Apparatus

Activities 1.7

Form a group and perform the following task. From locally available materials produce laboratory tools such as beaker, measuring cylinder, balance, tong, etc. and present its use to the class.

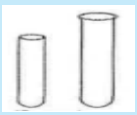
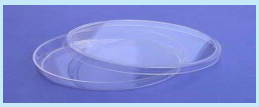
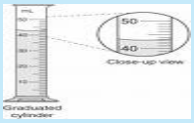
i) List down some laboratory safety rule

ii) Discuss hazard symbols on chemical bottles, electrical gadgets and other materials found in the laboratory

Laboratory equipment comprises different sets of apparatus, which are designed to perform various tasks in the laboratory by students, teachers and scientists.

The students can conduct laboratory work smoothly and more efficiently only when they are familiar with the apparatus commonly used in the laboratory. Some apparatus are shown in tables 1 described here below.

Table 1.1 Different laboratory tools and their use

Name	Picture	Use	Practice
Triple-beam balance		Obtaining the mass of an object	Using this tool measure mass of your book, balls, some stones --- etc
Beaker		Holding water (also used to heat liquids)	
Tongs		Transport a hot beaker; remove lid from crucible	
Thermometer		Used to measure temperature	Using this tool practice how to measure temperature of some body.
Test tubes		Holds small amounts of liquids for mixing or heating.	
Petri dish		Used to grow micro-organisms (like bacteria and fungi)	
Graduated cylinder		Marked with milliliter (ml) scale and is used to measure volume	
Bunsen burner		Heating (flame-safe) contents in the lab	
Fuse		A safety device consisting of a strip of wire that melts and breaks an electric circuit if the current exceeds a safe level.	
Syringe		Used for sucking in and ejecting liquid in a thin stream	

- **Laboratory equipment** refers to the various tools and equipment used by students, teachers and scientists working in laboratory
- **Laboratory report** is how you explain what you did in experiment, what you learnt and what the result mean

1.2.2. Making laboratory equipment/tools from locally available materials

Based on the availability of laboratory tools in their locality, encourage to do Some laboratory tools.

Project work 1.1

Prepare laboratory tools

Dear students, prepare some laboratory equipment's or tools such as beaker, measuring cylinder, balance, tongs, etc. from the locally available materials

1.2.3. Laboratory Safety Rules and procedure

Laboratory may be considered as a place of discovery and learning. However, by the very nature of laboratory work, it can be a place of danger if proper common-sense precautions are not taken. ***Follow the followings laboratory safety rules precautions when you perform an activity in laboratory.***

- Dress appropriately (wear, goggles, gloves, shoes and laboratory coats).
- Tie back loose hair.
- Know the locations of safety equipment like fire extinguisher.
- Know what to do in case of an accident.
- Do not taste or smell chemicals.
- Do not eat or drink in laboratory.
- Never add water to concentrated acid solutions. Always add acid into water.

Follow the Amharic AW! Not WA! (A-acid, W-water)

- Carry out only the experiments assigned by your teacher.
- Dispose of all chemical wastes properly.
- Basic Safety Rules

Basic safety rules for laboratory conduct should be observed whenever working in a laboratory. Many of the most common safety rules are listed below.

- Know locations of laboratory safety showers, eyewash stations, and fire extinguishers..
- Know emergency exit routes.
- Avoid skin and eye contact with all chemicals.
- Minimize all chemical exposures.
- No play will be tolerated.
- Assume that all chemicals of unknown toxicity are highly toxic.
- Avoid distracting or upsetting persons working in the laboratory.
- All containers must have appropriate labels. Unlabeled chemicals should never be used.
- Do not taste or intentionally sniff chemicals.
- Use equipment only for its designated purpose.
- Combine reagents in their appropriate order, such as adding acid to water.
- Avoid adding solids to hot liquids.
- Never leave containers of chemicals open.
- Never consume and/or store food or beverages or apply cosmetics in areas where hazardous chemicals are used or stored.

Points/procedures before starting an experiment.

- Know the location of the lab safety equipment and understand how to use it. In particular, know the location of the emergency exit, fire extinguisher, eyewash station, and safety shower.
- Read through the experiment before going to the lab. Make sure you understand the steps of the experiment. Jot down any questions you have so that you can ask them before starting the lab.
- Understand disposal procedures for the chemicals and other items used in your experiment. Don't throw items in the trash or dump liquids down the drain or in waste disposal containers until you are certain it is acceptable to do so.
- Be prepared to take data in the lab. Bring your notebook, a pen, and a

calculator.

⚠ Have personal safety gear, such as a lab coat and goggles, clean and ready to use before the lab.

1.2.4. Science laboratory safety symbol and hazard signs, Meanings

Depending upon the scientific investigation being conducted, a lab can be filled with dangerous chemicals, Biological specimen, sharp instrument, breakable objects. In order to safe workplace and avoid accidents, lab safety symbols and signs need to be posted throughout the workplace. The following laboratory safety symbols warn of possible dangerous in laboratory user to help keep safe and informed.

Figure: 1. 4 A) hazard signs

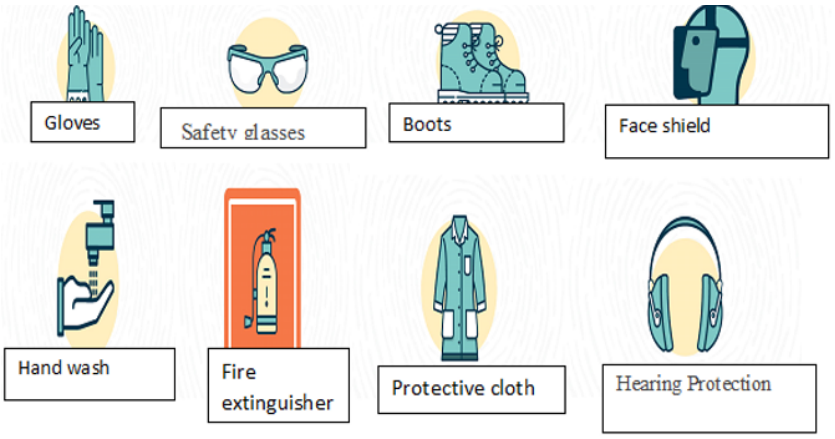


Figure: 1. 4 B) Laboratory safety symbols

Exercise 1.3

Choose the best answers for the following questions

1. Which one of the following is NOT allowed in science laboratory?

   A. Knowing the hazards of the materials being used
   B. Reading the labels on the reagent bottle carefully
   C. Wearing any type of cloth and shoes
   D. Never use laboratory glassware for eating or drinking purposes.

2. Which of the following laboratory tools used for the approximate measurements of volume of liquids

   A. Test tube
   B. thermometer
   C. measuring cylinder
   D. dropper

3. The type of laboratory equipment categorized under measuring equipment is

   A. Bunsen burner
   B. Triple-beam balance
   C. Flask
   D. Stand and clamp

KEY WORDS

- conventional science
- Ethics
- Hazard sign
- indigenous science
- Laboratory equipment
- Natural science
- Safety rule
- Laboratory
- Science
- Scientist
- Technologist
- Technology

Unit Summary

- *Science is a systematic method of gaining knowledge about the physical and natural world and the social aspect of human society.*
- *Science may be conventional or indigenous.*
- *Indigenous science is process by which Indigenous people build their empirical knowledge of their natural environment*
- *Conventional science is the system of knowledge which relies on certain laws that have been established through the application of the scientific method to phenomena in the world around us.*
- *Science has two major categories, which are natural science and social science.*
- *Natural science has three branches which are Biology, chemistry and physics*
- *Technology is the use of scientific knowledge to help human beings work easier and live better as well as enjoy their environment more.*
- *A person who studies technology is called a technologist*
- *Science and technology plays an important role in our daily life*
- *Mostly decisions are or should be based on two pillars: beliefs and values. A decision maker's beliefs are a reflection of his or her perceptions of reality, including facts, opinions, and uncertainties surrounding them whereas its values reflect his or her sense of what to strive for or to achieve, including goals, objectives, and associated compromises.*
- *Some famous scientists in Ethiopia are Dr. Aklilu Lemma, Engineer Kitew Ejigu, Dr.Gebisa Ejeta, Prof.Yalemtsehay Mekonnen and*
- *Famous scientists from the world Albert Einstein, Michael Faraday. Marie Curie and Isaac Newton etc.*
- *Laboratory equipment comprises different sets of apparatus, which are designed to perform various tasks in the laboratory.*
- *Knowing Laboratory safety rule is very important to reduce risks faced during laboratory investigation*

Unit Review Exercise

Part I. Write 'True' for the correct statements and 'False' for the wrong statements.

1. Natural science is the study of nature and natural laws.
2. Biology, Physics and chemistry do not share common areas of study.
3. Technology makes life easier or more pleasant and work more productive.

Part II: Choose the best answers for the following questions

1. The study of living things is the concern of

   A. Chemistry
   B. Physics
   C. Biology
   D. Geology

2. _____ is a branch of natural science which studies the nature of matter, energy and their interaction.

   A. Chemistry
   B. Physics
   C. Biology
   D. Geology

3. The famous Ethiopian scientist who discovered a natural treatment to schistosomiasis or bilharzia disease.

   A. Eng. Kitew Ejigu
   B. Dr. Aklilu Lemma
   C. Dr. Gebisa Ejeta
   D. Prof. Yalemtsehay Mekonen

4. Which of the following is NOT a laboratory safety rule?

   A. You should tie back loose hair
   B. You should add water to Acid.
   C. Do not suck solution in the pipette by mouth
   D. When lighting a Bunsen burner, you should light the match stick before turning on the gas

5. _____is a branch of Knowledge and the systematic study of universe and its all encompasses, one that based upon facts, observation and experiments

A. Theory
B. Natural law
C. Dogma
D. Science

Part III: Match the items in column 'A' with items in column 'B'

"A"	"B"
1. Biochemistry	A. Combination of biology and physics
2. Physical chemistry	B. Combination of Geology and physics
3. Biophysics	C. combination of biology and chemistry
4. Geo physics	D. combination of chemistry and physics

Part IV; Fill in the blanks with appropriate terms.

1. _____is the places where experiments in science is performed.
2. A person who study about technology is called_____
3. Who is the famous Ethiopian scientist has involved in development of African commercial hybrid strains of sorghum_____

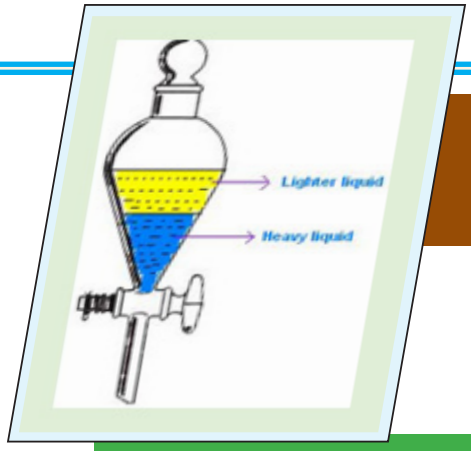
Part V: Give short answer to the following questions.

1. Define technology
2. What is the difference between science and technology?
3. List and explain the functions of some common laboratory apparatus (equipment's).
4. Mention the steps to write laboratory report.
5. Why ethics in science is important?
6. Explain the two pillars of science.

Self Assessment

Check List Competencies given below are expected to be achieved in this unit by students. You are required to respond by saying Yes or No. Put a tick (√) mark under "Yes" column if you are able to perform the competency or under "No" column if you are unable to perform the competency. This would help to evaluate yourself and you can revise the parts of topics for which the competencies are not met.

No.	Can I	Yes	No
1	*Define science as a body of knowledge and the processes and practices used to add to that body of knowledge*		
2	*Describe the main branches of science and explain their relationship*		
3	*Relate how science and technology affect one's beliefs, practices, and ways of thinking.*		
4	*Appreciate the contributions of outstanding scientists to science and technology.*		
5	*Discuss the importance of scientific values in decision making and problem solving.*		
6	*Relate how science and technology affect one's beliefs, practices, and ways of thinking.*		
7	*Identify the significant contributions of Ethiopian Scientists in science and technology.*		
8	*Identify different laboratory tools*		
9	*Demonstrate safe ways of using apparatus in the laboratory.*		
10	*Practice precautionary measures in the laboratory*		
11	*Exhibit knowledge of lab safety rules and procedures.*		
12	*Identify potential hazards and implement appropriate safety procedures when conducting laboratory*		



UNIT - 2

2. MATTER IN OUR SURROUNDING

Learning Outcomes

At the end of this unit, learners will able to:

- *use particles theory's postulates to explain properties and behaviour of materials.*
- *classify matter as an element, compound, homogeneous mixture, or heterogeneous mixture with regard to its physical properties.*
- *describe the structure of solids, liquids and gases in terms of particle separation, arrangement and types of motion.*
- *differentiate between physical and chemical properties and changes of matter.*
- *appreciate that matter can be classified based on physical or chemical properties.*
- *use properties of matter to identify substances and to separate them.*
- *demonstrate scientific inquiry skills along this unit: observing, classifying, comparing and contrasting, making mode, inferring, communicating, asking questions, designing experiments, drawing conclusions, applying concepts.*

Main Conents

Introduction

The object around us, called matter, exist in three physical forms or states. These are solids, liquids and gases. For example, water can exist as ice (solid), water (liquid) and steam (gas).The physical state of a given sample of matter depend on temperature and pressure. Energy must be added or removed to change one form or state of substance into another.

The idea that matter is made up of tiny particles is called the Particulate nature of matter.

Most of the changes that occur in our surrounding are either physical or chemical. A physical change is a change in the form of matter but not in its chemical identity. A chemical change, or chemical reaction, is a change in which one or more kinds of matter are transformed into a new kind of matter.

There are two principal ways of classifying matter: by its physical state as a solid, liquid or gas and by its chemical constitution as pure substance and mixture. Mixtures can be separated using a variety of techniques. Some of the methods used to separate mixtures are separation by hand, sieving, filtration, evaporation, magnetic separation, decantation and distillation.

2.1. Characteristics and Nature of Matter

Learning Competency

At the end of this section, learners will able to:

- *define matter with examples from day today life.*
- *demonstrate that matter is made up of tiny particles.*
- *state the postulates of the particle theory of matter.*
- *infer the particulate nature of matter from demonstration /investigation.*
- *apply particle nature of matter in explaining diffusion and every day effect of diffusion.*
- *describe and/or make a representation of the arrangement, relative spacing, and relative motion of the particles in each of the three states of matter.*

- *describe and explain compression in terms of distance between particles.*
- *use the terms melting, evaporating, condensing, and freezing/ solidification to describe changes of state.*
- *use the particulate nature of matter to explain: melting, freezing/Solidification, Evaporation, Condensation.*

Activity 2.1

Form a group and discuss the following questions and share your ideas with the rest of the class.

1. Describe matter by your own words?
2. Consider the followings: air, light, soil, plant, water, sound, table and heat. Try to classify them as matter and non-matter.

2.1.1. Meaning and Properties of matter

Q. What is matter?

Matter is anything that has mass and occupies space. The term mass refers to the amount of matter present in a sample. Matter includes all things both living and nonliving that can be seen (such as plants, water, soil, rocks, table and even this book), as well as things that cannot be seen by our naked eye (such as air and bacteria). Unlike matter, energy is known and recognized by its effect. It cannot be seen, touched, smell or weighed. Therefore, various forms of energy such as heat, light, and sound are not considered to be matter.

Exercise 2.1

1. Classify each of the following as matter or energy (non-matter).

a) Air
b) Pizza
c) Sound
d) Light
e) Gold
f) Virus
g) heat
h) Bacteria
i) Silver
j) Cake
k) Water
l) Magnetism

2.1.2. Particulate nature of matter.

Activity 2.2

Form a group and perform the following activity. Then present your finding to the class.

1. Inflate a balloon and observe its shape in the class room
2. Make observations while wind blowing leaves, or dust in your surroundings.

Based on the above activity

a) What do you think that matter is made of?
b) How do the particles move around in space

The particle model of matter states that all matter is made up of tiny, moving particles with spaces between them. Matter is made of particles too small to be seen that move freely around in space. The inflation and shape of balloon indicates that it is filled with a small particle of gas such as helium, hydrogen, nitrous oxide, oxygen, or air. On other hand, from the effect of wind blowing leaves or dust it is possible to understand the particle matter is in continuous motion.

The idea that matter is made up of tiny particles is called the Particulate nature of matter.

Activity 2.3

Perform the following activities. Fill in the blank by using the following words

{Increase, less, faster, cold, temperature, water, particles, moving, more, energy}

1. Everything is made of _____.
2. Particles are always_____.
3. An increase in _____makes particles move _____.
4. An increase in_____ is the same thing as an _____ in energy.
5. The particles in hot water have _____energy than _____water.
6. The particles in ice move _____ than particles in _____.

2.1.3. Particle theory of matter (Particle model of matter)

Particulate nature of matter means that all matter is made up of discrete tiny particles. Many years later, scientists came back to Democritus' idea and added to it. The theory they developed is called the particle model of matter.

The followings are main ideas (postulate) in the particle model of matter:

1. All matter is made up of tiny particles.
2. The particles of matter move continuously.
3. The particles have spaces between them.
4. Adding heat to matter makes the particles move faster.
5. There are forces between the particles.
6. Particles of one substance differ from the particles of other substance.

Scientists find the particle model useful for two reasons. First, it provides a reasonable explanation for the behavior of matter. Second, it presents a very important idea i.e. the particles of matter are always moving. The air you breathe, your books, your desk, and even your body all consist of particles that are in constant motion. Thus, the particle model can be used to explain the properties of solids, liquids, and gases.

Exercise 2.2

I. Give short answers

1. List the postulates of particle theory.
2. Describe the particulate nature of matter

Diffusion

Experiment: 2.1

Title: simple experiment on diffusion

Objective: To discover what is meant by diffusion

Materials: Perfume, ink, beaker, pipette, Water (H2O)

Procedure

Perfume - Take a bottle of perfume and open it in one corner of the room and record how long it takes to reach to different students at different distances to smell it.

Ink – add 2 or 3 drop ink into a beaker of water using a pipette and watch the ink diffuse to color the water. Write your result/conclusion from the above experiments

The mixing and spreading out of a substance with another substance due to the movement or motion of its particles is called diffusion. It is also defined as the net movement of particles from an area of high concentration to an area of low concentration. Concentration is the way of measuring how much or how many particles of a substance in that place.

Diffusion in gases is very fast. This is because the particles move very quickly in all direction. Example: The smell of hot sizzling food reaches us even when we are at considerable distance. When someone opens a bottle of perfume in one corner of room, its smell spreads in the whole room quickly.

Diffusion in liquids is slower than that in gas. This is because the particles in liquids move slower as compared to particles in gases. Example: If a drop of ink is put into a beaker of water, then the color of ink spreads into the whole water of the beaker.

Diffusion in solids is very very slow process because the particles of solids are highly restricted to motion.

Diffusion in Daily Life

Diffusion is everywhere around us in our *everyday* life. The followings are some common effect of diffusion in day to day activities.

Tea: A tea bag placed in a cup of hot water will diffuse into the water.

Perfume: When perfume is produced in one part of a room, it spreads to the rest through diffusion. There are fewer of the scent-producing chemicals in the further parts of the room, so the molecules naturally spread out.

Food Coloring: A drop of food coloring in a glass of water colors the water through

diffusion. The dye molecules slowly spread evenly through the liquid, creating one particular shade.

Soda: Leave a soda bottle open and the carbon dioxide bubble will diffuse and leave it flat. Air has a lower concentration of that bubbly carbon dioxide than the drink does, so the CO_2 molecules depart the beverage and spread into the air.

Exercise 2.3

1. Complete the blank space from the word box

Diffusion,	low,	scent,	high

You can smell axe in the classroom after someone sprays it in the hallway because the _____ moves from _____ concentration in the hallway to_____ concentration in the classroom. This is an example of _____

2. Arrange increasing order of the rate of diffusion of solids, liquids and gases.

2.1.4. Properties of solids, liquids and gases

Activity 2.4

Copy the table in your exercise book and complete it using objects around you. Discuss your reasons for each decision with your group.

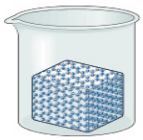
Substance	solids, liquids and gases	I know this is because….
Water	liquid	I can pour it.

According to Kinetic (particle) theory, all matter is composed of tiny particles (atoms, molecule, and ions).These particles are arranged differently in solids, liquids and gases.

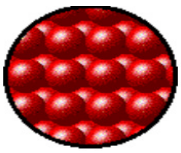
Solids

In solids the particles are arranged in fixed pattern. The particles held together strongly and are tightly packed. Particles in solid can vibrate but stay in the same

place. Solids have definite shape and definite volume. Examples of Solids are Stones, wood, metals etc.



Pattern of solids

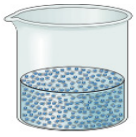


Microscopic view of solids

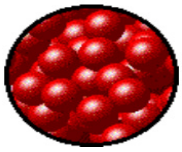
Figure 2.1: pattern and microscopic view of solids

Liquids

The particles in a liquid are separated by spaces that are large enough to allow the particles to slide past each other. It takes the shape of its container because the particles can move around more freely than they can in a solid. At room temperature water, ethanol, benzene, oil are liquids.



Pattern of liquids

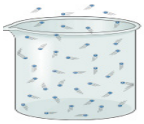


Microscopic view of liquids

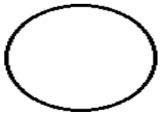
Figure 2.2: pattern and microscopic view of liquids

Gases

The particles in a gas are separated by much larger spaces than the particles in a liquid or a solid. Therefore, a gas is mostly empty space. For example, air, hydrogen, oxygen, carbon dioxide and nitrogen are gases



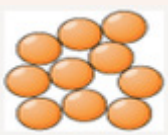
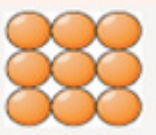
Pattern of gas



Microscopic view of gases

Figure 2.3 pattern and microscopic view of gases

Table Properties of solids, liquids and gases

Properties	Physical states		
	Gases	Liquids	Solids
Arrangement of particles	• disorderly arranged • particles are very far apart • almost no attractive force between particles	• less orderly • arranged particles are relatively close to each other • have relative attractive force between particles	• orderly arranged (regular pattern) • particles are very close to each other
Motion of particles	• flow(move) freely • flow together in random motion • are known as fluids	• flow together in random motion • are known as fluids	• do not flow or move • vibrate in a fixed position
Compressibility	• highly and easily compressible	• compressible to a very small extent	• not compressible
Volume and shape	• have no definite shape and volume • assume the shape of the container and entirely fill it.	• have no definite shape • assume the shape of the container	• have definite shape and volume
Density	• have very low density than liquids and solids	• have low density than solids • condensed state compared to gases	• denser than all • condensed state than all
Pressure	• Exert pressure equally in all direction	• Exert pressure towards depth.	• Exert pressure towards gravity
Diffusion	• diffuse spontaneously in all directions with random motion	• diffuse very slowly in random motion	• difficult to diffuse
Diagram			

Exercise 2.4

I. Give short answers

1. What is the three state of matter?
2. List the properties of solids
3. Name a property of liquids that do not share with solids
4. Name a property of gas that do not share with liquids
5. Give a characteristic that is the same for liquids and solids
6. Give a characteristic that is the same for gases and liquids
7. Which state of matter cannot poured?
8. Which state of matter can be compressed easily?

II. Multiple choice questions

1. Which state of matter are fluids?

   A. Solid
   B. Liquid
   C. Gas
   D. B and C

2. In which state of matter is particles close together?

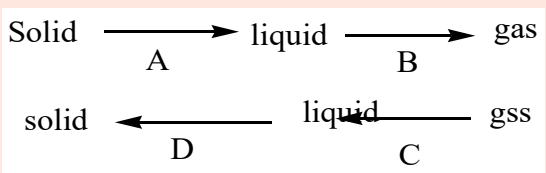
   A. Solid
   B. Liquid
   C. Gas
   D. All

2.1.5. Changes in state

Activity 2.5

Copy the flow chart. The arrows represent the process involved when matter change state.

Write the name for each process on the arrow to your flow chart.



A change of state is the change of a substance from one physical form of matter to another. A change in physical state is the most common type of physical change. Melting, freezing, evaporation, and condensation are all changes of state. The three states of matter can be interconverted without changing the composition of the substance. To change a substance from one state to another, energy must be added or removed.

Q. What happens when matter changes state?

During a change of state, the motion of the particles changes. Particles can break away from each other and gain more freedom to move, or they may attract each other more strongly and have less freedom to move. During a change of state, a substance gains energy from or loses energy to the environment, but the total amount of energy is conserved.

Q. How do solids and liquids change state?

When a solid is warmed, its particles gain energy and speed up, and the attraction between them decreases. Eventually they slide past one another. The process in which a solid substance changes into a liquid on heating is called **melting (or fusion).**

The process of changing a liquid into a solid is called **freezing (or solidification**). When a liquid is cooled, its particles have less energy, they slow down, and they lock into the fixed arrangement of a solid. The temperature at which a liquid substance changes into a solid is the liquid's **freezing point**.

Q. How do liquids and gases change state?

As a liquid is warmed, its particles gain energy. Some particles gain enough energy that they escape from the surface of the liquid and become a gas. The change from a liquid to a gas is called **evaporation**. The temperature at which a liquid substance changes into a gas is the liquid's **boiling point.**

As a gas is cooled, its particles lose energy. The attraction between particles overcomes the speed of their motion, and a liquid forms. The change of state from a gas to a liquid is called **condensation**.

Q. How do solids and gases change state?

Some solids and gases can change state without ever becoming a liquid. The change from a solid state directly into a gas is called **sublimation**. **Deposition** is the change in state from a gas directly to a solid. Some common substance undergo sublimation are: Iodine, ammonium chloride and solid carbon dioxide (dry ice).

When matter changes from one state to another, its physical state changes but its chemical identity does not. During a change of state, the energy of the particles, their movement, and the distance between them change. The mass of a substance does not change when its state changes. Each state contains the same amount of matter.

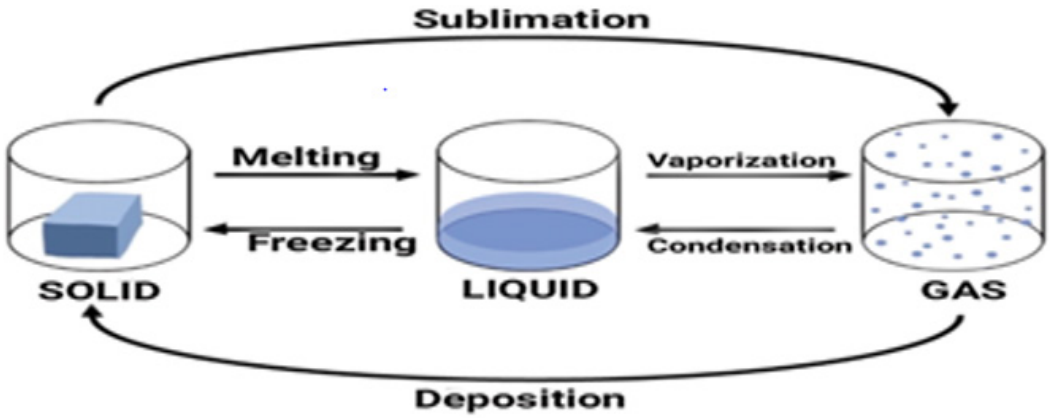


Figure 2.4: Interconversion process of the three state

2.2. Physical and Chemical Properties of Matter

Learning Competency

At the end of this section, learners will able to:

- *describe physical Properties.*
- *use physical properties of matter to identify substances.*

- *conduct experiments to identify properties of substances and make group report.*
- *identify chemical properties*
- *distinguish between physical and chemical properties.*

2.2.1. Physical Properties of matter

Activity 2.6

Perform the following tasks in groups and present your conclusions to the class. Given the following physical properties of substances: odor, color, taste, melting point, boiling point and density.

1. Which of these physical properties have constant values under specific condition, such as temperature?
2. Which physical properties can be recognized directly by our sense organs?
3. Which of these properties are measured using instruments?
4. What will happen to ice kept in a cup in the classroom?
5. Which sense organs help us to detect color, odor and taste?
6. How do you describe the taste of lemon?

Substances are identified by their properties as well as by their composition. A physical property can be measured and observed without changing the composition or identity of a substance. For example, we can measure the melting point of ice by heating a block of ice and recording the temperature at which the ice is converted to water. Water differs from ice only in appearance and not in composition, so this is a physical change; we can freeze the water to recover the original ice. Therefore, the melting point of a substance is a physical property. Other examples of physical property is gold is a shiny yellow metal, lead has a high density. Observations of these characteristics do not change the composition.

There are two kinds of physical properties, namely, extensive and intensive physical properties. ***Extensive physical properties*** are the properties, which depend on the amount or quantity of sample and therefore, can vary from sample to sample.

Examples: length, diameter, mass, and volume

Intensive physical properties are properties which do not depend on the amount of a substance present. Examples: density, color, melting point, and hardness. Intensive properties are useful in distinguishing between different substances because they do not vary from sample to sample.

Some Physical Properties of Substances are Listed Below

1. Physical Properties Detected by Sense Organs

Color: The color of a substance results from its interaction with light. Substances can be identified by their colors. For example, chalk is white, water is colorless, and gold is yellow and so on.

Odor: refers to the property of a substance perceived by the sense of smell. Terms commonly used to describe the odor of a substance are pungent, fragrant, spicy, fruity and odorless. For example water is odorless, flowers are fragrant, and orange smells fruity.

Caution! Care has be taken in smelling substance as they may be harmful

Taste: refers to physical properties that can be perceived by the taste buds of the tongue. The taste of a substance is usually described by terms like sweet, bitter, sour, salty, and tasteless. For example honey is sweet, lemon is sour and table salt tastes salty.

Caution! Testing can be used to identify substances only if the substance to be tasted is not harmful.

Activity 2.7

You are allowed to taste some acids in the forms of citric acid that are found in lemon and orange or acetic acid in the form of vinegar at home but you are never kind allowed to taste any kind of acids in the laboratory.

What is the reason?

- Discuss your finding in group and present to the class

2. Physical State:

Physical state is the form in which a substance is found under a given conditions such as temperature and pressure. The three physical states of matter are solid, liquid and gas. The same substance may exist in different states at different conditions. For example, water exists in three physical state form as a solid below 0 ºC, as a liquid between 0 ºC and 100 ºC, and as a vapor or gas above 100 ºC.

3. Measurable Physical Properties

Measurable physical properties are the properties of a substance that can be measured using an appropriate apparatus. These physical properties have constant values under specific conditions. Examples are melting point, boiling point, density and electrical conductivity.

Melting Point: is the temperature at which a solid substance changes to its liquid state. For example, ice is the solid form of water. Ice melts to liquid (water) at 0°C. Therefore, the melting point of ice is 0°C.

Boiling Point: is the temperature at which the vapor pressure of the liquid equals the surrounding atmospheric pressure. At sea level water boils at 100°C.

Density: is defined as the mass per unit volume of a substance. It is expressed mathematically as:

$$Density = \frac{Mass\ of\ substance}{Volume\ of\ substance} \quad or\ d = \frac{m}{V}$$

Units of density are kilogram per cubic meter (kg/m^3).

Electrical Conductivity: Electrical conductivity is the ability of a substance to conduct electricity. This is a physical property mostly characteristic of metallic substances such as copper, aluminum, iron, silver and zinc.

2.2.2. Chemical Properties of Matter

A chemical property is a characteristic of a substance that describes the way the

substance undergoes or resists change to form a new substance. Chemical properties cannot be determined just by viewing or touching the substance; the substance's internal structure must be affected for its chemical properties to be investigated.

Flammability is one *example* of a *chemical property*. *Reactivity* between two substances is another *chemical property* of matter.

Table 2.2: Comparison between Physical and chemical properties.

Physical properties	Chemical properties
Properties can be measured or observed without changing the chemical nature of the substance.	Properties that describe how a substance changes (or resists change) to form a new substance.
Easily identified.	Cannot be determined just by viewing or touching the substance.
The composition or identity of a substance not change.	The substance's internal structure must be affected for its chemical properties to be investigated.
Examples: color, density, volume, melting. boiling. Conductivity.	Examples :Flammability and reactivity

Exercise 2.5

1. Classify each of the following properties as a physical property or a chemical property.

   a) Iron metal rusts in an atmosphere of moist air.
   b) Mercury metal is a liquid at room temperature.
   c) Nickel metal dissolves in acid to produce a light green solution.
   d) Potassium metal has a melting point of 63°C.
   e) Copper metal possesses a reddish brown color.
   f) Titanium metal can be drawn into thin wires.
   g) Beryllium metal, when inhaled in a finely divided form, can produce serious lung disease.
   h) Silver metal shows no sign of reaction when placed in hydrochloric acid.
   i) Lead is denser than aluminum.
   j) Flammability of plastics.

2. Classify each of the following properties as intensive property or extensive property.

a) boiling point
b) length
c) mass
d) color
e) density
f) volume
g) melting point

3. Categorize the following physical properties as physical properties recognized by our sense organs or measurable physical properties

a) density
b) odor
c) taste
d) melting point
e) color
f) conductivity

2.3. Classification of substances

Learning Competency

At the end of this section, learners will able to:

- *use the particle theory to describe the difference between pure substances and mixtures*
- *differentiate between elements and compounds.*
- *classify common elements into metals and non-metals.*
- *investigate the properties of metals and non-metals and compile a list of general properties.*
- *investigate the properties of non-metals and compile a list of general properties.*
- *describe and classify mixtures as homogeneous and heterogeneous.*
- *use models/ particles diagrams to show differences between homogenous and heterogeneous.*
- *describe the relationship among elements, compounds, mixtures, homogenous mixture and heterogeneous mixtures.*

Activity 2.8

Perform the following tasks in groups and present your findings to the rest of the class.

i) Consider the following substances: chalk, bronze, sugar solution, iron, water, milk, oxygen, copper, gold, sugar, table salt, cooking oil, sulfur, air, silver, hydrogen, ink, chlorine and soil.

a) Classify them are pure substance or mixture.
b) Among pure substance ,state whether it is an element or a compound

In addition to its classification by physical state, matter can also be classified in terms of its chemical composition into two broad categories: pure substances and mixtures.

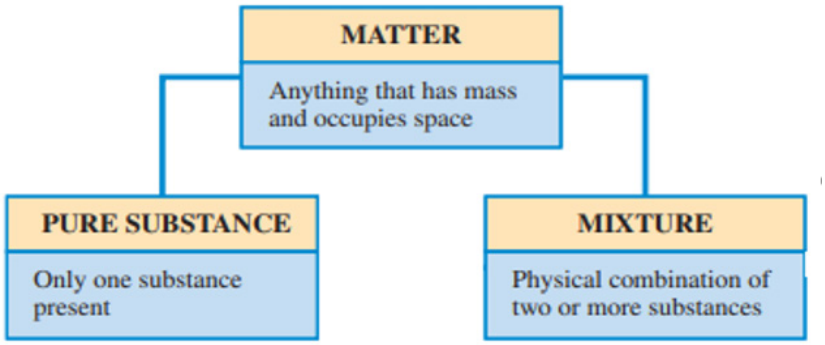


Figure 2.5 Matter falls into two basic classes: pure substances and mixtures.

2.3.1. A pure substance

Pure substance is a single kind of matter that cannot be separated into other kinds of matter by any physical means. All samples of a pure substance contain only that substance and nothing else. Pure water is water and nothing else. A pure substance always has a definite and constant composition. Some other common examples of pure substances are oxygen, sulfur, copper, silver, gold, sugar, table salt, water and carbon dioxide. Pure substances are classified as elements and compounds.

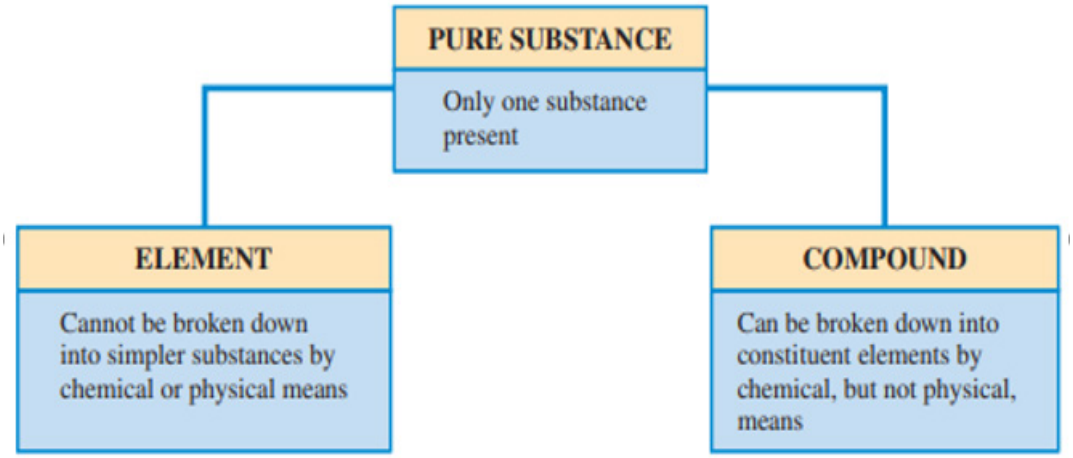


Figure 2.6 a pure substance can be either an element or a compound.

2.3.2. Elements and compounds

Elements An element is a pure substance that cannot be broken down into simpler substances by ordinary chemical means. It is composed of only one kind of particle (atoms), which is the smallest particle of an element. At present, 118 elements are known. Among these elements, 92 of them occur naturally on earth while the rest are man-made or artificial elements. Elements might be divided into metals and non-metals.

Metals: Many chemical elements are referred to as metals. Some examples of metals are gold, iron, silver, copper, aluminum, sodium and lead.

Metals are characterized by the following physical properties.

- They are shiny (lustrous) in nature
- They are good conductor of heat and electricity
- Their density and melting point is high
- Moldable (Malleable): malleability is the ability of a substance to be pressed into sheets when hammered.
- Ductile: ductility is the ability to be drawn into thin wire
- Are solid at room temperature except mercury that are found in liquid state.

Figure 2.7: Image of copper, silver & gold

Non-metals: non-metal is a chemical element that does not have metal's properties **and** are few in numbers as compared to metal. Carbon, oxygen, sulfur, fluorine and phosphorous are some common examples of nonmetal.

Activity 2.9

Perform the following activity

- Which non-metal is essential for our life?

They are characterized by the following physical properties. These are

- They exist in two of the three states of matter at room temperature: gases (oxygen) and solids (carbon). Only bromine exists as a liquid at room temperature.
- They are not shiny (dull appearance), and are non-conductors of heat and electricity
- They have relatively, low melting points and boiling points.

Figure 2.8: Images of carbon and sulfur

Table 2.3: Comparing properties of metals and non-metals.

Metals	Non-metals
These are solids at room temperature except mercury	These exist in all three states
These are very hard except sodium	These are soft except diamond
These are malleable and ductile	These are brittle and can break down into pieces
These are shiny	These are non-lustrous except iodine
Electropositive in nature	Electronegative in nature
Have high densities.	Have low density

Compounds

A compound is a pure substance that is made up of more than one type of atom bonded together. A compound can be broken into two or more elements by a chemical means. For example, Water is a compound. By means of an electric current, water can be broken down into the gases hydrogen and oxygen, both of which are elements. The ultimate breakdown products for any compound are elements. Elements can combine with other elements to form compounds. Sodium chloride is formed by the combination of sodium and chlorine elements. Such types of compounds that are formed by the combination of two different elements are called binary compounds. Most binary compounds contain metallic and non-metallic elements. Some examples of binary compounds are calcium oxide (lime) from calcium and oxygen, Carbon dioxide from carbon and oxygen, etc.

Q. What distinguishes an element from a compound?

A compound's properties are always different from those of its component elements, because the elements are chemically rather than physically combined in the compound.

Experiment 2.2

Title: Distinguishing compounds and mixtures.

Objective: To investigate the difference between a compound and a mixture.

Materials Required: Small bar magnet, iron filings, powdered sulfur, test tube, Bunsen burner, magnifying glass, test tube tong, sand, beam balance, watch glass and test tube made from soda glass tube.

Procedure

Part I

1. Prepare a mixture containing iron powder and sulfur powder in the ratio 7:4 by mass. Do this by weighing out 7 g of iron powder and 4 g of finely powdered sulfur onto separate pieces of filter paper (or use weighing boats). Mix the two powders by pouring repeatedly from one piece of paper to the other until a homogeneous mixture (by appearance) is obtained.
2. Note the appearance of the pure elements and the mixture. Demonstrate that iron can be separated from the mixture by physical means. Do this by bring one end of a magnet close to the mixture as shown in figure 2.9

Figure 2.9 Separating iron from a mixture of iron and sulfur

Questions:

i) What did you observe as you bring the magnet close to the mixture?
ii) What did you observe under the magnifying glass?

Part II

1. Place about 2 g of the mixture into a soda glass tube.
2. Insert a plug of mineral wool (mineral fiber) into the mouth of the test tube. Clamp the test tube as shown in the diagram
3. Heat the powder mixture at the base of the test tube – gently at first and then more strongly (use a blue flame throughout). Heat until an orange glow is seen inside the test tube. Immediately stop heating. Let the students see that the glow continues and moves steadily through the mixture.
4. Allow the test tube to cool down.
5. Once cool, it is possible to break open the test tube to show the appearance of the product, iron (II) sulfide. The test tube can be broken open using a pestle and mortar. It is advisable to wear protective gloves.
6. Take the product formed and powder it. Examine the product under a magnifying glass. Bring a magnet over it.

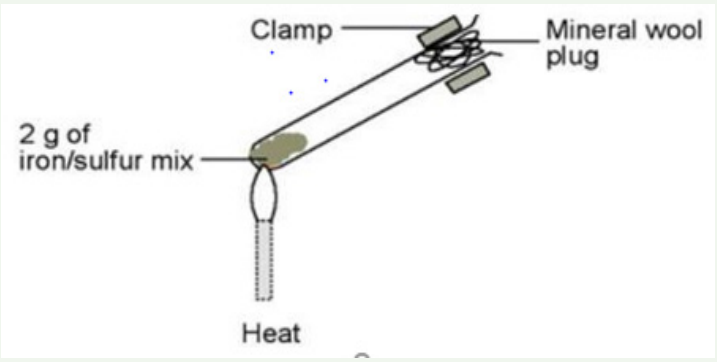


Figure 2.10: the reaction between iron and sulfur

Questions:

1. Under a magnifying glass, are the iron filings and sulfur seen separately?
2. Is it possible to attract the iron or sulfur by a magnet? Why?

Observations and Analysis

i) Which part of the experiment (Part I or II) indicates a compound? Give your reason

ii) Which part of the experiment (Part I or II) indicates a mixture?

2.3.3. Mixtures

Activities 2.10

Discuss the following ideas in groups and present your opinion to the rest of the class.

1. Suppose a teaspoon of magnesium filings and a teaspoon of powdered sulfur are placed together in a metal beaker. Would this constitute a mixture or a pure substance? Suppose the magnesium filings and sulfur are heated so they react with each other, forming magnesium sulfide. Would this still be a "mixture"? Why or why not?
2. What is the difference between pure water and a solution of sodium chloride in water?
3. Do you think air is a pure substance or a mixture? Why?

A mixture is a physical combination of two or more pure substances in which each substance retains its own properties. Components of a mixture retain their identity because they are physically mixed rather than chemically combined. Consider a mixture of small rock salt crystals and ordinary sand. Mixing these two substances changes neither the salt nor the sand in any way. Common mixtures include: - Soil- a mixture of different sized particles and plant material, Cooking oil – a mixture of vegetable oils. Ink—contains a mixture of dyes, dissolved in alcohol and water, Milk— contains proteins, carbohydrates, fats, water, minerals, Air— contain oxygen, nitrogen , carbon dioxide. Mixtures are sub classified as heterogeneous or homogeneous.

Homogeneous Mixture

Activity 2.11

Perform the following tasks in groups and present your findings to the rest of the class.

- The following substances are given: air, milk, soil, salt solution, brass, chalk, water, cooking oil, gold, silver, sugar solution, Pepsi. Identify which are the homogeneous mixture

Homogenous mixtures are a combination of two or more substances that has the same composition throughout and has no visible boundary. A homogeneous mixture also called solution. For example, a mixture of table salt and water (salt solution) is a homogeneous mixture because all the parts of the solution have the same salt-water composition. Homogeneous mixture (solution) may exist in one of the three states i.e. solid, liquids and gas.

Table 2.4: state and type of homogeneous mixture (solution)

Type of homogeneous mixture (solution)		Common examples
Gaseous	Gas in gas	Air, mixture of oxygen and nitrogen
Liquids	Gas in liquid	Soft drinks(Pepsi, Miranda, coca cola),beer
	Liquid in liquid	Alcohol in water
	Solid in liquid	Salt solution, sugar solution
Solids	Solid in a solid	brass (Zn/Cu), Bronze (cu/Sn)

Figure 2.11: Some common examples of homogeneous mixture

Heterogeneous Mixtures

Activity 2.12

Perform the following tasks in groups and present your findings to the rest of the class.

- Consider the following substances: ethanol alcohol, bronze, sugar solution, iron, water, milk, oxygen, copper, gold, sugar, table salt, cooking oil, sulfur, air, silver, charcoal, ink, chlorine and soil.
- Then identify among the list of substances which are heterogeneous mixture

Heterogeneous mixtures are a combination of two or more substances that has no uniform composition throughout and contains one or more visible boundaries between the components. The components of a heterogeneous mixture can be identified by our naked eyes or with the help of a microscope or a magnifying glass. For example, a mixture of sulfur and iron filings is a heterogeneous mixture. This is because the sulfur particles remain visible and physically separated. Others Examples of heterogeneous mixture are blood, milk, Mixture of sand and water, river water, muddy water, benzene and water, oil and water, dusty air, soil etc.

Figure 2.12. :some common examples of heterogeneous mixtures

Table 2.5: Differences between homogenous and heterogeneous mixtures.

Homogeneous mixture	Heterogeneous mixture
It has a uniform composition	It has a non-uniform composition
It has only one phase	There are two or more phase
The constituent cannot be seen easily.	The constituent can be seen easily
'Homo' means the same	'Hetero' means different
E.g. sugar solution, soft drinks, salt solution,	Milk, soil. sand and water, oil and water

Exercise 2.6

1. Classify each of the following as a mixture or a pure substance. Among the pure substances, which are elements and which are compounds?

a) water
b) uranium
c) blood
d) alcohol
e) oceans
f) iron
g) table salt
h) brass
i) hydrogen
j) gold
k) sugar
l) milk
m) honey
n) benzene

2. Define and give four examples illustrating each of the following terms.

a) element
b) compound
c) homogeneous mixture
d) heterogeneous mixture

II. Choose the best answers for the following questions

1. Which of the following is metallic liquid element at room temperature

A. bromine
B. mercury
C. sodium
D. iron

2. Substance y is hard, lustrous solid which readily conduct heat and electricity. Y is likely to be:

A. Salt
B. metalloid
C. metal
D. non metal

3. Which of the following substance make a homogeneous mixture with water

A. benzene
B. oil
C. sugar
D. sulfur

4. 4. Which substance is not a mixture?

A. air
B. sea water
C. pure water
D. brass

2.4. Changes around Us: Physical and Chemical Changes

Learning Competency

At the end of this section, learners will able to:

- *describe physical and chemical change*
- *distinguish the physical and chemical changes using their characteristic*
- *conduct some simple activities to show physical and chemical changes and write group report.*
- *observe and describe physical chemical changes that are important in everyday life.*
- *identify useful and harmful physical and chemical changes.*

Activity 2.13

The followings are day to day activities in your home. Copy and complete the table, by identifying which activities represent "physical change" and which one represent "Chemical change" by giving reasons for your choice

Name of activities	Physical changes	Chemical changes	Reasons
Burning of charcoal			
Melts of ice			
Dissolving sugar in water			
Fermentation			
Rusting of nail			
Evaporation of water			
Spoilage of food			
Burning candle			

Change is happening all around us all of the time. Changes are classified as either physical or chemical changes.

2.4.1. Physical change

A physical change is a process in which a substance changes its physical appearance but not its chemical composition. A new substance is never formed as a result of a physical change. A change in physical state is the most common type of physical change. Melting, freezing, evaporation, and condensation are all changes of state. In any of these processes, the composition of the substance undergoing change remains the same even though its physical state and appearance change. The

Figure 2.13: melting of ice

melting of ice does not produce a new substance; the substance is water both before and after the change. Similarly, the steam produced from boiling water is still water. Melting of ice, Grinding salt, Tearing paper into small pieces, Making an iron bar magnetic, evaporation of water, dissolving sugar in water and breaking a stick are common examples of physical changes.

2.4.2. Chemical change

A chemical change is a process in which a substance undergoes a change in chemical composition. Chemical changes always involve conversion of the material or materials under consideration into one or more new substances, each of which has properties and composition distinctly different from those of the original materials. Consider, for example, the rusting of iron objects left exposed to moist air. Some examples of chemical changes are: Iron nail going rusty, heating magnesium ribbon, Burning candle. photosynthesis,fermentation,etc

Figure 2.14: burning of candle

Experiment 2.3

Title: Rusting of iron.

Objective: To investigate the type of change that occurs during rusting of iron

Procedure:

1. Put a few lean, shiny iron nails into a test tube containing some fresh tap water. The water contains dissolved air.
2. Set the test tube in a rack. After a few days observe the change that has taken place.

Figure: 2.15 rusting of iron

Questions

1. What color do you observe on the iron nail?
2. Is the change physical or chemical? Why?

Characteristics of physical and chemical changes

Activity 2.14

Discuss the following idea in groups and present your opinion to the rest of the class

1. List the characteristics of physical and chemical changes you know
2. Compare and contrast the characteristics of physical and chemical changes

Characteristics of physical change

- No new substance is formed
- The composition of substance not altered
- It is easily reversed by physical means
- Energy changes are not neccerily
- It is a change in physical property

Characteristics of Chemical change

- New substances with new properties are formed
- The composition of substance altered
- It is accompanied by Energy changes

- The change is not easily reversed
- It is a change in physical property

2.4.3. Useful and Harmful physical and Chemical Changes

Activity 2.15

Perform the following tasks in groups and present your findings to the rest of the class.

List the important and harmful physical and chemical changes that encounter in our live.

a) important physical changes
b) important chemical changes
c) harmful physical changes
d) harmful chemical changes

Useful effect of Physical changes

Physical changes is useful in the following ways:

- Evaporation and condensation create water cycle
- Freezing preserves food, medicine, and other materials
- Melting, cutting, bending and mould different tools and accessories
- To get substances in the form, shape or size we want
- To mix two or more substances together
- To separate substances from their mixtures

Harmful effect of Physical changes

Even many physical changes are useful, it may also be harmful in several way: like cutting tree, bad weather condition, oil spills, etc.

Useful effect of chemical changes

Chemical Changes is useful in the following ways:

Photosynthesis: chemical changes which occur in plants (photosynthesis) produce substances which enable plants to grow. We depend on plants for our food. The change which occur in the food we consume are chemical change

Energy production: Most of the energy used nowadays, with the exception of wind, water and nuclear energy, is chemical energy. This energy released as heat or electricity when certain chemical change takes place.

Food & medicine production, Food digestion**,** Fermentation, food cooking, etc. are also some important chemical change in our live.

To produce new substance

Harmful effect of Chemical changes

In contrast to its usefulness, some chemical change has negative impact. For example Rusting (rusting of car, bridges, and ships), souring food, burning of fuel, smoke emission, plastic disposal, dumping of chemicals, etc. are harmful chemical change in our live.

Exercise 2.7

I. Give answer for the following question

1. Classify the following as physical changes or chemical changes.

a) The Cutting of wood
b) Interaction of food with saliva and digestive enzymes
c) The vigorous reaction of potassium metal with water to produce hydrogen gas is a change.
d) Straightening a bent piece of iron with a hammer is an example of a change.
e) The ignition and burning of a match involve a change
f) photosynthesis
g) Boiling of an egg.
h) boiling of water
i) dissolution of sal

II. Choose the best answers for the following questions

1. Change in size, shape and state of a substance is a____

   A. chemical change
   B. Physical change
   C. cyclic change
   D. none

2. Which of the following statements is correct?

   A. Evaporation is a chemical change
   B. Digestion of food is chemical change
   C. Burning of paper is physical change
   D. All

3. Among the following which is a physical change?

   A. Burning candle
   B. Fermentation
   C. Making an iron bar magnetic
   D. All

2.5. Separation of Mixtures and its Application periods

Learning Competency

At the end of this section, learners will able to:

- *list methods of separation of mixtures*
- *give some specific examples of mixtures that can be separated by filtration, decantation, simple distillation, magnetic separation and using separator funnel*
- *name apparatuses used in decantation, filtration, simple distillation, using separator funnel.*
- *assemble apparatuses used in decantation, filtration, simple distillation, separator funnel*

- *conduct and report on an investigation that uses physical means such as particle size, density, boiling point, solubility and magnetism to separation.*
- *perform simple activities in group, to carry out the separation of mixtures using local materials and write a group report.*
- *compare and evaluate the different ways of separating mixtures from products in community.*

Activity 2.16

Discuss the following questions in groups and present your conclusion to the class

1. Write the common separation methods you know for the following common mixtures from your daily life experiences
   a) Teff and peas
   b) A mixture of iron filings and sulfur powder
   c) A mixture of chalk particles in water
   d) A mixture of cooking oil and water
   e) Salt solution
   f) A mixture of alcohol and water
   g) A mixture of salt and sand
   h) Mixture of orange, banana and mango

2.5.1. Separation Techniques of Mixture

Most of the substances around us exist in the form of mixtures. However, these mixtures can be separated into pure substances using various separation techniques. The process of separating the constituent substances of a mixture by physical methods, taking advantage of the differences in their physical properties is called separation process.

Some of the methods used to separate mixtures are Separation by hand, sieving filtration, evaporation, magnetic separation, decantation and distillation. Note that the methods for the separation of mixtures into their components depend on the differences in the size, magnetic property, melting point, boiling point, solubility, etc. of the components. We will discuss some of the methods that are used to separate

the components of mixtures.

I. Magnetic Separation

Magnetic separation is used to separate magnetic and non-magnetic substances in a mixture. For example, if sand is mixed with iron filings the mixture is heterogeneous. To separate the iron filings from the sand, you can use a magnet. The iron filings (magnetic component) are attracted by the magnet, while the sand does not attracted.

(a) (b)

Figure 2.16 (a) the mixture contains iron fillings and sand. (b) A magnet separates the iron fillings from the mixtures.

Experiment 2.4

Title: Separation of mixture using bar magnet

Objective: To separate a mixture of iron fillings and sand

Equipment/ Materials: Magnetic bar, Iron fillings, Sand, Petri dish/ plastic plate/ bowl Plastic bag/wrapper, Spatula

Other requirements: Working bench/table, Open space, Laboratory coat, Eye goggles, Nose mask, and Hand gloves.

Experimental Procedure

1. Mix the sand with the iron filings in the plastic plate.
2. Wrap the plastic bag around the bar magnet
3. Suspend the bar magnet over the plate
4. The iron would be collected / attracted to the surface of the magnetic bar
5. Carefully remove the plastic bag around the magnetic bar and scrape off the iron filings

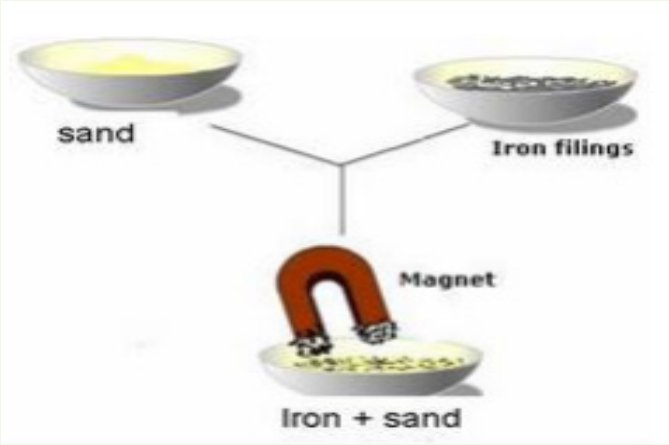


Figure 2.17 mixture of sand and iron fillings

On completion of the experiment, you should answer the following questions

1. Why was the sand not attracted to the magnet? What can you conclude from this experiment?
2. Can the same procedure be used to separate carpenter's nails from saw dust? Give a reason(s) for your answer.

II. Decantation

What type of separation method is used to get a cup of clear coffee as it is poured from coffee pot ("jebena") as shown in Figure 2.18?

Figure 2.18: Separation by decantation

Decantation is the process of separation of liquid from solid and other immiscible (non-mixing) liquids, by removing the liquid layer at the top from the layer of solid or liquid below. The process can be carried out by tilting the mixture after pouring out the top layer. This process can also be used to separate two liquids that do not mix with each other for e.g. cooking oil and water. When we leave the mixture of cooking oil and water, two separate layers are formed, with water at the bottom and oil, being lighter, at the top. We can remove the oil layer from the top by pouring it into another vessel, which leaves us with the water layer at the bottom.

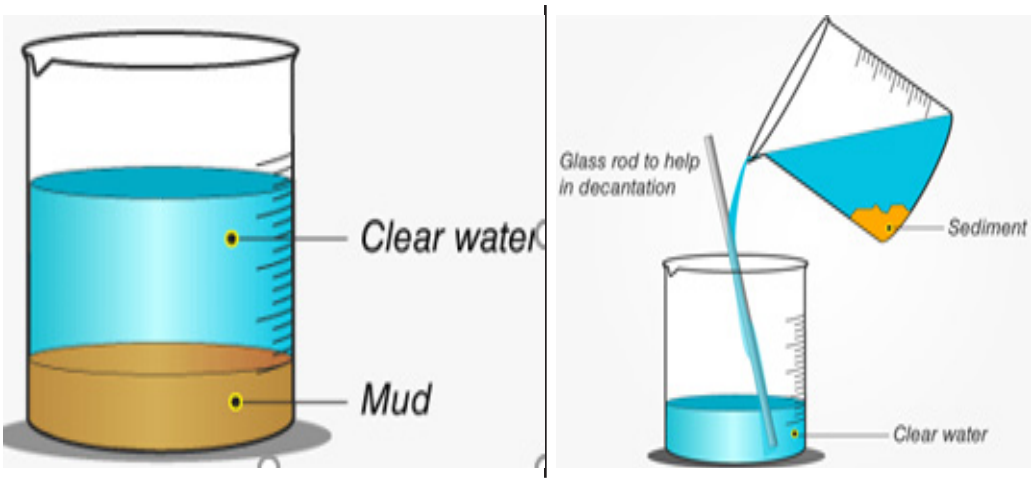


Figure 2.19: Decantation of solids from a solid-liquid mixture

Separating funnel:

When two liquids do not mix, they form two separate layers and are known as immiscible liquids. These two liquids can be separated by using a separating funnel. A separating funnel is a special type of glass funnel, which has a stop-cock in its stem to regulate the flow of liquid. It will separate the immiscible liquids into two distinct layers depending on their densities. The heavier liquid forms the lower layer while the lighter one forms the upper layer. Remove the stopper and open the tap to run the lower layer into a beaker. You will be left behind with just the upper layer in the funnel. Collect this liquid into another beaker. Examples: Kerosene and water mixture is separated by using separating funnel method. This method is also used to separate oil and water.

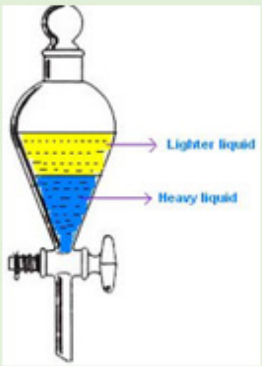


Figure 2.20: Separation of immiscible liquids using separating funnel

III. Filtration:

Filtration is a process by which insoluble solids can be removed from a liquid by using a filter paper. A filter paper is a special type of paper which has pores that are tiny enough to let only liquids pass through it. If you pass a solution through filter paper, any un dissolved solid particles will get left behind on the paper whereas the liquid will filter through. The liquid that passes through is called the filtrate and the un dissolved solid particles are called residue. Example: A mixture of chalk powder and water, soil and water, sand and salt solution, etc. can be separated by this method. In practical application, filtration is a key step in the purification of the tap water you drink.

Figure 2.21: Filtration

IV. Evaporation

Activity 2.17

Perform the following activity.

Dissolve sodium chloride (or any other soluble salt) and water to forms a homogeneous mixture (solution).

- How can you recover the salt again?

Evaporation is a method used to separate a soluble solid from a liquid in a solution or the process. of vaporizing the solvent to obtain the solute. It is used to separate a mixture containing a non-volatile, soluble solid from its volatile, liquid solvent. We can separate salt from a solution by evaporating the water from the solution.

Figure 2.22: Evaporation of a solution

V. Distillation:

This method is used for the separation of a mixture containing two miscible liquids that boil without decomposing and have a large difference between their boiling points. It also used in obtaining pure water from salt solution. Process of conversion of a liquid into vapor by boiling, and then re-condensing the vapor into liquid is called ***distillation***. In simple distillation, a mixture is heated and the most volatile component vaporizes at the lowest temperature. The vapor passes through a cooled tube (a condenser), where it condenses back into its liquid state. The condensate that is collected is called distillate. Figure show the simple distillation set up

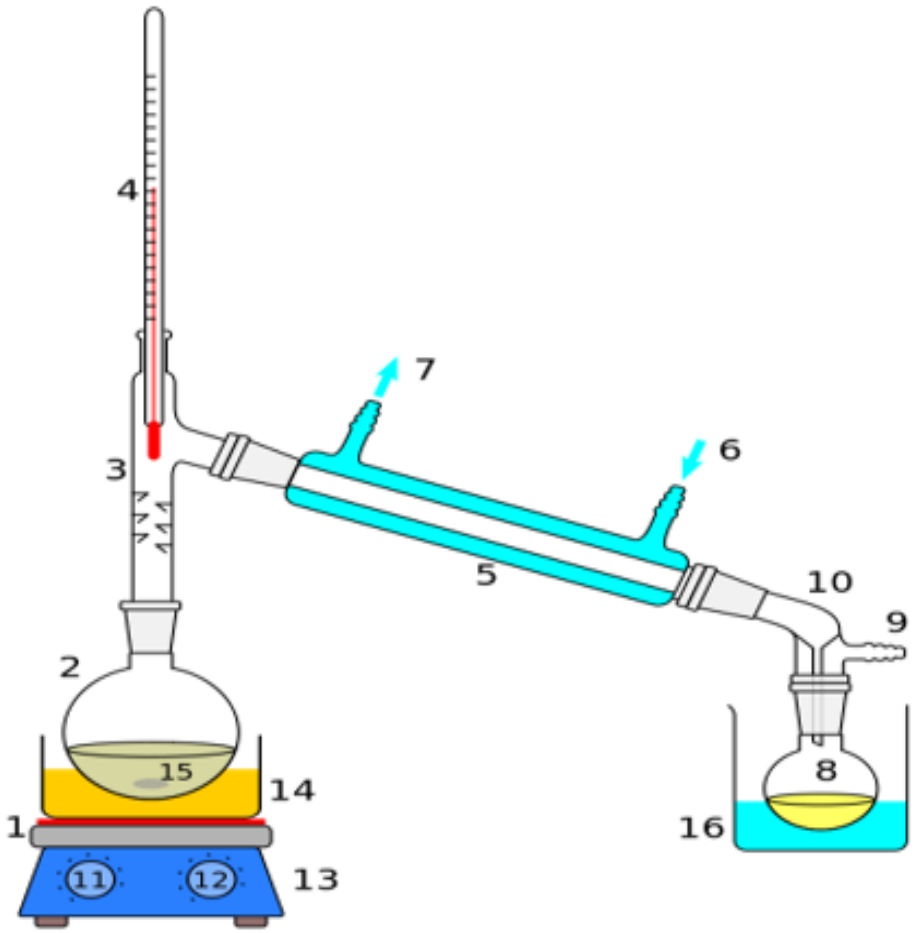


Figure 2.23: simple distillation set up

Notice: Laboratory display of distillation: in the above set up, each number indicates:	
1. A heat source	10. Still receiver
2. Round bottomed flask	11. Heat control
3. Still head	12. Stirrer speed control
4. Thermometer/	13. Stirrer/heat plate
5. Condenser	14. Heating (Oil/sand) bath
6. Cooling water in	15.Stirring mechanism (not shown) e.g. boiling chips or mechanical stirrer
7. Cooling water out	16. Cooling bath
8. Distillate/receiving flask	
9. Vacuum/gas inlet	

A mixture of two miscible liquids can also be separated by simple distillation. Liquids which mix with each other to form a solution are called miscible liquids. The mixture of alcohol and water, benzene and oil are some examples of miscible liquids. Consider a mixture of alcohol and water. Ethanol, which is an alcohol boils at 78°C, and water boils at 100°C. When the mixture is heated, the alcohol, which has the lower boiling point vaporizes more rapidly than the water. The vapor of alcohol passes through the condenser and then collected as a distillate in the receiver.

Activity 2.18

Perform the following tasks in groups and present your conclusion to the class. The following mixtures can be separated using a combination of separation techniques. Mention all the possible separation techniques.

i) Mixture of salt, sand and water
ii) Mixture of common salt, iron filling and salt
iii) Mixture of oil, water and sand
- sugar and clay

Is one separation method enough when salt and sand is mixed with water? Sometimes to separate such mixture may require combination of two or more techniques. For example, a mixture of common salt and sand can be separated by using the process of dissolving, filtration and evaporation. The first stage of separation is adding water to the mixture. The salt dissolves in water and forms a solution, but not the sand. Then by using filtration, the sand can be separated from the salt solution. Finally evaporation of the filtrate will cause the water to escape leaving the salt behind.

2.5.2. Application of separation techniques.

Activity 2.19

Perform the following tasks by asking your parents/guardians /grandparents/elders in the neighborhood on the separation techniques used in daily lives. Prepare a table of such activities of daily life in which sedimentation, decantation, filtration and evaporation are used/occurs. Then present your findings to the whole class.

Table 2.5 application of various separation techniques

No.	Physical process	Application
1	Filtration	River water is potable, Separation of honey from its comb
2	Evaporation	Common salt is obtained from sea water on large scale.
3	Distillation	Alcoholic beverage such as whisky, gin, brandy, areki are manufactured.
4	Magnetic separation	To separate iron and steel from non – magnetic objects such as, glass, plastic, aluminum, etc.
5	Sedimentation followed by decantation	Drink homemade coffee, tella

Project Work

Separation of mixtures using local materials

- There is a mixture of table salt, sulfur powder and iron filing inside a beaker.
- By using any local materials that are found around you, try to separate this mixture into their components.
- Hint: Both sulfur powder and iron filing are insoluble in water whereas sodium chloride (table salt) is soluble in water.
- Write a group report: In your report indicate the separation techniques and the materials used during the separation processes

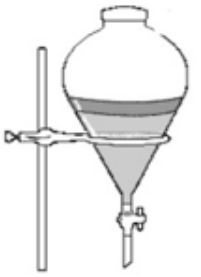
Exercise 2.8

I. Give answer short Answer.

1. How would you separate the following?

a) salt solution
b) common salt and sand
c) iron and charcoal
d) oil, water and sand
e) nitrogen and oxyge

2. Name the separation technique shown in the diagram

		
A	B	C
		
D	E	F

Key Terms

- Matter
- Particle theory
- Diffusion
- Physical property
- Chemical property
- Homogeneous mixture
- Pure substance
- Decantation
- Magnetic separation
- Boiling point
- Sublimation
- Mixture
- Non metal
- Heterogeneous mixture
- Density
- Freezing point
- Physical changes
- Compounds
- Elements
- Distillation
- Evaporation
- Filtration
- Freezing

Unit Summary

- *Matter is anything that has mass and occupies space. It can exist in three states: solid, liquid, and gas.*
- *The idea that matter is made up of tiny particles is called the Particulate nature of matter.*
- *Particle theory of matter tell us the particles of matter are always moving.*
- *Diffusion is the mixing and spreading out of a substance with another substance due to the movement or motion of its particles.*
- *The three states of matter (solids, liquids and gases) can be interconverted without changing the composition of the substance. To change a substance from one state to another, energy must be added or removed. Melting, freezing, evaporation, and condensation are all changes of state.*
- *A physical property can be measured and observed without changing the composition or identity of a substance.*
- *A chemical property is a characteristic of a substance that describes the way the substance undergoes or resists change to form a new substance.*
- *Matter can be classified in terms of its chemical composition into two broad categories: pure substances and mixtures pure substances.*
- *A pure substance is a single kind of matter that cannot be separated into other kinds of matter by any physical means.*
- *Pure substances are classified as elements and compounds.*
- *An element is a pure substance that cannot be broken down into simpler substances by ordinary chemical means.*
- *A compound is a pure substance composed of two or more elements that are combined chemically in a definite proportion by mass.*
- *A mixture is a physical combination of two or more pure substances in which each substance retains its own properties.*
- *A homogeneous mixture (also known as solution) has a uniform composition and properties throughout.*
- *Heterogeneous mixture is a mixture that does not have a uniform composition throughout.*
- *Changes are classified as either physical or chemical changes.*
- *A physical change is a process in which a substance changes its physical appearance but not its chemical composition.*
- *A chemical change is a process in which a substance undergoes a change in chemical composition.*
- *Mixtures can be separated using a variety of techniques. The process of separating the constituent substances of a mixture by physical methods, taking advantage of the differences in their physical properties is called separation process.*
- *Some of the methods used to separate mixtures are Separation by hand, Sieving Filtration, evaporation, magnetic separation, decantation and distillation.*

Review Exercise

Part I. Write 'True' for the correct statements and 'False' for the wrong statements.

1. Depending upon the temperature, water can exist in solid, liquid or gas states.
2. A gas has neither a definite volume nor a definite shape.
3. Dust, smoke, bacteria, air born viral particles are component of particulate matter.
4. Elements can be further decomposed by ordinary chemical means.
5. Heterogeneous mixture contains one phase.

Part II. Choose the best answers for the following questions

1. All of the followings are matter except

   A. plant
   B. stone
   C. air
   D. sound

2. Which of the following decrease during the phase (state) changes of

   Solids ⟶ liquids ⟶ gases

   A. Degree of order among particles
   B. Energies of particles
   C. Speed of particles
   D. Distance among particles

3. Which of the following is not the property of solids

   A. Solids have little tendency to diffuse
   B. Solids are extremely difficult to compress
   C. Solids are fluids
   D. Solids have definite volume and definite shapes

4. The particular physical state of substance depends on _

A. Temperature
B. Pressure
C. Strength of intermolecular force
D. All

5. Which of the following has no definite shape and volume?

A. Water
B. Carbon dioxide
C. Iron
D. Gold

6. The interaction of substance with light results

A. taste
B. odor
C. color
D. texture

7. Which of the following is not a physical change?

A. Sublimation of iodine
B. Burning of wax in a candle
C. Tearing a piece of cloth
D. Dissolving sugar in a tea

8. All of the following are heterogeneous mixtures except

A. soil
B. mixture of water and oil
C. salt solution
D. blood

9. Which of the following is not metal?

A. Iron
B. Sulfur
C. Copper
D. Sodium

10. Which of the following has variable composition?

A. Water
B. Salt
C. Milk
D. Silver

11. A mixture of sand and sugar can be separated by

A. Evaporation followed by distillation

B. Filtration followed by evaporation
C. Dissolution followed by filtration and evaporation
D. Dissolution followed by evaporation and filtration.

12. The conversion of a vapor directly to solid without passing through a liquid state is called_____

A. fusion
B. evaporation
C. sublimation
D. deposition

13. Distillation is used in the process of preparation of

A. coffee
B. areki
C. tella
D. honey

14. Identify the heterogeneous mixture among the following

A. Sea water
B. blood
C. bronze
D. air

15. Grade 7 students in a certain school were given the task of separating, iron fillings, sand and salt. Which of the following process is the most appropriate order?

A. Evaporation-Dissolution - filtration- magnetic separation
B. Dissolution –magnetic separation - filtration_ evaporation
C. Magnetic separation -Dissolution - filtration –evaporation
D. Magnetic separation - Dissolution – evaporation- filtration

16. Answer the following question based on the information below.

I. Physical changes are easily reversible.
II. Physical change do not produce new substance
III. Physical change do not involve change in mass.

Which of the above statement are correct?

A. I
B. I and III
C. II and III
D. I, II and III

17. Which two state of matter are fluids?

A. Solid and liquid
B. Liquid and gas
C. Solid and gas
D. Plasma and solid

18. All of the following are same process. **EXCEPT**

A. Condensation
B. Freezing
C. Crystallization
D. Solidification

Part III. Match the items in column 'A' with items in column 'B'.

"A"	"B"
1. Melting (fusion)	A. process of changing liquid to gas
2. Evaporation	B. process of changing liquid to solid
3. Sublimation	C. Process of changing solid to gas
4. Freezing	D. Process of changing gas to solid
5. Deposition	E. Process of changing gas to liquied
6. Condensation	F. Process of changing solid to liquid

Part IV. Fill in the blanks with appropriate terms.

1. Immiscible liquids can be separated by using_____
2. Separating a solid from a solution by cooling is_____
3. The separation technique that involves heating a solution until the liquid changes into a gaseous state, leaving behind a solid is known as____
4. When rain falls, this is because the water vapor in the clouds is condensing into liquid _____?
5. I put dirty water into a funnel with a paper lining. Clean water comes out of the funnel into my beaker and solid dirt gets left behind on the paper. This is an example of_____

Part V. Give short answer to the following questions

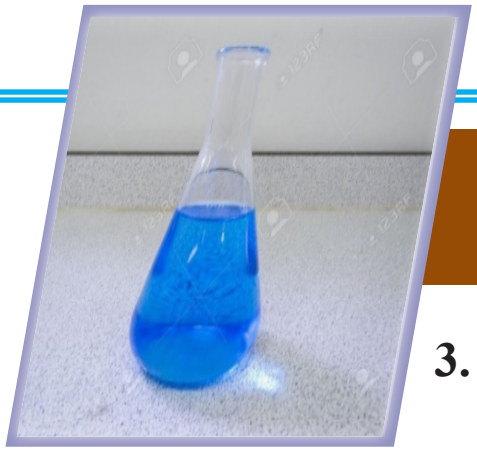
1. What is diffusion?
2. Why do solids have fixed shape and volume?
3. Write the difference between extensive and intensive physical properties.

Self Assessment

Check List Competencies given below are expected to be achieved in this unit by students. You are required to respond by saying Yes or No. Put a tick (√) mark under "Yes" column if you are able to perform the competency or under "No" column if you are unable to perform the competency. This would help to evaluate yourself and you can revise the parts of topics for which the competencies are not met.

No.	Can I	Yes	No
1	*Define matter with examples from day today life.*		
2	*Demonstrate that matter made up of tiny particles.*		
3	*State the postulates of the particle theory of matter*		
4	*Infer the particulate nature of matter from demonstration/ investigation.*		
5	*Apply particle nature of matter in explaining diffusion and every day effect of diffusion.*		
6	*Describe and/or make a representation of the arrangement, relative spacing, and relative motion of the particles in each of the three states of matter*		
7	*Describe and explain compression in terms of distance between particles*		
8	*Use the terms melting, condensing, and freezing/solidification to describe changes of stat*		
9	*Use the particulate nature of matter to explain: Melting, Freezing/ solidification, Evaporation, Condensation*		
10	*Describe physical Properties*		
11	*Use physical properties of matter to identify substances*		
12	*Conduct experiments to identify properties of substances and make group report.*		
13	*Identify chemical properties*		
14	*Distinguish between physical and chemical properties.*		
15	*Use the particle theory to describe the difference between pure substances and mixtures*		

16	*Differentiate between elements and compounds*		
17	*Classify common elements into metals and non-metal*		
18	*Investigate the properties of metals and compile a list of general properties*		
19	*Investigate the properties of non -metals and compile a list of general properties.*		
20	*Describe and classify mixtures into homogenous and heterogeneous.*		
21	*Use models/ particles diagram to show differences between homogenous and heterogeneous.*		
22	*Describe the relationship among elements, compounds, mixtures, homogenous mixture and heterogeneous mixture.*		
23	*Describe physical and chemical change.*		
24	*Distinguish the physical and chemical changes using their characteristics.*		
25	*Conduct some simple activities to show physical and chemical changes and write group report.*		
26	*Observe and describe physical chemical changes that are important in everyday life.*		
27	*Identify useful and harmful changes*		
18	*List methods of separation of mixture*		
29	*Give some specific examples of mixtures that can be separated by filtration, decantation, simple distillation, magnetic separation and using separator funnel*		
30	*Name apparatuses used in decantation, filtration, simple distillation, using separator funnel.*		
31	*Assemble apparatuses used in decantation, filtration, simple distillation, separator funnel.*		
32	*Conduct and report on an investigation that uses physical means such as particle size, density, boiling point, solubility and magnetism to separation*		
33	*Perform simple activities in group to carry out the separation of mixtures using local materials and write a group report*		
34	*Compare and evaluate the different ways of separating mixtures from products in community*		



UNIT - 3

3. ELEMENTS, COMPOUND AND CHEMICAL REACTION

Learning Outcomes

At the end of this unit, learners will able to:

- *compare elements to compounds and how they are represented by symbols and formulae.*
- *identify and write symbols of common elements or compounds.*
- *Name compounds given their formula and write formula given the name of the compound.*
- *use symbols and chemical formulae as a way of communicating information about elements and compounds.*
- *state and apply the Law of Mass conservation to writing balanced equations.*
- *interpret chemical formulae of compounds in terms of the elements present and the ratios of their atoms.*

Main Conents

Introduction

Pure substance, whether an element or compound, has its own unique name, symbol or formula. Scientists use chemical symbols in place of the names of the elements because it helps for scientists in writing chemical formulas and equations. The symbols and formulas are designed in such a way that they are internationally accepted. Therefore, they enable all scientists in the world to communicate easily. Symbols and formulas of elements or compounds are used in certain combination-ratios as a short hand representation of chemical reaction and these short hand languages is known as chemical equation.

3.1. Elements and their representation

Learning Competency

At the end of this section, learners will able to:

- *define element*
- *identify symbols of some common elements.*
- *write chemical symbols for common elements*

Activity 1.1

Form a group and discuss the following questions and share your ideas with the rest of the class.

1) From your previous knowledge, what is an element?
2) List some common elements you are familiar with.

Try to classify them as

a. metal b. non -metal

3.1.1. Common elements

An element is a pure substance that cannot be broken down into simpler substances by ordinary chemical means. An element is composed of only one kind of matter (atoms).There are 118 known elements.92 out of 118 elements naturally occurring elements.

As you have learnt in unit two, elements classified as metal and nonmetals. Oxygen, aluminum, iron, calcium, sodium, potassium, magnesium, hydrogen, nitrogen, gold, silver, copper, sulfur, and chlorine are some common elements.

3.1.2. Chemical symbols

Activity 3.2

Perform the following activities in group. Then present your opinion to the whole class

1) What is atomic symbol?
2) Explain why some symbols for examples He, Cl and Si-have two letters

Scientists use symbols as abbreviation of names of an elements. An atomic symbol is defined as shorthand way of representing elements or atoms of an element..

Every element has its own symbol. No two elements can have the same symbol.

Q. How to write symbols of elements?

Chemists use chemical symbols in place of the names of the elements because they are much easier and quicker to write symbol. A symbol for element is taken from the first letter or the firs letter plus another letters of the common name or Latin/Greek name of the element. If a symbol has one letter it is written in capital letter and if it has two letters the first is in capital and the second is in small letter.

For example, S stands for sulfur, O stands for oxygen and K represents potassium. In the case of potassium, the symbol is derived from the Latin name, Kalium.

Q. Why are not all elements symbolized by the first letter of their names?

The names of some elements such as carbon and calcium begin with the same letter

"C". Therefore, we cannot use the letter "C" as a symbol for both elements. Hence two letters are used for other elements except one. The first letter "C" is assigned as a symbol for carbon. The other element calcium is represented by two letter symbols Ca. The same things true for hydrogen and helium. The first letter "H" is assigned as a symbol for hydrogen while "He" symbol stands for element helium.

Table 3.1: Name and symbols of some elements

Name of elements	Symbol	Name of elements	Symbol
Hydrogen	H	Magnesium	Mg
Helium.	He	Aluminum	Al
Lithium	Li	Silicon	Si
Beryllium	Be	Phosphorus	P
Boron	B	Sulfur	S
Carbon	C	Chlorine	Cl
Nitrogen	N	Argon	Ar
Oxygen	O	Calcium	Ca
Fluorine	F	Zinc	Zn
Neon	Ne	Bromine	Br
Magnesium	Mg	Iodine	I

Symbols of element derived from their Latin names are listed below.

Table 3.2: Symbols of element derived from Latin names

English name	Latin name	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe
Copper	Cuprum	Cu
Silver	Argentum	Ag
Gold	Aurum	Au
Lead	Plumbum	Pb
Tin	Stannum	Sn
Mercury	Hydrargyrum	Hg

Exercise 3.1

I. Write "true" for correct statement and "false" for wrong statement

1. "Ca" is the symbol of sodium.
2. Water is not an element.
3. Elements are pure substance.

II. Multiple choice questions

4. Which of the following is the correct chemical symbol for silicon?

   A. S
   B. Si
   C. SI
   D. Sl

5. "C" stands for_____

   A. calcium
   B. Chlorine
   C. Carbon
   D. Copper

6. Fill the missing symbols and names of the elements in the following table

Name of element	Symbol		Name of element	Symbol
Potassium			Iodine	
	He			B
Chlorine			calcium	
	Cu		Nikel	
Gold				H
	Li		silver	

3.2. Compounds and their representation

Learning Competency

At the end of this section, learners will able to:

- *define compound as a substance formed when two or more elements chemically combined together.*
- *define valence numbers as the combining power of an atom*
- *write the formulae of simple binary compounds using symbols and valences*
- *name binary compounds*
- *describe polyatomic ion*
- *write the chemical formulas of common compounds that contain polyatomic ions*
- *name compounds containing polyatomic ions.*
- *identify the elements and number of atoms, given a chemical formula*

3.2.1. Compounds

Activity 3.3

Form a group and discuss the following questions and share your ideas with the rest of the class.

1) From your previous knowledge, what is a compound?

Copy the table on your exercise book and classify the substance as element and compound

Substance	Element	Compounds
Sodium chloride (table salt)		
Water		
Gold		
Iron		
Carbon dioxide		

As you have learnt in unit two, a compound is a pure substance consists of two or more elements which have been chemically combined. For example, water is a compound of hydrogen and oxygen. Each of its molecules contains two hydrogen atoms and one oxygen atom. There are many different compounds. Some examples of compounds are sodium chloride, iron sulfide, carbon dioxide, sugar, calcium carbonate, calcium oxide, etc.

3.2.2. Chemical formulas

It is the symbolic representationof an element or a compound. Chemical formulas can be classified as formulas of elements and formulas of compounds.

Formulas of Elements

The formula of an element consists of one kind of symbol.

A **molecule** is the smallest particle of an element or a compound that has a stable,independent existence.

The elements helium, neon, argon, krypton, xenon and radon are collectively known as noble gas. Because they exist uncombined as single atoms,they are also known as monoatomic gases. Their formula are the same as their symbols.Example He for Helium, Ne for Neon Ar for Argon.

Some nonmetallic elements exist as molecules containing two, four, or eight atoms. Hydrogen, nitrogen, oxygen, fluorine, chlorine, bromine and iodine are found as **diatomic molecules**.

Table 3.3 symbols and formulas of diatomic elements.

Name	Symbol	Formula
Hydrogen	H	H_2
Nitrogen	N	N_2
Oxygen	O	O_2
Fluorine	F	F_2
Chlorine	Cl	Cl_2
Bromine	Br	Br_2
Iodine	I	I_2

Elemental formula also found in homo polyatomic molecules that contain more than two atoms. Examples:- **Ozone-O_3, Phosphorus-P_4 and Sulfur-S_8**

Formulas of Compound

Elements combine to form compounds. Just as **symbol** is a shorthand way of representing element, a chemical formula comprising two or more different symbols, is a short hand representation of a compound. In formulas of compound, the following points are noticed.

- In each formula, the symbol of elements which form the compound are given. Each symbol is immediately followed by a subscript showing the number of atoms of that element.
- Chemical formulas indicate the relative number of atoms of each element present in the compound.
- For example, water (H_2O) is a compound of hydrogen and oxygen. Each of its molecules contains two hydrogen atoms (2H) and one oxygen atom (O).

Exercise 3.2

I. Choose the correct answer from the given alternative.

1. Elements exists as a diatomic and polyatomic molecular form except?

   A. Phosphorus C. Oxygen
   B. Nitrogen D. Neon

2. For which of the following do the atom and molecule have different formula?

   A. Helium C. Nitrogen
   B. Argon D. Neon

3.2.3. Valence number

Activity 3.4

Discuss in groups and share your ideas to the class

1) What is valence number?

Elements combine in accordance to the laws of nature at atomic levels. Each element in a formula of a compound has a combining power. The combining power of an element is called **valence.** If we know the combining power (valence number) of the elements, it is easy to write the formula of a compound. Most common elements have valence 1, 2, or 3.

Some elements have more than one valence number, which is different combining powers under different conditions. Common examples of these elements that have variable valence are iron, copper, lead and tin.

Ions are atoms that have positive or negative charge. The number of negative or positive charge an ions carries is equal to the valence number of the ion.Thus, the valences of of Cl^{-}, O^{2-} and Al^{3+}= are 1, 2 and 3 respectively. The following table shows the combining power of some common elements.

Table 3.4: valences of some common elements.

Elements	Valence 1		Valence 2		Valence 3	
	Name	symbol	Name	symbol	Name	symbol
Metals	Lithium	Li	Magnesium	Mg	Aluminum	Al
	Sodium	Na	Calcium	Ca	Iron(III)	Fe
	Potassium	K	Iron(II)	Fe		
	Copper(I)	Cu	Zinc	Zn		
	Silver	Ag	Lead(II)	Pb		
Non-metal	Chlorine	Cl	Oxygen	O	Nitrogen	N
	Bromine	Br	Sulfur	S		
	Iodine	I				
	Fluorine	F				

3.2.4. Formulas of Binary Compounds

Binary compounds are compounds formed from two different types of elements. To write formulas of binary compounds, follow the following simple rule

i) Write the symbol of the elements
ii) Write the valence number above the symbol
iii) Criss-cross the valence numbers to conserve charge or to become the com-

pound electrically neutral and write below the symbols. If the valence number is one omit the subscript.

Examples write the formula for:

1. Write the chemical formula for Potassium iodide

Solution

Step 1: K I

Step 2:
1 1
K I

Step 3:
1 1
K I = K_1I_1

Since the subscript is 1 we omit and the chemical formula for Potassium iodide is KI.

2. Write the chemical formula for calcium chloride

Solution

Step 1 Ca Cl

Step 2:
2 1
Ca Cl

Step 3
2 1
Ca Cl = $CaCl_2$

Therefore, the chemical formula for of calcium chloride is $CaCl_2$

Exercise 3.3

I. Give short answers

1. Write the chemical formula for

A. Copper (II) oxide
B. Magnesium nitride
C. Sodium chloride
D. Aluminum Oxide
E. Iron (III) Oxide
F. Iron (II) bromide
G. Silver Oxide
H. Calcium fluoride

2. Write the chemical name for

A. MgO: B. FeS: C. AgCl:

II. Choose the correct answer from the given alternative

3. Which of the following is the chemical formula of aluminum nitride

A. Al_5N_3
B. Al_3N_2
C. AlN_3
D. AlN

4. How many valence number for aluminum?

A. 1
B. 2
C. 3
D. 5

3.2.5. Naming Binary Compounds

Activity:3.5

Perform the following activities.

- A student wrote this name for a compound made of calcium and sulfur: Sulfur calcium.
- What is wrong with this name?
- Write the correct name for the compound.2.

In naming a compound, the positive ion (metal) mention first followed by the negative ion (nonmetal). Binary compound is a compound that is made of only two different elements in a certain whole number ratio.

Rules for naming simple binary compounds.

1. If the binary compounds consists of metal and non -metal, the name of the metal named by its elemental name while the letters of the non-metal is replaced by the suffix-ide.

Table 3.6 Names of nonmetallic elements in binary compounds

Nonmetallic Element	Name in Binary	Non-metallic Element	Name in Binary
Nitrogen	Nitride	Bromine	Bromide
Oxygen	Oxide	Iodine	Iodide
Fluorine	Fluoride	Phosphorous	Phosphide
Chlorine	Chloride	Sulfur	Sulfide

2. There are metals that form more than one positive ions. In naming compounds of metals with more than one valence number, state valence with Roman number in bracket to indicate positive charge. Thus Fe^{2+} is Iron (II) (read as '' iron two '') and Fe^{3+} is iron (III) (read as "iron three")

Example: $FeCl_3$ Iron (III) chloride and FeO Iron (II) oxide

3.2.6. Polyatomic Ions

Ions are atoms or a group of atoms that have positive or negative charges. They can be simple ions as Cl^-, O^{2-} and Al^{3+} or polyatomic ions as NH_4^+,OH^-,NO_3^-,SO_4^{2-}And PO_4^{3-}

A polyatomic ion, also called compound ion is positively or negatively charged group of atoms. The following tables give the valence number of some polyatomic ions.

Table 3.5some common valence of polyatomic ions

Valence 1	Valence 2	Valence 3
Ammonium ion (NH_4^+)	Sulfate ion(SO_4^{2-})	Phosphate ion (PO_4^{3-})
Hydroxide ion (OH^-)	Carbonate ion(CO_3^{2-})	Phosphite (PO_3^{3-})
Nitrate ion (NO_3-)	Sulfite ion (SO_3^{2-})	
Nitrite (NO_2^-)		
Hydrogen carbonate (HCO_3^{-})		
Hydrogen sulfate ion(HSO_4^-)		

In writing chemical formulas of compounds that contain polyatomic ions, follow the same steps you used for writing formulas of binary compounds and use bracket if the valence number is different from 1 and not simplified.

Examples

1) Write the formula for ammonium chloride

Step 1 NH_4^+ Cl^-

Step 2 NH_4^+ Cl^-

Step 3 NH_4^+ Cl^-

So the molecular formula for ammonium chloride is =NH_4Cl

2) write the formula ammonium sulfate

Step 1 NH_4^+ SO_4^{2-}

Step 2 NH_4^+ SO_4^{2-}

Step 3 NH_4^+ SO_4^{2-}

So the molecular formula for ammonium sulfate is $(NH_4)_2SO_4$

In naming compounds containing polyatomic ions, the name of metals and ammonium ion are written first followed by the name of the polyatomic ions. Examples: NH_4Cl (ammonium chloride), $Al_2(SO_4)_3$ (aluminum sulfate) and $Fe(Cl)_3$ Iron (III) chloride,

Exercise 3.4

1. Fill in the blank by writing the formula of a compound

Ions	Nitrate	Sulfate	Carbonate	Phosphate
Na^+				
Ca_2^+				
Al_3^+				
NH_4^+				
Fe_3^+				

2. Name the following compounds.

A. NH_4Cl
B. $Cu(NO_3)_2$
C. $NaHCO_3$
D. $FePO_4$

3. Which three elements are combine in magnesium carbonate

4. Which four elements are combine in ammonium sulfate.

3.2.7. Interpreting formula

Activity 3.6

Perform the following activities.

1) What information is obtained from the coefficient and subscript in a formula?

When a formula is interpreted, it will give qualitative and quantitative meanings. Chemical symbols and formulas with numbers around them at particular positions give specific information. Thus, symbols and formulas of elements have qualitative and quantitative meaning.

Qualitatively : A symbol represents the identity (kind) of the element.

For example:

- Cl2 qualitatively the subscript 2 shows a chlorine molecule.
- The symbol O represents an atom of oxygen. No other element can be represented by the symbol O.
- Fe stands for iron metal
- CaO is qualitatively stands for calcium oxide made from one atom of calcium and one atom of oxygen.
- Ca (NO3)2 qualitatively stands for calcium nitrate made from one atom of calcium and two nitrate groups.

Quantitatively: a symbol represents the number of atoms of the elements.

In Cl2 quantitatively 2 shows there are two atoms in chlorine molecule

- Number preceding symbols, called coefficient, indicates the number of atoms of the element in a formula.2Fe stands for two atoms of iron (The number 2gives a quantitative meaning while Fe itself gives a qualitative meaning.
- A subscript written after a symbol (to the right) indicates that the element is in molecular form. For example, Cl2 a chlorine molecule and O2 is oxygen molecule
- The coefficient of a molecule or formula unit indicates the number of molecules or formula unit of that substance.
- 3H2O;the coefficient three shows that there are 3 molecules of water
- 2CO2 the coefficient 2 shows that there are 2 molecules of carbon dioxide
- 4NaCl the coefficient 4 shows that there are 4 formula unit of sodium chloride.
- CaO quantitatively it shows one formula unit of CaO
- Ca(NO3)2 quantitatively it shows one formula unit of Ca(NO3)2

Exercise 3.5

1. What does $3H_2O$ represents?

   A. $3H_2O$ atoms
   B. 6H molecule
   C. $3H_2O$ molecule
   D. 3O molecule

2. Write the qualitative meaning for

   A. 2Fe
   B. CO_2
   C. O_2

3. Write the quantitative meaning

   A. $3H_2$
   B. $4H_2O$
   C. NaCl

Project Work

Writing and interpret formulae of common compounds

By using reference materials, such as a Science books and/or the Internet, try to discover the formulae of common compounds such as baking soda, Vinegar (acetic acid), lime ,sugar(sucrose), chalk, milk of magnesia etc. and interpret them in terms of the elements present and the ratios of their atoms

3.3. Simple chemical reactions and equations

Learning Competency

At the end of this section, learners will able to:

- *define chemical reaction and give examples*
- *describe evidences that show chemical reaction has occurred.*
- *state the law of conservation of mass*

- *conduct an experiment in group to show simple chemical reaction.*
- *write a chemical equation*
- *balance simple chemical equation by inspection*
- *create and use models of particles to demonstrate balanced equations.*

3.3.1. Simple chemical Reaction

Activity 3.7

Discuss in groups and share your ideas with the rest of the class

1) Give some examples of chemical changes that takes place in your home or school.
2) What kind of chemical changes occurred when you cook food?
3) Imagine that you drop a glass beaker and it breaks down.
   a. Does a new substance formed?
   b. Is this a physical change or chemical change?

A chemical reaction is a process in which some substances is changed into one or more different new substances.

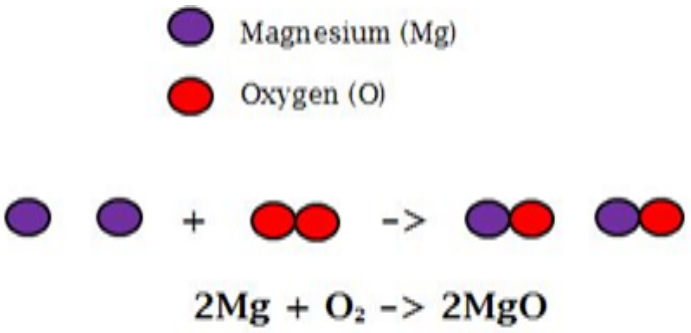
The starting materials in chemical reaction called reactants, react alone or with each other to produce one or more new substances, called products.

A chemical reaction involves the transformation of reactants into products.

Reactants ⟶ **Products**

An arrow (⟶) separates the two side and can be read as 'produce', 'give', form, 'yield'.

Reactants are always written on the left hand side of the arrow while product is written on the right hand side by putting "+" sign if there are two or more products. The "+" sign means "combines with" or "reacts with". For example when magnesium is in its metal form it will burn very easily in air. In burning of magnesium, the reactants are magnesium and oxygen while the product is the white ash known as magnesium oxide.



Similarly in the reaction between iron and sulfur, the iron and sulfur atoms are reactants where as the formed new substance Iron sulfide is the product.

By chemical reaction, some of the common examples of changes brought about include Rusting of iron, Fermentation and Digestion of food.

3.3.2. Evidences that show chemical reaction has occurred

Activity 3.8

Form a group and perform the following activity. Then present your finding to the rest of the class.

Record and describe the various chemical changes that occur in your daily lives (e.g cooking food, etc.) and describe the evidence you use to determine that chemical reaction occurred.

In a chemical reaction, new products are formed from the reactants. How can you tell this happened? There are few signs that indicate a chemical reaction has occurred. These are: A color changes

Gently heating black copper oxide with sulfuric acid produce a blue solution of copper sulfate.

Copper oxide + sulfuric acid ⟶ copper sulfate + water

(Black) (Blue)

Figure 3.1: blue copper sulfate solution

2. Evolution of a gas (formation of bubbles)

When magnesium is placed in hydrochloric acid, bubble of hydrogen gas are given off.

Magnesium + hydrochloric acid ⟶ magnesium oxide + hydrogen

3. Change of temperature (heat change):- either endothermic or exothermic

When potassium is placed in water, hydrogen gas is given off. The reaction produces so much heat the gas burns.

Potassium + water ⟶ potassium hydroxide + hydrogen

4. Precipitate (formation of a solid)

If you mix solutions of silver nitrate and sodium chloride, a chemical reaction takes place. In the reaction insoluble solids is formed. This is called a precipitate. The solid is silver chloride.

Figure 3.2 white precipitate of AgCl

silver nitrate + sodium chloride ⟶ silver chloride + sodium nitrat

3.3.3. Law of Conservation of mass

Activity.3.9

Form a group and perform the following activity. Then present your opinion to the class.

When we burn something it gets lighter or, in other words, it loses mass. For example when paper burn, the solid ash leftover lighter than the original paper. Does it mean that mass is not conserved? Discuss in groups and present your ideas to the whole class?

In chemical reactions the elements you begin the reaction with are the ones you end the reaction with. Nothing is added or taken away. The mass you begin with is the mass you end with. This important idea is called law of conservation of mass.

The law of conservation of mass states that matter is neither created nor destroyed during a chemical reaction. It means that the mass of reactants is exactly equal to the mass of the products.

3.3.4. Investigating Chemical Reaction

Experiment 3.1

Title: burning of Magnesium ribbon

Objective: to investigate the chemical reaction

Apparatus: Burner, crucible, a pair of tongs

Chemicals: Magnesium ribbon

Procedure

1) Take about 5 cm of magnesium ribbon. Rub its surface gently with an abrasive. Notice its color and hardness.
2) Hold it by a pair of tongs and burn it.

Experiment 3.1

Hazards!!!

In addition to being extremely bright, burning magnesium produces some ultraviolet light; avoid looking directly at it. The burning magnesium is very hot; do not touch it or let it come in contact with other flammable materials.

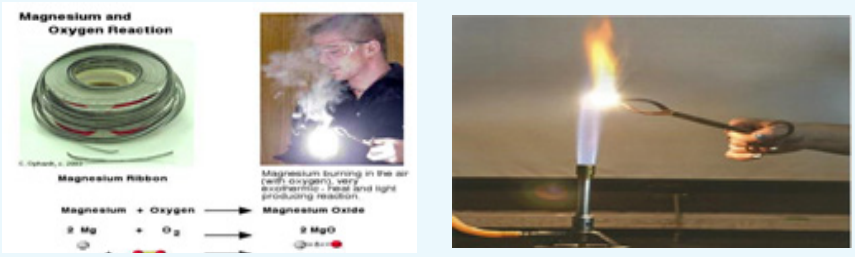


Figure 3.3: burning of magnesium

Collect the substance formed.Then add in a crucible and examine it carefully. Feel it. Notice its color.

After you complete the experiment, answer the following questions

1. What is the reactant materials?
2. Does it bend? It is shiny? Will it burn if heated again? Does it have any resemblance to the magnesium ribbon you started with?
3. Is chemical (change) reaction occur?

3.3.5. Writing and balancing simple chemical equation

Writing chemical equation

Activity 3.10

Perform the following activity

1) What is chemical equation?

A chemical equation is shorthand expression of a chemical changes (chemical reaction) through symbols and formulas.

In order to write a correct chemical equation, we look first for the experimental data to check that the reaction really takes place, and then identify the reactant and products involved in the reaction. We can then proceed to writing a word equation to represent the reaction. For example the reaction between hydrogen and oxygen to give water

1. **Hydrogen + Oxygen ⟶ water**

The next step is to represent each substance by its correct symbol and formula. The elements Hydrogen, nitrogen, oxygen, fluorine, chlorine, bromine and iodine are represented by the formulas H_2, N_2, O_2, F_2, Cl_2 Br_2, I_2. Because they found as diatomic molecules. Thus we have

2. $H_2 + O_2 \longrightarrow H_2O$

The law of conservation of mass requires that the number of atoms of each element should be the same as before and after the reaction, i.e. the atoms on both side of the equation must be balanced.

3. $2\,H_2 + O_2 \longrightarrow 2\,H_2O$

In the equation the coefficient and subscript give information when two molecule of hydrogen react with one molecule of oxygen give two molecule of water. In general, to write a chemical equation for a given reaction one can follow the following three steps.

Step 1: Write a word equation for the reaction.

Step 2: Change the word equation to a chemical equation i.e., write the correct symbol or formula for each reactant and product.

Step 3: Balance the equation so that it obeys the law of conservation of mass.

3.3.6. Balancing Chemical equation

Activity 3.11

Perform the following activity

Why should the chemical equation be balanced?

Chemical equation is balanced in order to obey the law of conservation of mass.So a balanced chemical equation is an equation in which the total number of atoms on the left hand side is equal to the total number of atoms on the right hand side. When we balance a Chemical equation, we have to change the coefficients not subscripts. This is because, changing subscripts changes the identity of substances. In balanced chemical equation:

Mass reactants = Mass of products

Number of atoms in reactant side = Number of atoms in product side

There are many methods of balancing chemical equations. Only 2 methods of balancing chemical equations are discussed in this book, namely

1. The inspection method
2. Least common multiple (LCM) method

1. The inspection method-

is trial and error method. It involves examining the equation and adjusting the coefficients until each kind of atoms are equal on the reactant and product sides.

For example, to balance the equation when nitrogen react with hydrogen to give ammonia

$$N_2 + H_2 \longrightarrow NH_3$$

Balance nitrogen by placing 2 before ammonia

$$N_2 + H_2 \longrightarrow 2NH_3$$

Now you have 6 hydrogen atoms on the product side. To balance hydrogen write a coefficient 3 before H2

$$N_2 + 3H_2 \longrightarrow 2\,NH_3$$

Finally check whether the equation balanced or not

Reactants	*Products*
N (2)	N (2)

H (6) **H (6)**

Therefore, the equation is balanced.

2. Least common multiple (LCM) method

The steps used in this method are shown by the following examples.

Consider the reaction between aluminum and oxygen to form aluminum oxide.

Step 1: represent the reaction by word equation

Aluminum + oxygen ⟶ aluminum oxide

Step 2: Write the correct formula for each of the reactants and products

Al + O ⟶ Al2O3

Step 3: Find the total valence number (subscript time's valence number) and place above each symbol and formula

Step: 4 Find the total valence number and place it above the arrow. The LCM of 3, 4, and 6 is 12

Step 5: Divide the LCM by each total valence number to obtain the coefficients for each of the reactants and products. Place the coefficients thus obtained in front of the respective formula. Check

4Al + 3O2 ⟶ 2 Al2O3

Reactants	*Products*
Al (4)	Al (4)
O (6)	**O (6)**

So the equation is balanced

Exercise 3.6

1. Balance the following by inspection

   A. $CaCO3\ (s) \longrightarrow CaO(s) + CO2(g)$
   B. $H2 + I2 \longrightarrow HI$
   C. $C2H2(g) + O2(g) \longrightarrow CO2(g) + H2O(l)$
   D. $Ca + H2O \longrightarrow Ca(OH)2 + H2$
   E. $Fe2O3 + CO \longrightarrow Fe + CO2$

2. Balance the following by LCM

   A. $Fe + O_2 \longrightarrow Fe_2O_3$
   B. $Cu + H2SO_4 \longrightarrow CuSO_4 + SO_2 + H_2O$

3.4. Uses Of Chemical Reactions in Every Day Situation

Learning Competency

At the end of this section, learners will able to:

- *describe the uses of chemical reactions in everyday situations*

Activity 3.12

Discuss in groups and share your ideas with the rest of the class.

1) How do the local people in Ethiopia prepare alcoholic beverages like "Tella"? What raw materials? Is the process a chemical change?
2) Give some examples of useful chemical reactions such as fermentation in brewing which produces carbon dioxide and ethanol/ alcohol and other indigenous knowledge.

3.4.1. Uses of chemical reaction

Chemical reaction happen everywhere. It happen inside your body to keep you alive- For example, reactions to digest food i.e. the breakdown of large molecules (protein, starch and fats) into smaller ones, so that they can be absorbed. Chemical reactions are an integral part of technology, of culture, and indeed of life itself. Burning fuels, smelting iron, making glass and pottery, brewing beer, and making wine and cheese are among many examples of activities incorporating chemical reactions that have been known.

Some Important Chemical Reactions

1. Synthesis of ammonia: Reaction: $3H_2(g) + N_2(g) \longrightarrow 2NH_3(g)$

Hydrogen gas and nitrogen gas are combined in the presence of a catalyst at high temperature and pressure to produce ammonia gas.

Significance: Synthesis of ammonia leads to the production of fertilizer (ammonium nitrate) and to the production of ammunitions.

2. Combustion of hydrogen: $2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$

Hydrogen gas and oxygen combine to produce liquid water.

Significance: In the forward direction this is a spontaneous reaction that explosively oxidized hydrogen to water.

3. Combustion of methane (hydrocarbons)

Reaction: $CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$

Methane gas and oxygen gas combine exothermically to produce carbon dioxide gas and water vapor.

Significance: Methane is the simplest of the hydrocarbons, all of which combine with oxygen and undergo oxidation. If the oxidation is complete the products are carbon dioxide (a greenhouse gas) and water.

4. Photosynthesis

Reaction: $CO_2(g) + 6H_2O(l) \longrightarrow 6O_2(g) + C_6H_{12}O_6(aq)$

Carbon dioxide and water combine in the presence of sunlight (and many biologically catalyzed reactions) to produce oxygen and glucose (sugar). Significance: Our atmosphere is 21% oxygen - in spite of the tendency of oxygen to react with so many substances. The constant level of oxygen is maintained by the many plants that inhabit our planet through the reaction of photosynthesis. This is truly solar energy at its most efficient and productive!

5. Synthesis of sulfuric acid Reaction:

$2S(s) + 3O_2(g) + H_2O(l) \longrightarrow 2H_2SO_4(aq)$

Sulfur is first oxidized to sulfur dioxide and then to sulfur trioxide. This gas is bubbled through water to produce sulfuric acid.

Significance: Sulfuric acid is a very important chemical and an indicator of a nation's industrial strength.

KEY WORDS

- Element
- Chemical symbol
- Chemical formula
- Molecule
- Chemical reaction
- Balanced chemical equation
- Valence
- Binary compounds
- Poly atomic ion
- Inspection method
- Reactants
- Products
- Chemical equation
- Law of conservation of mass
- LCM method

Unit Summary

- *An atomic symbol is defined as shorthand way of representing elements or atoms of an element.*
- *A compound is a pure substance consists of two or more elements which have been chemically combined.*
- *Chemical formula is the symbolic representation of an element or a compound.*
- *A molecule is the smallest particle of an element or a compound that has a stable, independent existence.*
- *The combining power of an element is called valence. Most common elements have valence 1, 2, or 3.*
- *Binary compounds are compounds formed from two different types of elements. In naming a compound, the positive ion (metal) mention first followed by the negative ion (nonmetal).*
- *A polyatomic ion, also called compound ion is positively or negatively charged group of atoms.*
- *A chemical reaction is a process in which some substances is changed into one or more different new substances. The starting materials in chemical reaction called reactants, react alone or with each other to produce one or more new substances, called products.*
- *There are few signs that indicate a chemical reaction has occurred. These are: color change, evolution of gas, heat change and formation of precipitate.*
- *The law of conservation of mass states that matter is neither created nor destroyed during a chemical reaction.*
- *A chemical equation is shorthand expression of a chemical changes (chemical reaction) through symbols and formulas.*
- *There are many methods of balancing chemical equations. Some of them are inspection method, Least common multiple (LCM) method.*

Review Exercise

I. Write 'True' for the correct statements and 'False' for the wrong statements.

1. A compound is pure substance.
2. In a chemical reaction atoms are neither created nor destroyed.
3. O2 and 2O have the same meaning.
4. The symbol copper denoted by Co.
5. When we balance chemical equation we change the subscript but not coefficient.
6. Respiration is a chemical change (chemical reaction).
7. The combining power of an element is called valence.
8. The formula and symbol of nitrogen is the same.
9. A number in front of a symbol or formula is coefficient
10. A chemical symbol is a short hand notation for the chemical name of an element.

II. Choose the correct answer from the given alternatives.

11. The Latin name of silver is

A. Argentum
B. Kalium
C. Natrium
D. Cuprum

12. In 4O3 the coefficient and subscript respectively

A. 3, 4
B. 4,3
C. 7,3
D. 3,7

13. The formula of nitrate ion is

A. NO
B. NO3-
C. NO2-
D. N2-

14. All of the following elements can exist as diatomic molecules EXCEPT

A. Hydrogen
B. Oxygen
C. Sodium
D. Chlorine

15. What is the chemical formula for Iron (III) chloride?

A. $FeCl_2$
B. FeCl
C. $FeCl_3$
D. Fe_2Cl_3

16. The chemical symbol for Helium is

A. H
B. Hl
C. He
D. HE

17. Which of the following is the correct name of MgO?

A. Magnesium oxygen
B. Oxygen magnesium
C. Magnesium oxide
D. Molybdenum oxide

III. Give short answers

18. Write the symbol of

a. Zinc
b. Phosphorous
c. Mercury
d. Calcium
e. Tin

19. Balance the following chemical equations

a. $Al(OH)_3 \quad Al_2O_3 + H_2O$
b. $NH_3 + O_2 \quad NO + H_2O$
c. $Ca(OH)_2 + H_3PO_4 \quad Ca_3(PO_4)_2 + H_2O$

20. Write chemical equations for the following reactions and balance them.

a. Aluminum + bromine → .Aluminum bromide
b. Sodium + Nitrogen → Sodium nitride
c. Potassium + Water → Potassium hydroxide + Hydrogen

Self - Assessment

Check List Competencies given below are expected to be achieved in this unit by students. You are required to respond by saying Yes or No. Put a tick (√) mark under **"Yes"** column if you are able to perform the competency or under **"No"** column if you are unable to perform the competency. This would help to evaluate yourself and you can revise the parts of topics for which the competencies are not met.

No.	Can I	Yes	No
1	*Define element*		
2	*Identify symbols of some common elements*		
3	*Write chemical symbols for common elements*		
4	*Define compound as a substance formed when two or more elements chemically combined together.*		
5	*Define valence numbers as the combining power of an atom*		
6	*Write the formulae of simple binary compounds using symbols and valences.*		
7	*Name binary compounds*		
8	*Describe polyatomic ion*		
9	*Write the chemical formulas of common compounds that contain polyatomic ions*		
10	*Name compounds containing polyatomic ions.*		
11	*Identify the elements and number of atoms, given a chemical formula*		
12	*Define chemical reaction and give examples.*		
13	*Describe evidences that show chemical reaction has occurred.*		
14	*State the law of conservation of mass.*		
15	*Conduct an experiment in group to show simple chemical reaction.*		
16	*Write a chemical equation.*		
17	*Balance simple chemical simple chemical equation by inspection*		
18	*Create and use models of particles to demonstrate balanced equations.*		
19	*Describe the uses of chemical reactions in everyday situations.*		

UNIT - 4

4. CELLS AS THE BASIS OF LIFE

Learning Outcomes

At the end of this unit, learners will able to:

- *define a microscope*
- *explain the use of a microscope*
- *distinguish the different types of microscopes*
- *describe the basic parts and functions of a microscope*
- *use a microscope to view objects*
- *define a cell*
- *explain how cell was discovered and who discovered it*
- *draw a cell and label its major parts*
- *describe the functions of the major structural parts of a cell*
- *distinguish between unicellular and multicellular organisms*
- *give examples of cell shape*
- *explain why cell shape and structure vary*
- *discuss the differences of cell, tissue, organ and organ system*
- *define respiration and write its chemical equation*
- *define photosynthesis and write its chemical equation*

Main Conents

Introduction

These units deals about cell as the basis of life and organized in to two sub units. The first deals about the purpose and types of microscope. And the second parts deals about the cell, this section focuses on discover and definition of cell, structures of cell and function, types of organism, and level of organization of organism will be discussed.

A cell is the smallest unit of life. Most cells are so small that they cannot be viewed with the naked eye. Therefore, scientists must use microscopes (magnifying) instrument to study cells.

4.1. Microscope

Learning Competency

At the end of this section, learners will able to:

- *identify the major parts and functions of a basic microscope*
- *use a microscope to view objects*
- *discuss the role of a microscope*
- *differentiate between simple and light microscope*
- *draw diagram of a microscope and label the major parts*
- *build microscope from locally available materials*

Introduction

Microscope have opened up a whole new dimension in science, by using microscope scientists were able to discover the existence of the microorganisms, study the structure of cell, ***and see the smallest parts of plants, animals, and fungi. Cells*** are the smallest *units from which all life forms are made.*

Activity 4.1

Discuss in group and share your ideas

- What kind of organisms found in your environment?
- How can you observe those cannot see by your naked eye?

4.1.1. Purpose and invention of microscope

Q. What is a microscope?

A microscope is an instrument that is used to observe objects too small to be seen clearly with the naked eye. Microscope uses lenses or system of lenses to produce a magnified image of an object under study. **Microscopic** means invisible to the eye unless aided by a microscope. The science of investigating small objects using such an instrument is called **microscopy.**

Word Roots and Origins

The word microscope is derived from two Greek words

"Micro" meaning tiny and **"scope"** meaning to view or look at

Q. What is the use of microscope?

Microscope enlarges/ magnifies the size of the object observed so that it looks bigger than its actual size. This offers a chance to closely study and learn more about

smaller organisms like cell and microorganism.

Q. Who invented a compound microscope and when?

Grinding glass to use for spectacles and magnifying glasses was common place during the 13th century. In the late 16th century several Dutch lens makers designed devices that magnified objects.

Dutch spectacle makers ***Zaccharias Janssen*** and ***Hans Lipperhey(1595)*** are noted as the first men to develop the concept of the compound microscope by placing different types and sizes of lenses in opposite ends of tubes.

In 1665 ***Robert Hooke*** an English scientists built compound microscopes, which have multiple lenses. However, his microscope is a compound microscope, the lenses are not very good and magnifications of more than 30x are very blurred and do not show much detail.

Later in the 1674 century, ***Anton van Leeuwenhoek*** Dutch merchant began polishing and grinding lenses when he discovered that certain shaped lenses increased an image's size. The glass lenses that he created could enlarge an object many times. The quality of his lenses allowed him, for the first in history, to see the many microscopic animals, bacteria and intricate detail of common objects. Leeuwenhoek is considered the founder of the study of microscopy and played a vital role in the development of cell theory.

- **Microscope:-** an optical instrument used to observe very small objects.
- **Microscopic:-** very small objects which are only viewed with microscope.
- **Magnifications:-** increasing the image of an object
- **Lens:-** a piece of glass used to converge or diverge light and form optical images.
- **Resolution:-** is ability of the microscope to show the detailed or the scattered part of an object.

4.1.2. Types of microscope

There are many types of microscopes, and they may be grouped in different ways. According to the type of radiation they use for observation microscopes grouped into two main types of microscopes these are the **light microscope** and the **electron microscope**. The light microscope uses a beam light to form the image of an object, while the electron microscope uses the beam of electron to form the image.

Based on the number of lenses it has and uses the light microscopes are categorized into two ***simple microscope*** *and* ***compound microscope.***

Simple light microscope

A simple microscope consists of a single convex lens that is capable of magnifying an object. A hand lens (magnifying glass) and reading lens an example of simple microscope. They can magnify about ten times (10X) to twenty (20X). Single lensed simple microscope can magnify up to 300X.

Figure: 4.1 types of simple light microscope

Compound light microscope

Compound microscope is a microscope that uses multiple lens systems at the same time to improve magnification and resolution. The two lens systems are the eyepiece (ocular) lens and the objective lenses. The objective lenses include:

- Lower power objective **(4x)**
- Middle power objective **(10x)**
- High power objectives **(40)**
- Oil immersion lenses **(100x)**

Microscope has two major **abilities**: magnification and resolution

1. **Magnification;** is increasing the size of an object to be viewed.
2. **Resolution:** is ability of the microscope to show the detailed or the scattered part of an object. It helps us to distinguish between two separate point

KEY WORDS

- ***Monocular compound microscope:*** A compound microscope with single eyepiece lens.
- ***Binocular compound microscope:*** compound microscope with two eye piece lens

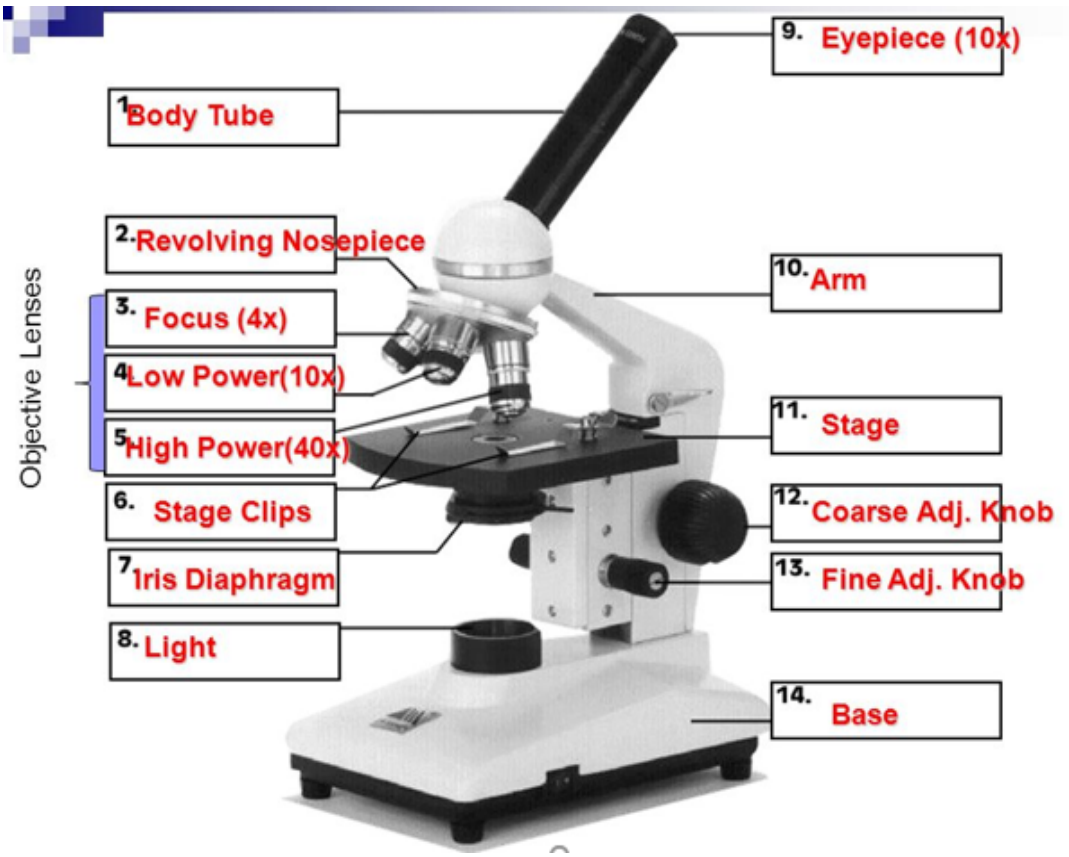


Figure 4.2 Parts of compound monocular microscope

N.B: Your teacher will provide you with a microscope so that you can identify the parts and their functions

4.1.3. Basic parts of compound light microscope

Table 4.1 parts of compound microscope and their function.

Parts	Function
Base	Support the microscope
Arm	Used to carry the microscope
Stages	Supports the glass slide and contains the specimen being Observed.
Stage clips	Holds the slide in place on the stages
Eyepiece	Magnifies image for the viewer
Objective lens	Low, medium and high power lenses that magnifies the specimen
Course adjustment	Large knob used for focusing the images under low power
Fine adjustment	Smaller knob used for focusing the image with high power objectives
Diaphragm	Controls the amount of light that pass through the specimen
Light course	Provide light for viewing the specimen
Body tube	Separates the objective and the eyepiece and assures continuous alignment of the optics.

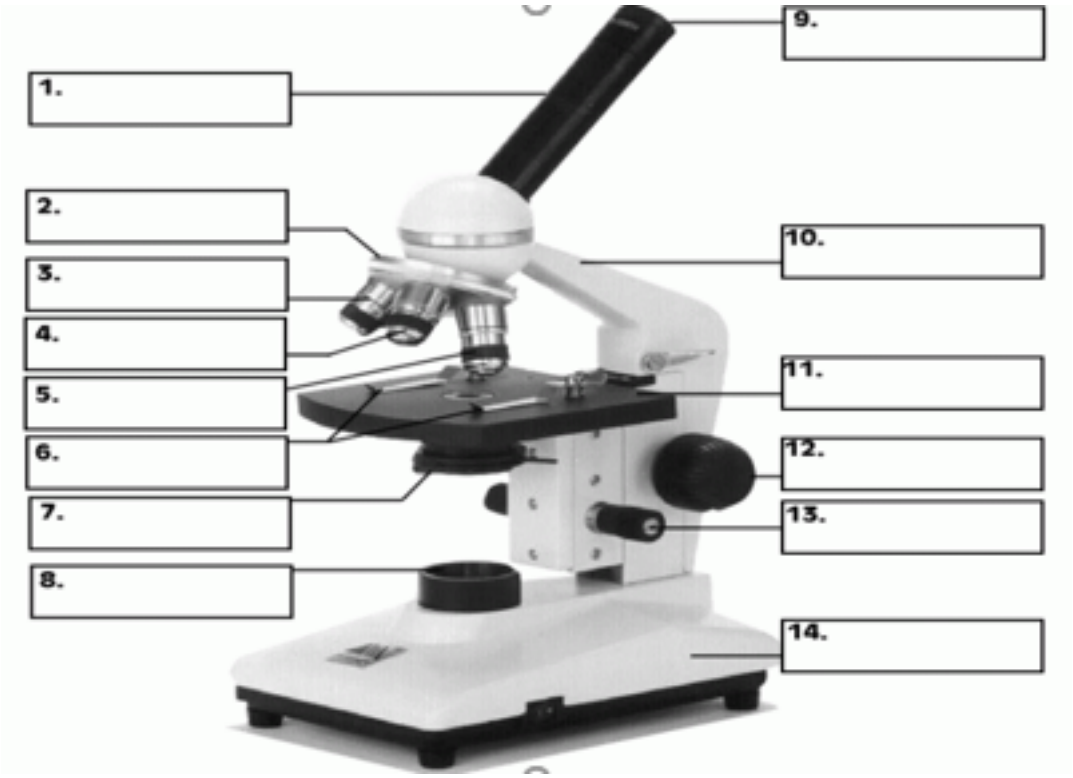
Project work

Construct a model of light microscope from locally available materials in group of five students and submit it to your teacher.

Activity 4.3

group work

- What component of microscope uses to magnify an object and in witch parts of microscope it is located?
- Discuss the total magnification of a compound microscope.



The eyepiece lens usually magnifies ten times and is labeled 10X. The objective lenses magnify four to hundred times. The total magnification of an object is calculated by **multiplying** the magnification of the **objective** lens by the magnification of the ocular lens.

For example, if the magnification of the eye lens is 10X and the magnification of the objective lens is4X, then the total magnification is 40X. Because two lenses are used, compound microscopes are capable of higher magnifications than simple microscopes, which use only one lens

KEY WORDS

- ***Mounting:*** is preparing a specimen for observation under a microscope.
- ***Focusing:*** is adjustment of focus to observe specimen clearly.
- ***Specimen:*** a sample of a substance or material for examination or study

Expriment 4.1

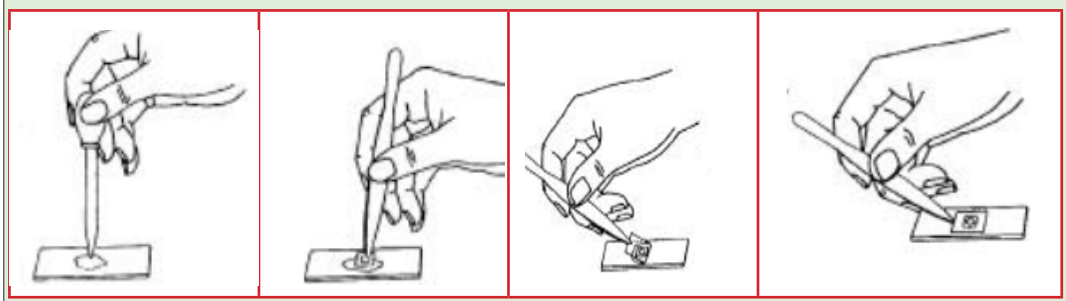
Title: **Practicing mounting and focusing**

Materials you require:

- Clean slide and cover slip
- Very fine fiber
- Dropper with nipple
- Forceps
- Water in a beaker
- Compound light microscope

Procedure:

1) Lay down the very fine fiber on a clean microscope slide as shown in the figure 4:4



Add a drop of water to a slide the edge of the water	Place the specimen in the water	Place the edge of a coverslip on the slide so that it touches trapping air bubble	slowly lower the coverslip to prevent forming and

2) Place one drop of water directly over the specimen and cover it with a cover slip.

3) If you put too much water over the specimen, cover slip will float on top of the water. This makes it harder to observe the specimen!` This process, if done correctly, there should be no air bubble trapped in the water between the slide and the cover slip.

4) Air bubbles confuse the observer.

5) Cover slips protect objective lens and keep the specimen in position. Place the slide on the microscope stage, with the specimen directly over the center of the glass circle on the stage (directly over the light).

6) Always start and end with Low Power objective. Lower the objective lens to the lowest point, then focus using first the coarse knob, then with the fine focus knob.

7) Adjust the Diaphragm as you look through the Eyepiece, and you will see that more detail is visible when you allow in less light! Too much light will give the specimen a washed-out appearance. Try it out!!

8) Once you have found the specimen on low power, then, without changing the focus knobs, switch it to medium power. Move the object or the hand lens until you are able to see clearly through the lens.

9) Once you have it on Medium and High Power remember that you only use the fine focus knob! (Never use the oil immersion lens)

10) Click the high power objective lens in position and only use the fine adjustment knob to focus on specimen. At this point, if the specimen is too light or too dark, try adjusting the diaphragm.

11) Then, focus using the fine adjustment for sharp focusing. Do not use the coarse adjustment

12) Explain what change you have observed. Is the fine fiber compact or relaxed? Draw it.

EXERCISE: 4.1.

Choose the best answer from the give suggested option

1. From the follow lists chose the correct order in which light passes through it.

A. mirror----objective------ lens----eyepiece --- lens
B. mirror-----slide-------objective lens-----eye piece
C. Lens-----slide------eye piecelens------objective lens
D. Eye piece-----objective lens----slide------mirror

2. Which parts of microscope combined to give magnified view of specimen?

A. Light source and objective lens
B. eye piece and objective lens
C. Stages and eyepiece
D. eye piece and focus knob

3. To focus on specimen is the best to start with which objective lens?

A. lower magnification
B. High magnification
C. intermediate magnification
D. Oil emersion

4. To which parts of microscope do you look through to see an object magnified?

A. Eyepiece
B. Stage
C. Focus knob
D. objective lens

5. One of the following is not the function of a microscope.

A. Magnifying the image of the sample
B. Showing the details of the sample.
C. Enabling one to observe something seen with naked eye.
D. Enlarging the size of the sample.

6. Magnification power of a microscope is related to its ability to:

A. Increase the size of the image.
B. Showing the fine details of the sample.
C. Resolving the image.
D. All of the above

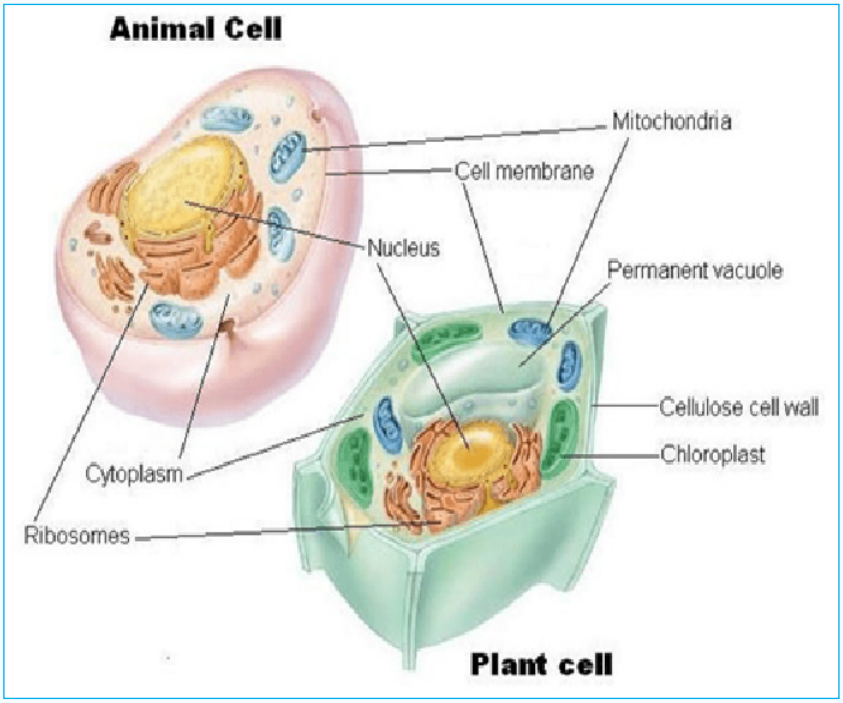


Figure 4.5: Basic structure of animal and plant cell

4.2. Cell

Learning Competency

At the end of this section, learners will able to:

- *explain how cell was discovered*
- *draw a cell*
- *label the basic structures and functions of a cell (cell membrane, cell wall, cytoplasm, nucleus, mitochondria, chloroplast, vacuole, and endoplasmic reticulum)*
- *explain why cell shape and structure vary*
- *distinguish between unicellular and multicellular organisms*
- *differentiate among cell, tissue, organ and organ system with examples*
- *examine the importance of cellular respiration and photosynthesis*

Introduction

In the previous section you have already learnt that about microscope; the instrument that magnifies the images of an object. This enables scientists to look at and study smaller things like cells which are not seen by naked eye. In this sub unit, you shall learn about the basic structural unit of organ, which is the cell; cell may be compared to bricks. Bricks are assembled to make a house, similarly cells assembled to make the body of organism.

4.2.1. The discovery and definition of cell

Many biologists and other scientists contributed to the discovery of cells. Among this the English scientists **Robert Hooke** (1665) was he first to use the **cell** for he observed at very tiny slice of cork through his microscope he noticed that the cork was porous and comprised of many tiny square boxes that remained him of the small

rooms in monastery. Hence, the word cell comes from the Latin **cellula** meaning "a small room"

Word Roots and Origins

Word cell comes from the Latin **"cellula"** meaning a small room

Soon after Robert Hooke discovered cells in cork, **Anton van Leeuwenhoek** (1674) made his own simple microscope with only one lens. However, van Leeuwenhoek is very skilled at grinding lenses and so his microscope can achieve magnifications of 300X. He was the first person sees living, moving unicellular organisms (Protista) in a drop of water. He calls the moving organisms 'animalcules'. He also sees bacteria (from his teeth), which he also calls 'tiny animalcules'.

By the late 1830s, botanist **Matthias Schleiden** and zoologist **Theodor Schwann** were studying tissues and proposed the unified cell theory, which states that all living things are composed of one or more cells, that the cell is the basic unit of life, and that all new cells arise from existing cells.

Q. What is a cell?

Cells Are the Basic Units of Living Organisms which responsible to carry out basic structural, functional, and biological unit of all known organisms.

Cells are the building blocks of all living beings provide structure to the body. Organisms may be made up of a single cell or many cells. Cells are complex and their components perform various functions in an organism. It comprises several cell organelles that perform specialized functions to carry out life processes.

4.2.2. Structure of a cell

Cells are the tiny structural units of life, are made up of different parts. The parts of cells are known as sub-cellular structures or organelles. Different sub-cellular structures carry out different functions in cells. When observed under compound or electron microscope, all cells share four common components:

1. A plasma membrane, an outer covering that separates the cell's interior from its surrounding environment;

2. Cytoplasm, consisting of a jelly-like region within the cell in which other cellular components (organelles) are found
3. DNA (nucleus), the genetic material of the cell and
4. Ribosomes, particles that synthesize proteins.

Animal and plant cells share some common features like the cell membrane, nucleus and cytoplasm.

There are several types of organelles within organism cell. The sub cellular structures found in cells are cell wall, cell membrane, mitochondria, plastids, ribosomes, nucleus, Golgi apparatus, lysozyme, endoplasmic reticulum, vacuoles and others. Organelles are adapted or specialized for carrying out one or more vital function.

Table 4.2 Summary of the common and difference parts of animal and plant cell

	Name of part	Description	Function
Animal and plant cell	**Cytoplasm**	jelly-like, with particles and organelles in	contains the cell organelles, e.g. mitochondria, nucleus, site of chemical reactions
	cell membrane	a partially permeable layer that forms a boundary around the cytoplasm	prevents cell contents from escaping and controls what substances enter and leave the cell
	nucleus	a circular or oval structure containing DNA (genetic material)	controls cell activities controls cell division controls cell development
Plant cells only	**cell wall**	a tough, non-living layer made of cellulose surrounding the cell membrane	prevents plant cells from bursting allows water and salts to pass through (freely permeable)
	Vacuole	a fluid-filled space surrounded by a membrane	contains salts and sugars helps to keep plant cells firm
	Chloroplast	an organelle containing chlorophyll	traps light energy for photosynthesis

Exercise 4.2

1. Compare and contrast animal cell with plant cell.

Structures and functions of organelles

Cell wall: The outer covering of cells that surrounds the cell membrane in plant cell. The cell wall is a rigid covering that protects the cell; plant cell needs protection against variation in temperature, high wind speed, atmospheric moisture, etc. They are exposed to this variation because they cannot move.

Cell membrane: is the outermost covering of the cell that separates the content of the cell from its external environment. It Controls materials that get in and out of the cell.

Nucleus: controls reproduction and the activities of the cell.

Cytoplasm: it contains different sub-cellular structures in which chemical processes take place.

In eukaryotes, the cytoplasm is contained all materials (organelles) located in within the cell, excluding the nucleus. The part of the cytoplasm that does not contain any organelles is referred to as the cytosol.

Mitochondrion: Known as the powerhouse of the cell, the mitochondrion (plural: mitochondria) is the double-membrane organelle where the process of cellular respiration takes place.

Chloroplast: Specific/unique to plant cells, chloroplasts are double-membrane organelles that can convert light energy, carbon dioxide (CO2), and water (H2O) to carbohydrates in a process called photosynthesis.

Ribosome: Ribosomes are the sites where protein synthesis occurs. Because protein synthesis is essential for all cells, ribosomes are found in almost in every cell,

Endoplasmic Reticulum: is a series of interconnected membranous tubules that collectively modify proteins and synthesize lipids. Most cells contain two types of endoplasmic reticulum: the rough and the smooth.

The rough endoplasmic reticulum (RER) is so named because the ribosomes

attached to its cytoplasmic surface give it a studded appearance when viewed. Protein molecules undergo modifications such as folding or addition of sugars.

The smooth endoplasmic reticulum (SER) is continuous with the RER but has few or no ribosomes on its cytoplasmic surface. The SER's functions include synthesis of carbohydrates, lipids (including phospholipids), and steroid hormones; detoxification of medications and poisons; alcohol metabolism; and storage of calcium ion.

The Golgi apparatus: is a series of flattened membranous sacs. The sorting, tagging, packaging, and distribution of lipids and proteins take place in the Golgi apparatus (also called the Golgi body)

Lysosomes:- In animal cells, the lysosomes are the cell's "garbage disposal." Digestive enzymes within the lysosomes aid the breakdown of proteins, polysaccharides, lipids, nucleic acids, and even worn-out organelles. In single-celled organism lysosomes are important for digestion of the food they ingest and the recycling of organelles.

Vesicles and Vacuoles:- Vesicles and vacuoles are membrane-bound sacs that function in storage and transport materials. The central vacuole in plant cell plays a key role in regulating the cell's concentration of water in changing environmental conditions.

Peroxisomes:- Peroxisomes are small, round organelles enclosed by single membranes. They carry out oxidation reactions that break down fatty acids and amino acids. They also detoxify many poisons that may enter the body. Alcohol is detoxified by peroxisomes in liver cells.

4.2.3. Cell Shape and Size

Different cells have different shapes and their unique morphologies are directly related to their function:

- Plant cells, in general, have rectangular, rigid walls, and distinct edges. Such structure is contributed by the presence of cell wall that forces the cell to have a definite shape.
- Unlike plant cells, animal cells tend to have more irregular body shapes due to the absence of cell wall in their overall structure.

- Microorganisms like bacteria have three types of cell shape: oval (cocci), rod-shaped (bacilli), spiral, star-shaped, and rectangular. See the difference between the plant cell and animal cell from figure 4.3

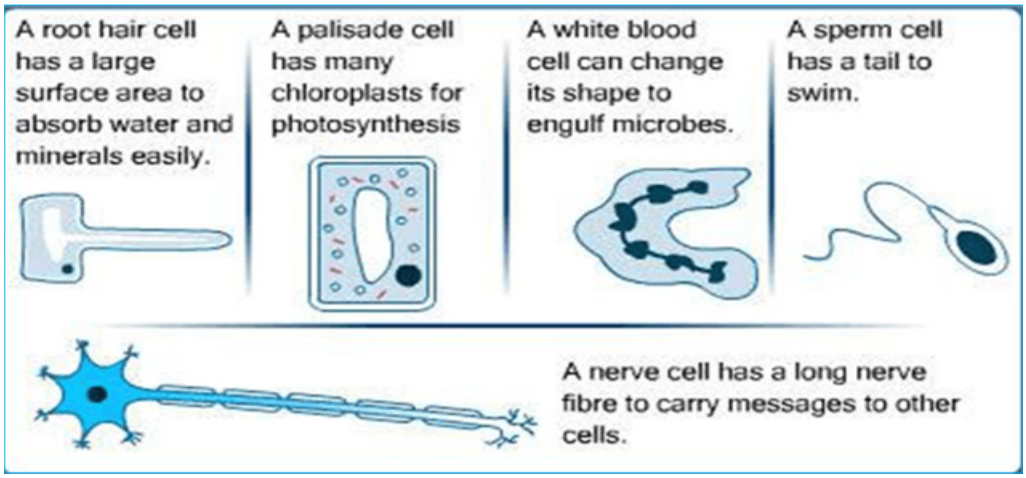


Figure: 4.6 the shapes and sizes of different cell

Like shapes, the size of cells is also linked to their functions. Depending on the type of organism, the size of the cell greatly varies.

- In particular, egg cells are the largest cells that an organism has. This is very much related to their function as the development of the zygote after fertilization requires huge amounts of energy. Approximately, the human egg cell measures **0.12 mm** in diameter.
- On the other hand, the smallest cell is that of the parasitic bacterium Mycoplasma gallicepticum. This bacterium, which thrives in the bladder, respiratory and reproductive tracts of mammals. This cell has an average diameter of **0.0001 mm**

4.2.4. Unicellular Organisms

Q. What is a unicellular organism?

A cell is the basic unit of life. All living organisms are composed of one (unicellular) or more (multicellular) cells.

Unicellular organisms are those organisms composed of one cell.

They are typically microscopic in nature and cannot be seen with naked eyes.

Life processes such as excretion, digestion, feeding and reproduction occur in one cell. Examples of unicellular organisms include different bacteria, most algae, unicellular fungi (yeast) and protozoans such as, amoeba and paramecium

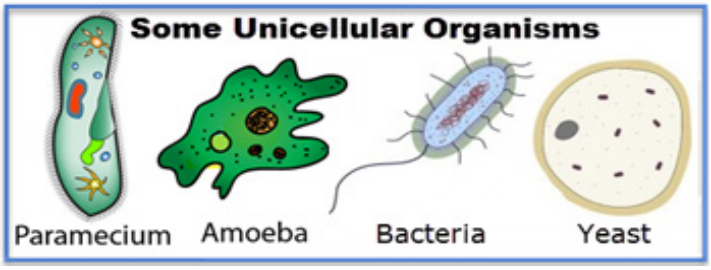


Figure: 4.7 some unicellular organisms

Experiment 4.2

Title: Examining different water samples and prepared slides for the presence of organisms

In the first part of this activity, you will examine prepared slides of unicellular organisms under a compound microscope in the second part of this activity; you will prepare a wet mount of amoeba culture.

Materials you will require:

- Hand lens,
- Water samples from pond, river, lake, well or standing water,
- Compound light microscope,
- Prepared slides of amoeba, euglena, paramecium, bacteria, yeast, and algae

Procedures:

Observation using a hand lens

1. Collect water samples in open mouth container (beakers).
2. Observe the surface of each sample with a hand lens for the presence of living organisms.
3. Can you observe anything moving? Please, draw it.

B. Observation of prepared slides

1. Place a prepared slide of amoeba on the stage of the microscope.
2. With your microscope on low power, observe the slide.
3. Move the slide around on the stage until you find some cells.
4. Now, using the medium- or high-power objective lens, focus on one cell and observe and draw what you see.
5. Label all visible structures.
6. Repeat steps 1-5 for prepared slides of Paramecium, euglena, yeast and bacteria.
7. For each organism you view, be sure to include the name of the organism and the total magnification used.

After completing these practical activities, compare your drawings with the figures given on; 4.6

4.2.5. Multicellular Organisms

Multicellular Organisms are organisms that are made of up many cells. Plants and animals are examples of multi cellular organism. In multi cellular organism cell are specialize to perform different functions. Human being are multicellular organism consist different types of cell like blood cells, skin cells, brain cells, heart cells and many types of other cells. Similarly, plants have different cell like stem Cells, root cells, and many other types.

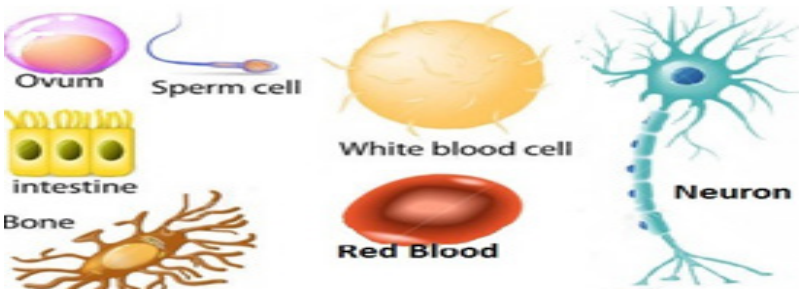


Figure: 4.8. Some different types of cells that build up human body

4.2.6. Levels of Organization of Living Things

(Cell, tissue, organ, organ system, organisms)

Cell: All living things are made of cells; the cell itself is the smallest important unit of structure and function in living organisms it performs various metabolic functions like providing structure and rigidity to the body, converting food into nutrients and energy, and others.

Regardless of their small size, cells are organized in a precise manner. Some cells contain groups of macromolecules surrounded by membranes; these are called **Organelles**: Organelles are small structures that exist within cells and perform specialized functions.

At cellular level, organisms can be classified into two: single-celled organisms (unicellular) and multiple-celled organisms (multi-cellular)

Tissue: In most multicellular organisms, cells combine to make **tissues**, which are groups of similar cells carrying out the same function. For example, *muscle tissue, connective tissue, and nervous tissue.* Like cells, tissues perform metabolic processes that keep the organism alive.

Organs: are collections of tissues grouped together based on a common function. Organs are present not only in animals but also in plants. In plants, their organs include the flowers, roots, stems, and the leaves. On the other hand, organs of animals include the *brain, heart, stomach, eyes*, and many more.

Organ system: is a higher level of organization that consists of functionally related (associated) organs. While each organ system in an organism works as a distinct entity, they all function in cooperation with each other in order to help keep the organism alive. In plants, organ systems include the root and shoot system, while animal organ systems include the ***digestive system, nervous system circulatory system, and others.***

An organism can be simply defined as any living thing that is composed of various organ systems that function altogether. **Organisms** are individual living bodies.

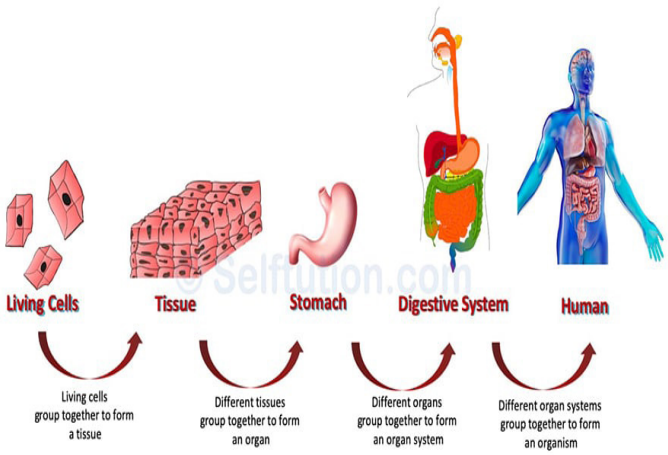


Figure: 4.9 Level of organization in human being

Exercise 4.3

Choose the best answer for each of the following questions.

1. One of the following is **true** about cells.

A. Cells are generally too small to be seen with the naked eye.
B. Cells are the structural and functional units of all life forms.
C. Cells are the smallest units that carry out all process of life.
D. All of the above

2. One of the following is part of a cell and only found in animal cell?

A. Cell membrane
B. Chloroplast
C. Cell wall
D. Lysosome

3. One of the following is **true** about cells.

A. Cells are generally too small to be seen with the naked eye.
B. Cells are the structural and functional units of all life forms.
C. Cells are the smallest units that carry out all process of life.
D. All of the above

4. One of the following is part of a cell and only found in animal cell?

A. Cell membrane
B. Chloroplast
C. Cell wall
D. Lysosome

5. One of the followings is a unicellular organism.

A. amoeba
B. yeast
C. bacteria
D. Paramecium
E. all

6. Which one the following is not an organ

A. heart
B. lung
C. nerve
D. stomach

7. One is formed from groups of similar cells carrying out the same function.

A. organ
B. tissue
C. organ system
D. organism

4.2.7. Respiration and mitochondria.

Cellular respiration is a process that occurs in the mitochondria of all organisms. **Mitochondria** (singular = mitochondrion) are often called the "powerhouses" or "energy factories" of a cell because they are responsible for making *adenosine triphosphate* (ATP), the cell's main energy-carrying molecule. Mitochondria are oval-shaped, double-membrane organelles that have their own ribosomes and DNA. Each membrane is a phospholipid bilayer embedded with proteins. The inner layer has folds called cristae, which increase the surface area of the inner membrane. The area surrounded by the folds is called the mitochondrial matrix. The cristae and the matrix have different roles in cellular respiration.

The formation of ATP from the breakdown of glucose is known as **cellular respiration**. In this process, both plants and animals break down simple sugars into carbon dioxide and water and release ***energy*** in the form of ***adenosine triphosphate (ATP).***

Cellular respiration or aerobic respiration is a series of chemical reactions which begin with the reactants of sugar in the presence of oxygen to produce carbon dioxide and water as waste products.

Cellular respiration has four stages

The first metabolic pathway during cellular respiration is **glycolysis.** Coming from the Greek word **"glyk"** which means **"sweet"** and **"lysis"** which means **"dissolution"**, glycolysis is the breakdown of one molecule of glucose (sugar) into two molecules of **pyruvate.**

As shown in the above diagram, glycolysis takes place in the cytosol.

$$C_6H_{12}O_6 + 2NAD+ + 2ADP + 2\ P \rightarrow 2\ pyruvic\ acid,\ (CH_3(C=O)\ COOH + 2ATP + 2NADH + 2\ H+$$

Glycolysis produce two ATP molecules; four molecules are actually produced during the entire process. However, two molecules are consumed during the preparatory phase, hence, resulting to a net of just two ATP molecules.

The second stages is so-called "**link reaction"** that occurs. Pyruvate from glycolysis is oxidized (converted) to acetyl coA, one molecule of NADH (nicotinamide adenine dinucleotide), and one molecule of carbon dioxide.

The third stage is called as the **Tricarboxylic Acid (TCA) cycle**, or simply the Citric Acid cycle, the Krebs cycle (identified by Hans Adolf Krebs)

The Krebs cycle, which occurs in the matrix of the mitochondrion, includes a series of oxidation-reduction reactions that result in the oxidation of the acetyl group to two carbon dioxide molecules.

Hence, from one glucose molecule (that formed 2 pyruvate), a total of

6 NADH, 2 FADH2 and 2 ATP molecules are produced.

The forth stages is the electron transport chain (ETC) and oxidative phosphorylation which both occur in the inner membrane of the mitochondrion.

- In ETC, electrons are transferred from one complex to next where the electrons reduce oxygen to produce water. Such reactions produce the majority of ATP during cellular respiration.

- Overall ETC produces water, NAD and FAD (which are both recycled back to glycolysis and Krebs cycle), and up to 34 ATP per one molecule of glucose!
- In total, the resulting product of aerobic cellular respiration from a single glucose molecule can be up to 38 ATP.

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

(Glucose + 6 Oxygen → 6 Carbon Dioxide + 6 Water + ATP)

Q. What is the role of Oxygen in cellular respiration?

Oxygen is an essential molecule in cellular respiration. Basically, oxygen can be found at the end of the ETC (during aerobic respiration) where it accepts electrons while picking up protons in order to produce water molecules. Because of this, oxygen is also called as the "final electron acceptor". When oxygen levels are depleted, electrons will be simply dispersed and the electron transport chain will discontinue.

An aerobic respiration: Respiration in cells can take place anaerobically (without oxygen), to transfer energy; it simply involves the incomplete breakdown of glucose into lactic acid. This occurs when the body can't supply enough oxygen for aerobic respiration, such as during vigorous exercise

- In animal cells, this process is called the lactic acid fermentation. It is almost the same with aerobic respiration except that it produces lactic acid in the process. It can be simplified in the equation:

$$C_6H_{12}O_6 \rightarrow 2CH_3CH(OH)COOH + 2CO_2 + 2ATP$$

- On the other hand, microorganisms like yeastrespire without oxygen produce ethanol and carbon dioxide. Such process is referred to as the ethanol or alcohol fermentation.

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + 2ATP$$

In both types of fermentation process, only 2 ATP are produced from a glucose molecule

4.2.8. Photosynthesis and chloroplast

Plants make sugar by using energy from sunlight to change carbon dioxide (CO_2), a gas absorbed from the air, and water (H_20) taken from the ground by roots into glucose ($C_6H_{12}O_6$) and oxygen (O_2). This process is called photosynthesis and occurs in the chloroplast of the plant cell.

Chloroplasts have outer and inner membranes, within the space enclosed by a chloroplast's inner membrane; is a set of interconnected and stacked, fluid-filled membrane sacs called thylakoids. Each stack of thylakoids is called a granum (plural grana). The fluid enclosed by the inner membrane and surrounding the grana is called the stroma.

The chloroplasts contain a green pigment called chlorophyll, which captures the energy of sunlight for photosynthesis.

Photosynthesis is a series of chemical reactions that convert carbon dioxide and water into glucose (sugar) and oxygen in the presence of sunlight.

Carbon dioxide + Water ⟶ Glucose (sugar) + Oxygen+ Water

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

Exercise 4.5

1. Compare the functions of the mitochondrion and chloroplast. How are they different? How are they similar?
2. Write the chemical equations of cellular respiration and photosynthesis

- Microscope
- Magnification
- Monocular
- Respiration
- Resolution
- Mounting
- Binocular
- Photosynthesis
- Unicellular
- Multicellular
- Cellular
- Anaerobic
- Lens
- cell
- tissue
- Aerobic

Unit Summary

- *A microscope is an instrument that is used to observe objects too small to be seen clearly with the naked eye.*
- *Microscopes are grouped in different type According to the type of radiation they use for observation or image formation. The most common are light and electron microscope.*
- *The light microscope uses a beam light to form the image of an object, while the electron microscope uses the beam of electron to form the image.*
- *A simple microscope consists of a single convex lens that is capable of magnifying an object.*
- *Compound microscope is a microscope that uses multiple lens systems at the same time.*
- *Microscope has two major abilities these magnification and resolution*
- *Magnification is increasing the size of an object to be viewed.*
- *Resolution is ability of the microscope to show the detailed or the scattered part of an object.*
- *Mounting is the process preparing a specimen for observation under a microscope.*
- *A cell is the smallest unit of a living thing. Thus, cells are the basic building blocks of all organisms.*
- *All cells commonly have cell membrane, cytoplasm, nucleus or DNA and ribosome*
- *Unicellular organisms are those organisms that are made up of single cell.*
- *Multicellular organisms are those organisms that are made up of many cells.*
- *Multicellular organisms have different levels of organization like cell, tissue, organ, organ system, and organisms.*
- *Mitochondria and chloroplast are double membrane organelles perform cellular respiration and Photosynthesis respectively.*
- *The formation of ATP (energy) from the breakdown of glucose using oxygen is known as cellular respiration.*
- *Photosynthesis is food making process in green plants using CO2, water, chlorophyll pigments in chloroplast and light from the sun*

Review Exercise

Part I. Choose the correct answer from a given alternative options.

1. The _____ is the basic unit of life.

A. organism
B. cell
C. tissue
D. organ

2. Which of these structures do all cell share?

A. nuclear envelope
B. cell walls
C. organelles
D. plasma membrane

3. which of the following scientists discover the cell

A. Robert Hooke
B. Anton van Leeuwenhoek
C. Zaccharias Janssen
D. Hans Lipperhey

4. Which of the following feature will help you in distinguishing a plant cell from an animal cell?

A. Cell wall
B. Cell membrane
C. Mitochondria
D. Nucleus

5. Which part of the cell contains organelles?

A. Cytoplasm
B. Cytosol
C. Cell wall
D. nucleus

6. The shape and size of the cell are directly related to:

A. the size of organism
B. their functions
C. environment
D. all

7. Which of the following levels of biological organization shows the correct order from simplest to complex level?

A. Organism--------organ system------organ-------tissue-----cell

B. Tissue----cell----organ------ -----organ system------organism
C. Cell------tissue-------organ------organism--------organ system
D. Cell------tissue-------organ------organ system--------organism

8. Which organelles are responsible for digesting cell waste and foreign bacteria?

A. Golgi apparatus
B. Cytoskeleton
C. Nucleus
D. Lysosome

9. Which of these organelles modifies cell products and then packages them for distribution?

A. The nucleus
B. The cell membrane
C. The mitochondrion
D. The Golgi apparatus

10. The 'powerhouse' of the cell that generates the cell's energy-rich ATP molecules is the:

A. Mitochondrion
B. Smooth ER
C. Chloroplast
D. Nucleus

Part II: Match items given in column 'B' with items given in column 'A'

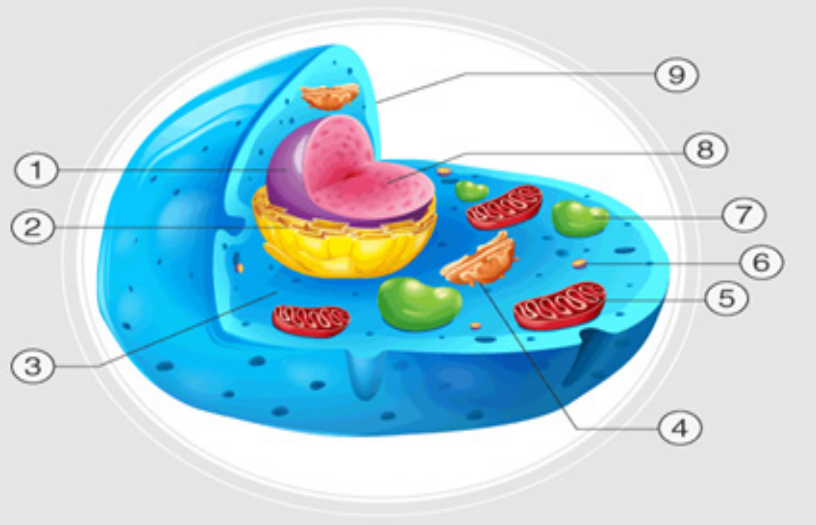
column 'A'	*column 'B'*
1) Cell wall	A. sorting, tagging and distribution of lipids
2) Nucleus	B. provides support, and gives shape to the cell
3) Ribosome	C. it direct and control cell activities
4) Mitochondria	D. modify proteins and synthesize lipids
5) Chloroplast	E. the power house of cell
6) Golgi apparatus	F. the site were photosynthesis occur
7) Endoplasmic reticulum	G. Synthesize protein

Part III. Fill in the blank spaces with correct answer.

1. The instrument used to observe cells is _____
2. The ability of the microscope that makes the specimen appear large is known as----------
3. The objective lenses of a compound microscope are------, ----, -----, and-----
4. ----------is preparing a specimen for observation under a microscope.

Part IV: Give short answers for the following questions.

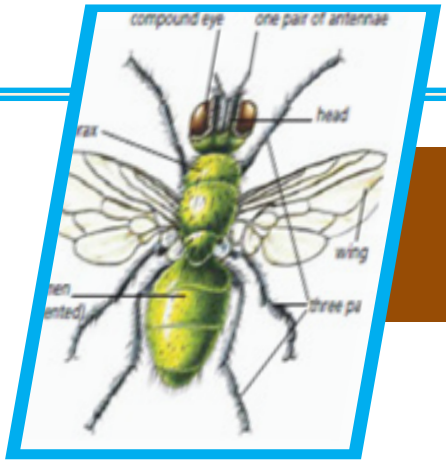
1. Cells consist of many organelles, yet we do not call any of these organelles as structural and functional unit of living organisms.
2. Explain how do you calculate the total magnification of your specimen when using a compound light microscope?
3. Reorder the following parts of living things from larges to smallest (Cell, organ, organism, tissue, atom, molecule, organ system, organelle)
4. Write the difference between magnification and resolution
5. The figure 4:10 given below is the structural organization of the animal cell. Depict the organelles that is indicated by each number



Self Assessment

Check List Competencies given below are expected to be achieved in this unit by students. You are required to respond by saying Yes or No. Put a tick (√) mark under "Yes" column if you are able to perform the competency or under "No" column if you are unable to perform the competency. This would help to evaluate yourself and you can revise the parts of topics for which the competencies are not met.

No.	Can I	Yes	No
1	*identify the major parts and functions of a basic microscope*		
2	*Use a microscope to view objects*		
3	*Discuss the role of a microscope*		
4	*Differentiate between simple and light microscope*		
5	*Draw diagram of a microscope and label the major parts*		
6	*Build microscope from locally available materials*		
7	*Explain how cell was discovered*		
8	*Draw and label the basic structures and functions of a cell*		
9	*Explain why cell shape and structure vary*		
10	*Distinguish between unicellular and multicellular organisms`*		
11	*Differentiate among cell, tissue, organ and organ system with examples*		
12	*Examine and weigh the importance of cellular respiration*		
13	*Examine and weigh the importance of photosynthesis*		



UNIT - 5

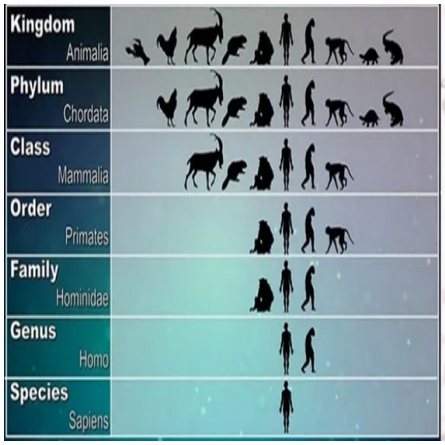
5. LIVING THINGS AND THEIR DIVERSITY

Learning Outcomes

At the end of this unit, learners will able to:

- *distinguish between living and non-living things by describing the features that characterize living organisms*
- *discuss if movement i.e. locomotion can characterize all living things or not*
- *define classification and its purpose*
- *explain the purpose of scientific name*
- *list down the hierarchical levels in the classification of organisms*
- *describe the distinguishing characteristics of kingdom Animalia, Plantae, Protista, Monera and Fungi.*
- *list common examples of animals, Plantae, Protista, Monera and Fungi*
- *describe the body plan of a common animals, Plantae, Protista, Monera and Fungi*
- *describe habitats of animals, Plantae, Protista, Monera and Fungi*

Main Conents



Activity 5.1

Discuss in group and present your ideas to classmates.

- What makes living things different from non-living things? Consider as an example better fly and stone

Introduction

There are at least five million different kinds of living things in the word. These organisms are classified according similarities and differences. The need for classifying living things is to identify them and to study their relationship, their origin and development and to understand how life originated.

5.1. Living Things

Learning Competency

At the end of this section, learners will able to:

- *differentiate between living and non-living things*
- *organize and describe characteristics of living things*
- *justify why movement or locomotion from one place to another cannot be a defining characteristic of all organisms*
- *relate diversity with classification of organisms*
- *justify why scientific names of organisms should be used in science than the local names*
- *analyze and describe the relationships of the hierarchical levels (Kingdom to Species) in the classification of organisms.*

Introduction

If you observe your environment you realize that there are millions of different organisms living on the Earth, including animals, plants and microorganism. In this unit you are going to learn about the characteristics of life, naming and how to classify those organisms in to different group.

5.1.1. Characteristics of living things

Living things belong to any organism or a life form that possesses or shows the characteristics of life or being alive. However, a living thing possesses certain properties that help define what life is.

All groups of living organisms share several key characteristics or functions: movements, respiration, sensitivity, growth, reproduction and excretion. When viewed together, these seven characteristics serve to define life.

Characteristics of Living Organism

- **Movement**: an action by an organism or part of an organism causing a change of position or place. Most single-celled creatures and animals move about as a whole. Fungi and plants may make movements with parts of their bodies.
- **Respiration:** the chemical reactions that break down nutrient molecules in living cells to release energy for metabolism
- **Sensitivity**: the ability to detect or sense stimuli in the internal or external environment and to make appropriate responses. Organisms can respond to diverse stimuli. For example, plants can grow toward a source of light, climb on fences and walls, or respond to touch. Even tiny bacteria can move toward or away from chemicals or light.
- **Growth**: a permanent increase in size and dry mass by an increase in cell number or cell size or both. Non- living organisms grow by addition of new material to the out sides surface, however living organism grow from within using food

- **Reproduction**: All living organisms must have the ability to reproduce. Living things make more organisms like themselves. Whether the organism is a rabbit, or a tree, or a bacterium, life will create more life. Reproduction is the process of making the next generation and may be a sexual or an asexual process.
- **Excretion**: the removal from organisms of toxic materials, the waste products of metabolism (chemical reactions in cells including respiration) and substances in excess of requirements Example the process of respiration produces west product, carbon dioxides, which can be harmful in excess and must be removed
- **Nutrition**: the taking in of materials for energy, growth and development; plants require light, carbon dioxide, water and ions; animals need organic compounds, ions and usually need water

Activity 5.2

Discuss in group and share your ideas to the class

1) Are plants categorized in living things or nonliving things? Justify why?

2) Why movement or locomotion from one place to other cannot be taken as defining characteristics of all living things?

Exercise 5.1

1. List and explain the characteristics of life.
2. Explain why movement or locomotion from one place to another cannot be a defining characteristic of all organisms?

5.1.2. Classification and scientific names of organisms

Scientists have found and describe approximately1.75million species, moreover new species are being discovered every day. With such diversity of life on the earth

how does one go about making sense of it all? One ways to make sense of it is by classification. Classification is an important step in understanding the present diversity and past evolutionary history of life on Earth. It helps make sense of the overwhelming diversity of living things.

Q. What is classification?

Classification is sorting or grouping things together on the basis common features / defined characteristic or criteria.

The science of classification is called **Taxonomy.** Classification is usually a hierarchical process. One begins with general and broad differences, and then one systematically introduces more and more detailed and specific criteria.

Q. Why we do we classify?

Biologist/Taxonomist classify living things because of:

- To identify those most at risk of extinction and to understand common ancestors.
- It helps scientists to sort organisms in order and to make easy for study.
- It helps them to identify new organisms by finding out which group they fit.

Taxonomy has two branches: the *naming* of organism or **nomenclature** and *Placing* of organism in to group, or **systematic** which is done on the basis of their similarities and differences.

There are two ways of classifying organisms. These are **artificial** and **natural.**

The **artificial classification** based on one or a few easily observed characteristics and usually designed for practical purpose with an emphasis on convenience and simplicity.

Example: You could put all the animals that fly in the same group. This group would then include birds, bats and many insects. You could put all animals that live in water and have streamlined, fish-like bodies in the same group. This group would then include fish and whales. Are based on arbitrary groupings and have little meaning. **Natural or biological classification** systemtries to use natural relationships between

organisms it consider more evidence than artificial classifications including **internal** as well as **external** features.

- ***Taxonomy:*** the science of classifying and naming organisms.
- ***Classification:*** sorting things based on defined characteristics or criteria
- ***Nomenclature:*** naming of organism
- ***Genera:*** a group of closely related species.
- ***Species:*** is the group of organism that can reproduce to produce fertile offspring
- ***Binomial system:*** is an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and the species.

The smallest natural group of organisms is the **species**. A species can be defined as a group of organisms that can reproduce to produce fertile offspring.

Scientific Naming of Organism

The Binomial System

Organisms were first classified by a Swedish naturalist called Carl Linnaeus (1707 to 1778) in a way that allows the subdivision of living organisms into smaller and more specialized groups. He designed a scientific system of naming organisms called **binomial nomenclature**.

The **binomial system** of naming species is an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and the species. Binomial means 'two names'; the first name gives the genus and the second gives the species. Carl Linnaeus named organisms in Latin using the binomial system.

The scientific naming or binomials naming system should follow the following rules

- Should d contain two names (first and the second)
- The first name is the name of the genus name to which group the organisms belongs and it should begin in capital letter
- The second name is the name of species to which the organism belongs .it is written in small letter.
- The scientific name must always be either written underlined or printed in italics.

The scientific name of our human race is *Homo sapiens*/Homo sapiens, similarly the scientific name of some organism listed below in the table

No	Common name	Scientific name
1	African elephant	Loxodontaafricana
2	Lion	Pantheraleo
3	Teff	Eragrostistef
4	Domestic cat	Felisdomesticus

An organism will always have only one scientific name even though they might have more than one common name.

Before Linnaeus, the use of common names to refer to organisms caused confusion because there were regional differences in these common names.

Because of the scientific names is international agreed and universal it avoids the confusion of local variation in common names. For instance, every biologist will understand that *Feliscatus* means 'house cat' without resorting to the dictionary, no matter what language they speak.

Activity 5.3

- The activity below is not Life Sciences related, but expresses the process of classification. Discuss in group and present the result of your discussion the relationships among the administrative structure: Country, Region, Zone, Wereda and correlates with biological levels of classification

Exercise 5.2

1. Explain the importance of scientific naming organisms.
2. Define what is species?

5.1.3. Hierarchy in the classification of organisms (Kingdom to species)

Linnaeus eventually extends the binomial system to include more groups than just genus and species. These he arranged in hierarchy with largest group, the **kingdom** at the top of hierarchy, the groups he proposed are still used to day and, in descending order of size: The sequence of classification is: ***Kingdom, Phylum, Class, Order, Family, Genus, and Species***

When trying to identify animals, it is this hierarchy or ranking scheme that we follow. We start by identifying the kingdom, to which an organism belongs, then its phylum, class, family, order, and so on.

As you go through the classification hierarchy, you will see that scientists have used broader features to put organisms into kingdoms, which are the largest groups of organisms. When you move down towards the species, which are the smallest groups of organisms, features are becoming specific. In other words, two organisms that belong to the same species share more features than those in the same kingdom but in different species.

Table 5.1. The taxonomic breakdown of a few familiar animals and plant

Taxon	Dog	Tiger	Maize
Kingdom	Animalia	Animalia	Plantae
Phylum	Chordata	Chorodata	Magnoliophyta
Class	Mamalia	Mammalia	Liliopsida
Order	Carnivora	Carnivora	Poales
Family	Canidae	Felidea	Poaceae
Genus	Canis	Felis	Zea
Species	Familiaris	Tigris	Mays

Exercise 5.3

- Writes the classification hierarchy for human being from kingdom to species

KEY WORDS

- ***Kingdom:*** are grouped of related phyla or divisions
- ***Phylum:*** or Division: a group of related classes
- ***Class:*** a group of related orders
- ***Order:*** a group of related families
- ***Family:*** a group of related genera
- ***Genus:*** a group of closely related species.
- ***Species:*** basic unit of classification or taxonomy

A species can be defined as a group of organisms with similar features and these organisms are capable of breeding and produce fertile offspring.You are probably aware of the fact that horses and donkeys belong to the same kingdom, phylum, class, order, family as well as genus but they are from different species. Therefore, if a donkey and the horse happen to breed, they produce an offspring called a mule. The mule is infertile, meaning that it cannot reproduce offspring because it is a product of organisms of different species.

Figure 5.1: Diagram showing hierarchy of classification.

Classification hierarchy has many uses. First, it helps scientists to sort organisms in order. Second, it helps them to identify new organisms by finding out which group they fit. Third, it is easier to study organisms

when they are sorted in groups.

Activity: 5.4

- make you own mnemonic to remember the sequence of the classification system. This activity allows the learners to be creative. Give the learners the freedom to choose which platform suits them best. The learners have fun and learn the classification system at the same time.
- Instructions: Make an easy to remember memory aid to remember the sequence of levels of the classification system.
- Materials: pen, paper, imagination!
- Procedure: coin mnemonics using first letters of the levels such as—K for Kingdom, —P for Phylum, etc. for frequent memorization easy and of the levels. Example of such mnemonic as: King Philip came over for Good Spaghetti (KPCOFGS) rehearse this mnemonic at the beginning of your class until this unit is completed.

Exercise 5.4

I. Choose the best answer from a given alternative option

1. The Swedish scientists who create the binomial naming system

   A. Robert Hook.
   B. Carlous Linnaeus
   C. Robert H. Whittaker
   D. Charles Darwin

2. Which of the following in the classification system is the smallest?

   A. Kingdom
   B. Species
   C. Genus
   D. Class

3. Excretion, irritability and reproduction are characteristics of:

   A. all animals and plants
   B. animals only
   C. plants only
   D. some animals and some plants only

4. The Swedish scientists who create the binomial naming system

A. Robert Hook
B. Carlous Linnaeus
C. Robert H. Whittaker
D. Charles Darwin

5. Which of the following in the classification system is the smallest?

A. Kingdom
B. Species
C. Genus
D. Class

6. What characteristics of living organisms does this demonstrate?

A. Excretion and movement
B. excretion and nutrition
C. growth and irritability
D. irritability and movement

7. The scientific name of human being is Homo *sapiens,* the second parts of the scientific name represent-------

A. genera name
B. kingdom name
C. species named
D. family name

II. Complete the passage below by choosing the words from list

***List:* excretion, growth, Sensitivity, movement, nutrition, organisms, reproduction, respiration**

A. Living things are often called _____.

B. All living things release energy from their food in a process called _____, which happens inside their cells

C. Some of the energy is used for _____, which usually happens more quickly in animals than in plants.

D. The food from which the energy is released is taken into the body in a process called _____.

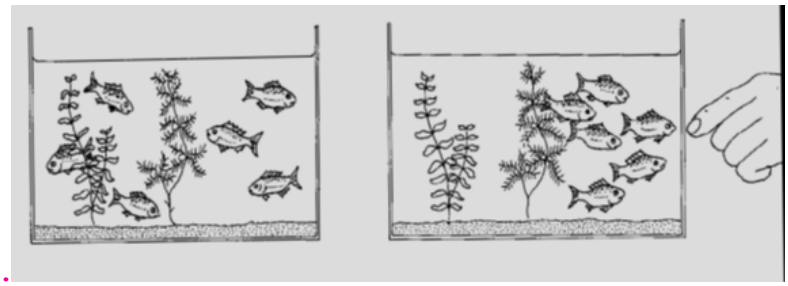
E. All living things get bigger as they get older. This process is called _____

F. The production of young is called _____.

G. Waste substances are removed from organisms by the process of _____

H. The seventh characteristic shown by all living organisms is _____, which means that they are sensitive to things around them.

Figure: 5 .2 below shows how fish react when the glass on one side of an aquarium tank is tapped with a finger



5.2. The kingdom of life

Learning Competency

At the end of this section, learners will able to:

- *compare the five Kingdoms of living things by describing their distinguishing characteristics*
- *summarize the commonest examples of organisms belonging to each Kingdom*
- *describe the body plans of insects such as butterfly, amphibians such as frogs, mosses, liverworts, ferns, conifers such as junipers, flowering plants, Paramecium, Algae, and Mushroom*
- *relate each Kingdom of organisms to their major habitat types as aquatic, terrestrial or moist.*

Activity: 5. 5

- Have you ever thought of multitudes of life forms that surround as and can you list same if them

Activity: 5.6

- Make groups of five, and then categorize the following organisms given in the following charts in to some named group and present the results of your discussion for the class.

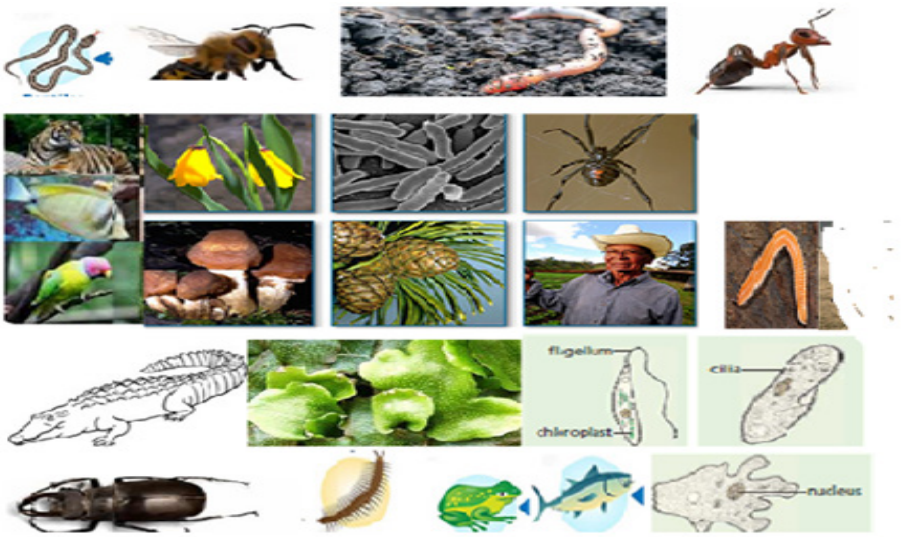


Figure: 5.3 same diversity of life on planet earth.

Activity 5. 7

- Categorize the organism listed in figure 5.1 above based on the five kingdom of life and explain your reason to classify under any of the kingdom?

The five kingdom system is the most common way of grouping living things based on simple distinctive characteristics. The five-kingdom system was developed by Robert H. Whittaker in 1969 and was built on the work of previous biologists such as Carolus Linnaeus. Living things can be classified into five major kingdoms:

- Kingdom Animalia
- Kingdom Plantae

- Kingdom Fungi
- Kingdom Protista
- Kingdom Monera (Bacteria)

5.2.1. Kingdom Animalia

Major characteristics of animals

Members of the animal kingdom are eukaryotic and multicellular but have no cell wall or photosynthetic pigments. They are mostly motile and they are heterotrophic, which means they must feed on other organisms and cannot make their own food. They reproduce sexually or asexually. Animals store carbon as glycogen and fat.

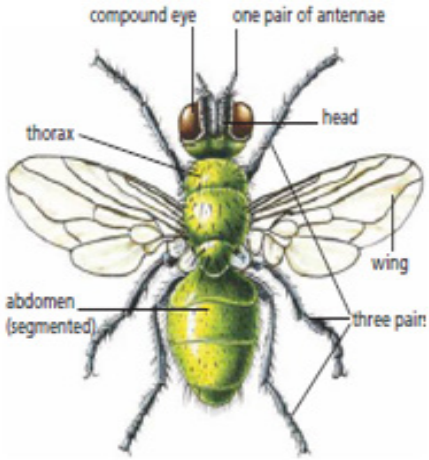


Figure: 5.4 the body structure of insects

Major groups of animal and their habitats

Invertebrates

Insects (Arthropods)

The insects form a very large class of arthropods**.** Insects live in every possible environment on Earth and are among the most highly adapted of all animal species

Bees, butterflies, mosquitoes, houseflies, earwigs, greenfly and beetles are just a few of the subgroups in this class.

Insects have segmented bodies with a firm exoskeleton, three pairs of jointed legs, compound eyes and, typically, two pairs of wings. The body is divided into three parts:head, thorax and abdomen regions. Insects have only one pair of antennae and only three pairs of legs and have no limbs on the abdominal segment.

KEY WORDS

- **Heterotrophs:** heterotrophs are organisms that cannot produce their own food.
- **Multicellular:** an organism composed of many cells.
- **Exoskeleton:** is the external skeleton that supports and protects an animal's body.

Worm: Worms are members of several invertebrate phyla, animals that typically have a long cylindrical tube-like, flattened, or leaf like shaped body, no limbs, and no eyes.

It includes Platyhelminthes (flatworms), Annelida (segmented worms), Nemertea (ribbon worms), nematode (roundworms, pinworms) etc. They vary in size from less than 1 mm (0.04 inch) in certain nematodes to more than 30 m (100)

They live in marine, freshwater, and terrestrial habitats. Some types of worms are parasitic, others are free-living.

Figure: 5.5 different worms of phylum Annelida

Activity: 5.8

Collecting and examining flatworms and insects

Materials you require: A. containers, nets, hand lenses,alcohol solution

Procedure:

I) You may need to use nets to catch some of the organisms. Take care handling any organisms which may sting or bite Keep different types of specimen you collected (butterfly, grasshopper, spider, Bees, mosquitoes) in appropriate container and examine as the following

II) What features the specimens have in common?

III) Examine their characteristic features, i.e. number of limbs, presence and number of antennae and number of body parts, presence and number of wings.

IV) You should then make a table of characteristic features like in the following tables

V) Make large well-labeled drawings of each of their specimens

Specimen	Number of body parts	Number of limbs	Antenna	wings
Butterfly				
Grasshopper				

B. Looking at Platyhelminthes (flatworms)

Material used: preserved or fresh specimens of Platyhelminthes (flat worm) hand lenses. Observe, draw and label specimens of these invertebrate phyla

Activity: 5. 9

Collecting and examining amphibian (frog)

Material you require: transparent container or cage, pairs of forceps, pairs of gloves.

Procedure:

i) Collective or freshly killed toads or frogs keep in transparent container or cage.

ii) Examine the head and trunk regions of the toad. You should note and identify the following characteristic features: Mouth, Nostrils, Eyes Ear, Trunk, limbs.

iii) Does the toad/frog have a tail?

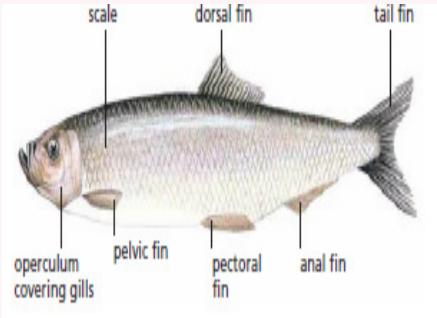
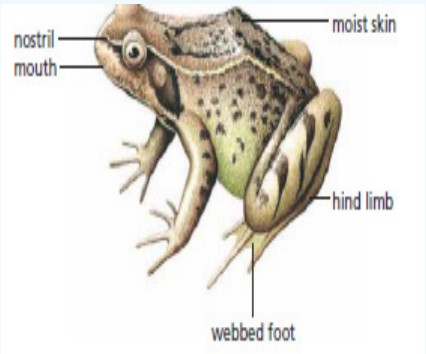
iv) Make a large well-labeled drawing of the toad/frog as seenfrom the slide

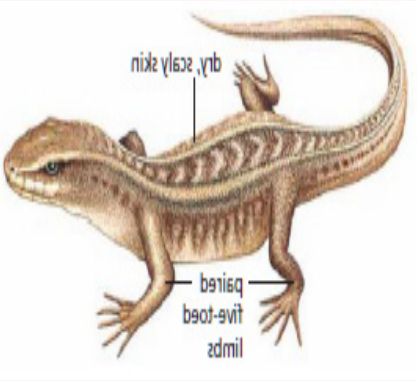
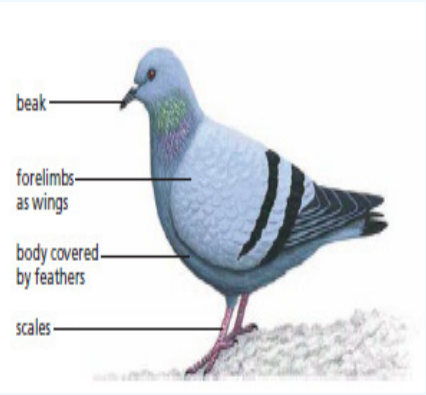
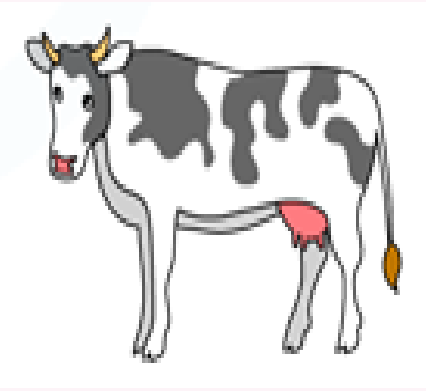
KEY WORDS

- Poikilothermic: is an animal whose internal temperature varies considerably.
- Homoeothermic: organisms able to maintain a constant internal body temperature.

Vertebrates (fish, amphibian, reptiles, birds & mammals). Vertebrates are animals which have a vertebral column. The vertebral column is sometimes called the spinal column consists of a chain of cylindrical bones (vertebrae) joined end to end.

Table 5.3 major groups of animals and their characteristics

Class	Main features	Examples
FISH	✔ Poikilothermic (cold blooded) vertebrates. ✔ Many of them have a smooth, wet scales on skin, streamlined shape ✔ Breath by gills, reproduce sexually fertilization external ✔ Fins (also used for balance) ✔ Live only in water (aquatic environment)	
AMPHIBIAN	✔ Poikilothermic (cold blooded) ✔ Have moist skins with a good supply of Capillaries ✔ Have lungs and skin for breathing ✔ Fertilization external, produce jelly-covered eggs in water ✔ Four limbs, back feet are often webbed to make swimming more efficient ✔ Live both in water and on land.	

REPTILES	✔ Poikilothermic (cold blooded) ✔ dry skin, with scales ✔ four legs (apart fromsnakes) ✔ produce eggs with a rubbery, waterproof shell; laid on land ✔ Have lungs for breathing ✔ Most reptiles live in warm habitats	
BIRDS	✔ are homoeothermic (warm blooded ✔ feathers, with scales on legs ✔ two wings and two legs ✔ produce eggs with a ✔ hard shell, laid on land ✔ lungs for breathing; beak ✔ live in water and on land	
MAMMALS	✔ are homoeothermic (warm blooded) ✔ produce live young ✔ lungs for breathing ✔ females have mammary glands to produce milk to feed young; ✔ four types of teeth ✔ live on land	

Exercise 5.5

1. Which of the following vertebrates are characterized by four limbs with back feet are often webbed, moist skin and live both in water and on land?

   A. Mammal
   B. Fish
   C. Reptiles
   D. Amphibian

2. Which of the following is **not** true about insect? They posses

   A. three segmented body
   B. a pair of antennae
   C. two pairs of legs
   D. typically two pair's wings

3. Writes the distinguishing characteristic of mammals and birds.

5.2.2. Kingdom Plantae

Major characteristics of plants

Organisms belonging to the plant kingdom are eukaryotic and multicellular organisms. They have a distinct cell wall made of cellulose. Cells are organized into true plant tissues. Plants contain plastids and photosynthetic pigments such as chlorophyll. They are non-motile. Plants make their own food by photosynthesis and are therefore said to be autotrophic. Plants undergo both sexual and asexual reproduction. They store food as starch.

Major groups of plants and their habitats:

Important examples of plants are mosses, ferns, conifers and flowering plants.

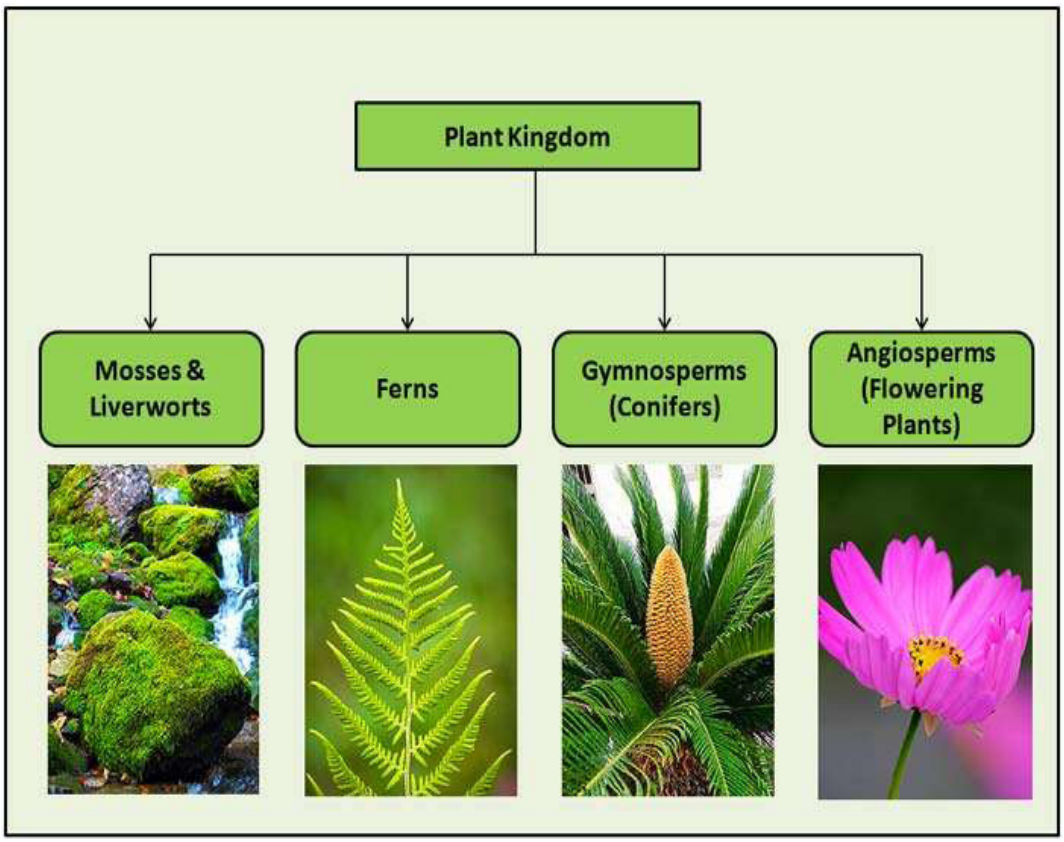


Figure: 5.6 major groups of plants

Non vascular plants (lack vascular tissue)

Vascular systems consist of xylem tissue, which transports water and minerals, and phloem tissue, which transports sugars and proteins.

Bryophytes:

The Phylum Bryophyte, are the most diverse group with more than 10,000 plant species.

- This phylum includes the mosses, liverworts, and hornworts.
- They lack vascular tissue and wood that can render them structural support.
- They also lack true leaves, stem, and roots that can help them transport water

and nutrients.

- Live in moist places and somehow have adapted several methods that can help them thrive in dry periods.
- Reproduce through spores.
- Play an important role in minimizing erosion along bodies of water, carrying out water and nutrient cycling

		
Mosses	*liverwort*	*hornwort*

Figure: 5.7 different types' bryophytes

Activity: 5. 10

Collecting and Examining Mosses

Materials you require: **microscopes, hand lenses, scalpel blades, forceps, microscope slides and cover slips.**

Procedure:

I) in groups search around the school for moss plants around damp walls, rocks, tree barks or damp verandas. Then you should carry collected specimen into the laboratory for detailed study.

II) With the help of a hand lens examine the specimen carefully and identify the parts.

III) You draw and label your specimen.

KEY WORDS

Vascular Plants:

- possess vascular tissues (*xylem* and *phloem*) that aid them to transport water and minerals.

Figure: 5.8. the structure of pteridiophytes (fern)

Pteridophytes

- have well-developed xylem and phloem
- Pteridophytes are seedless plants but they pass their genetics to offspring through spores that are located on the underside of their leaves known as sporophylls.
- Unlike bryophytes, they are already vascular plants and capable of transporting fluids.
- The stem and leaves have sieve tubes and water conducting cells similar to those in the xylem and phloem of a flowering plant.
- The stem is usually entirely below ground and takes the form of a structure called a rhizome.
- The leaves of ferns vary from one species to another
- Pteridophytes have already adapted to a wide range of habitat: they can be aquatic, terrestrial, and even cold-resistant.

Activity: 5.11

Collecting and examining a fern

Material you require: hand lenses, scalpels, clean slides, cover slips, and microscopes.

Procedure:

i) In groups, you should search for a fern along rivers/stream banks, shady areas beneath trees and along fences.

ii) Examine your specimens and identify as many structures as they can.

iii) Draw and label their specimen.

iv) Observe the lower surface of the leaves (fronds).

v) Draw the lower surface of the specimen showing the arrangement of the spore-forming bodies if there are any there.

vi) Using forceps or a needle, remove a capsule if they can see one, mount it on a slide and view under low power. Draw what you see.

Exercise 5.6

1) What is the difference between bryophytes and pteridophytes

2) Writes the importance of bryophytes in the environments

Gymnosperms (confers plant)

The name "*gymnosperm*" literally means "*naked seed*", which is exhibited by the members by having **cones** instead of seeds to reproduce. Their seed are not enclosed in fruit.

Fig 5.9 structures of gymnosperm

They are widely distributed in the planet but dominate the temperate and arctic regions. The stem and leaves have sieve tubes and water conducting cells similar to those in the xylem and phloem of a flowering plant.

- They are characterized by having wood, and green needle-like or scale-like foliage.
- Gymnosperms are good sources of wood and paper

Activity: 5.12

collecting and examining conifers

Material you require: **saw, conifer leaves and cones.**

Procedure: **In groups, you should search and collect a conifer tree in you school compound.**

1. Obtain some conifer leaves and cones.
2. Observe them carefully.
3. Make large well-libeled drawings of the leaves of conifer.
4. Examine some conifer cones. Note the seeds attached to the cone. Carefully remove one seed from the cone of conifer and draw it.

B. Collecting and examining angiosperm

Material you require: bean/peaplants with flowers and bean/pea seed, maize plants with flowers and maize grain, hand lenses.

Procedure: Make a collection of flowering plants around your school. Identify them and then classify them according to whether they are monocotyledons or di cotyledons

1. Collect a bean/pea plant and a maize plant.
2. Compare their roots, stems, leaves, flowers and seeds.
3. Make a table of differences between the bean plant and the maize plant.
4. Draw well-labeled diagrams of the bean plant and the maize plant.

Angiosperms (flowering plants)

- They have true root, stem, leaves and flowers as reproductive organ and the seed are enclosed in fruit.
- They reproduce by seeds which are formed in flowers.
- Flowering plants are divided into two subclasses: **monocotyledons and cotyledons.**
- Their leaves are usually broad and the leaf veins form a branching network

Most angiosperms are good sources of food, medicine, clothing fibers, and wood.

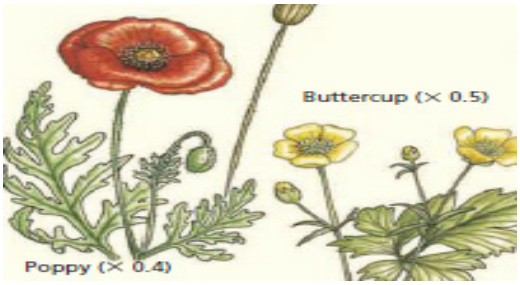


Figure 5:10 flowering plants

Activity 5.13

Develop a table that simplifies and summarizes the kingdoms from mosses to flowering plants as follows. You should copy the example shown here and fill it in.

Division	Characteristics	Examples
Bryophyta		
Pteridophyta		
Gymnosperm		
Angiosperm		

EXERCISE: 5.7

Choose the best answer from the give suggested option

1. True root, stem and leaves are found in

A. lichens B. algae C. fungi D. ferns

2. A group of plant characterized by the possession of amassesof spore bearing structures under side of their leaves are;

A. ferns B. lichen C. algae D. worst

3. A seed bearing but non flowering plants are

A. algae
B. angiosperm
C. gymnosperm
D. ferns

4. One is not belonging to Bryophytes

A. Liverwort
B. mosses
C. hornwort
D. ferns

5. Which group are vascular plants?

A. liverworts
B. mosses
C. Ferns
D. Hornwort

5.2.3. Kingdom Protista

Major characteristics of Protista

Protista are eukaryotic and can be unicellular. The kingdom protest a is diverse group one ways to classify protests according to the way they obtain nutrition. There are animal like, plant like, funguses like protistas. They reproduce sexually or asexually. Important examples of protistas include the organism known as ***Plasmodium (which causes malaria), Amoeba and Euglena, Trypanosomes.***

There are two major groups of Protista include:

i) **Protozoans**: are similar to animal cells in that they do not have cell walls. Organisms such as Amoeba and Paramecium take in and digest solid food and thus resemble animals in their feeding.

They may be called **unicellular 'animals'**

ii) **Protophyta:** the plant-like cells which do have cell walls and are similar to algae. Euglena and Chlamydomonas possess chloroplasts and make their food by photosynthesis

They often referred to as **unicellular 'plants'**

Activity: 5. 14

Making hay infusion and observing protozoan (paramecium)

Materials: A hand full of hay, a large beaker, pond water, some milk

Method:

1. Take a hand full of dried grass or hay (free from pesticides or herbicides) and cut the grass into smaller pieces
2. Place the cut grass into the beaker and about 0.5-1 liter of water.
3. Add 1-2 drops of milk. The water will turn slightly turbid. The milk is food for the bacteria and they will start to reproduce. The ciliates feed on the bacteria and will also reproduce.
4. Let the beaker stand open for several days, protected from direct sunlight as this may result in overheating and the heat will reduce the oxygen concentration. Do make sure that the beaker receives sufficient light, though. Photosynthetic algae present in the pond water will produce oxygen.
5. Keep adding 1-2 drops of milk when the turbidity disappears. Bubble some air through the water at regular intervals (using an air-pump from an aquarium) or agitate the water a bit to enrich it with oxygen.
6. Replace the evaporated water.
7. Take some sample from the surface of the water (where there is oxygen) for microscopic investigation. If the water is agitated, then the microorganisms are (of course) not able to collect beneath the water surface.
8. Observe paramecium using microscope and draw the structure. Follow the mounting procedure explained in unit four.

5.2.4. Kingdom Monera

Major characteristics of Monera

The Kingdom Monera consists of prokaryotic unicellular organisms. No nuclear membrane or membrane-bound organelles such as chloroplasts, Golgi complex,

mitochondria or endoplasmic reticulum are present. Monera have a cell wall of protein plus polysaccharide compound, but not cellulose. They reproduce asexually by binary fission. Important examples of Monera include blue green algae and Bacteria.

Major groups of monera and their habitats (Blue Green algae &Bacteria)

Blue Green algae

Blue-green algae:- is prokaryotic singled celled photosynthetic organisms containing a blue pigment in addition to chlorophyll they also called **cyanobacteria.**

Predominantly occur singly or in colonies in diverse habitats in freshwater or a terrestrial environment

They are microscopic but can be seen when they are in a colony, or bloom.

Cyanobacteria contain only one form of chlorophyll (a green pigment) In addition, they contain various yellowish carotenoids, the blue pigment phycobilin and, in some species, the red pigment phycoerythrin. The combination of phycobilin and chlorophyll produces the characteristic blue-green color from which these organisms derive their popular name.

Cyanobacteria are the first organisms known to have produced oxygen as a byproduct of photosynthesis

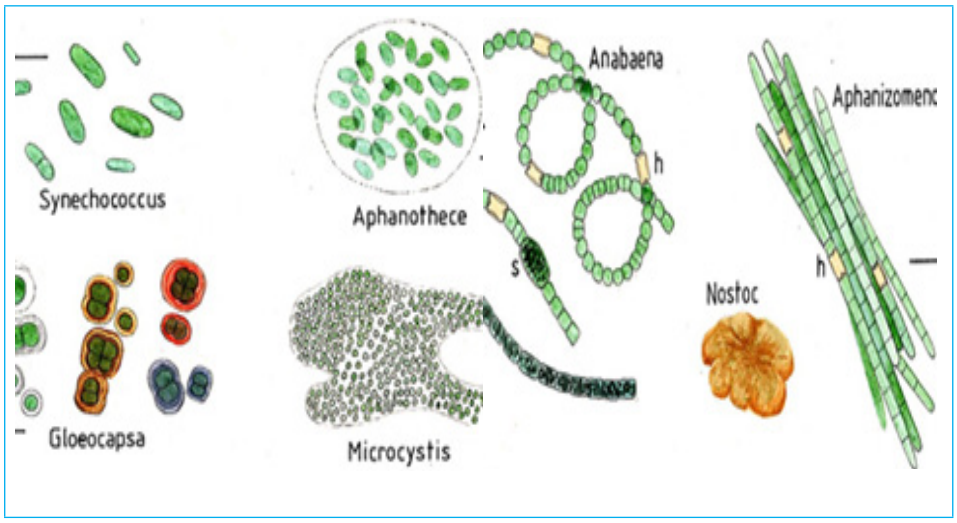


Figure.5:12. Colony and filamentous form of blue green algae

Bacteria: are very small organisms consisting of single cells they lack organized nucleus and chlorophyll pigments

Their cell walls are made, not of cellulose, but of a complex mixture of proteins, sugars and lipids (peptidoglycan).

They can be found in various shapes and sizes, may be spherical, rod-shaped or spiral and some have fi laments, called **flagella**, projecting from them and serve for movement.

The genetic material **DNA** is contained in the cytoplasm called nucleoid.Bacteria are found everywhere and are the most numerous organisms on Earth.

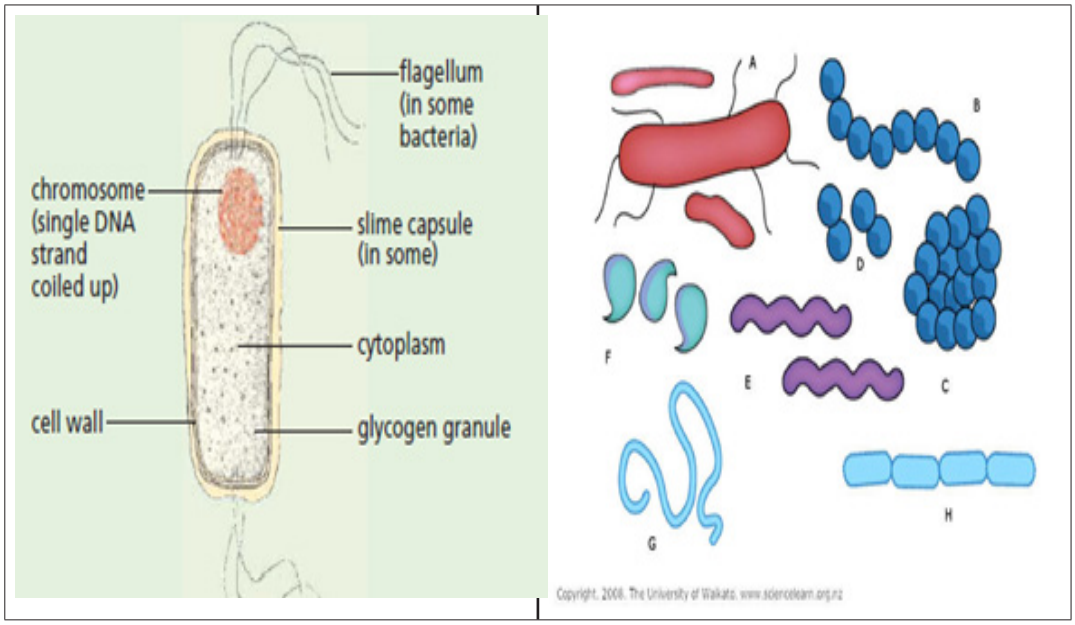


Figure: 5.13 structures and shapes of bacteria

Exercise 5.8

1) Define prokaryotes and eukaryotes cell.
2) Explain the difference between prokaryote and eukaryotes.

5.2.5. Kingdom fungi

Major characteristics of fungi

Fungi are eukaryotic (have membrane bounded nucleus) organisms that can be multicellular or unicellular. Mushrooms and molds are examples of multicellular fungi and yeast is an example of a unicellular fungi. All fungi have a cell wall made of chitin. They are non-motile (not capable of movement) and consist of threads called hyphae. Fungi are heterotrophic organisms which mean they require organic compounds of carbon and nitrogen for nourishment. They are important as decomposer (saprophytes) and can be parasitic. They store carbon as glycogen, not in the form of starch. Fungi reproduce sexually and asexually by spore formation.

Figure 5:14 different types of fungi

Yeast: single-celled fungi. It converts **complex carbohydrates** in to alcohol and carbon-dioxide. Used for a variety of commercial purposes like baking (“injera” or bread) and in the production of alcohol.

Mould: fungi which grow on decayed bread, cheese, fruit or other food. Many of the mould fungi live in the soil or in dead wood.

Another important example of a useful fungus is ***Penicillium*** (a fungus which was used to make penicillin, one of the most powerful antibiotics ever created)

Activity: 5.15.

Collecting and looking at fungi

Materials you require: **microscopes, hand lenses, scalpel blades, forceps, microscope slides and cover slips.**

Procedure: in groups search around the school for mushroom in the school compound or if necessary you can grow your own fungi (moulds) on a little moist injera or by letting a piece of fruit go rotten. Some of them may be quite big like (mushroom) but they may want to use a microscope to look at some of them.

Look at different structures of fungi (fruiting body or mycelium) .Draw several different types of fungus.

KEY WORDS

- Living things
- Classification
- Specie
- Binomial System
- Kingdom
- Multicellular
- Sorting
- Phylum
- Order
- Genus
- Pteridophytes
- Class
- Family
- Eukaryotic
- Unicellular
- Bryophytes
- Gymnosperms
- Protista
- Monera
- Vascular
- Angiosperms
- Spore
- Prokaryotic
- Poikilothermic

Unit Summary

- *The seven characteristics of living things are movement, respiration, sensitivity, growth, reproduction, excretion and nutrition*
- *A species is a group of organisms that can reproduce to produce fertile offspring.*
- *The binomial system is an internationally agreed system in which the scientific name of an organism is made up of two parts showing the genus and the species.*
- *Classification is a way of sorting organisms into a meaningful order*
- *The artificial classification based on one or a few easily observed characteristics*
- *Natural or biological classification system tries to use natural relationships between organisms*
- *The smallest natural group of organisms is the species*
- *The five kingdom system is the most common way of grouping living things based on simple distinctive characteristics.*
- *The sequences of classification are Kingdom, Phylum, Class, Order, Family, Genus, and Species*
- *Living things can be classified into five major kingdoms: Kingdom Animalia, Plantae, Fungi, Protista, and Monera (Bacteria*
- *Animal kingdom is eukaryotic and multicellular but has no cell wall or photosynthetic pigments. They are mostly motile and they are heterotrophic,*
- *Insect has three parts: head, thorax and abdomen regions with three pairs of jointed legs, compound eyes and, typically, two pairs of wings*
- *Plant kingdom is eukaryotic and multicellular organisms. They have a distinct cell wall made of cellulose.*
- *Bryophytes are non-vascular plants that lack true leaves, stem, and roots that can help them transport water and nutrients.*
- *Pteridophytes are vascular plants that have well-developed xylem and phloem that reproduce by spores.*
- *Gymnosperms are vascular plants that bearing cone.*
- *Angiosperms are flowering plants that reproduce by seeds which are formed in flowers.*
- *Protista are eukaryotic and can be unicellular or simple multicellular. They reproduce sexually or asexually.*
- *Monera are of prokaryotic unicellular organisms that lack the membrane bounded organelle and reported by binary fusion*
- *Bacteria are very small organisms consisting of single cells they lack organized nucleus and chlorophyll pigments*
- *Fungi are eukaryotic (have membrane bounded nucleus) organisms that can be multicellular or unicellular and have chitin cell wall.*

Review Exercise

I. Write "true" if the statements are correct and "false" if the statements is incorrect

1. Blue green algae belongs to the kingdom-Protista
2. Bacteria are found everywhere and are the most numerous organisms on Earth.
3. The Kingdom Monera consists of prokaryotic multicellular organisms.
4. Protoctists are single-celled organisms containing a nucleus.
5. Amphibians can breathe in air or in water.
6. Mammals have fur, they suckle their young and the young develop inside the mother.
7. Mosses have well-developed stems, leaves, roots and reproduce by spores.
8. Fungi are made up of thread-like hyphae and an autotroph organism.
9. Insects mostly live on land and have wings and two pairs of legs.

II. Match the following items in "A" sides with the item in" B"

"A"	" B"
1. Plants	A .made up of thread-like hyphae & reproduce by spores.
2. Fungi	B. makes their food by photosynthesis.
3. Protists	C. gets their food by eating plants or other animals.
4. Animal	D. is single-celled organisms containing anucleus.
5. Monera	E. is single celled organism lacking nucleus

III. Fill the following question by the appropriates terms

1. The type naming organism using the Latin name indicating genus and species is called_____
2. _____group of organisms which are able to interbreed and produce fertile offspring.

3. _____is the scientific name of our human race.
4. _____the type of asexual reproduction in the Kingdom Monera.
5. Highest grouping in a classification system_____

IV. Choose the best answer from the following suggested option

6. Which one of the following is not a defining characteristic of all organisms?

A. Growth
B. Respiration
C. Locomotion
D. Reproduction

7. The smallest natural group of organisms is the_____.

A. kingdom
B. species
C. phylum
D. class

8. If two organisms belong to the same order, then they must also belong to the same

A. Genes
B. Class
C. Family
D. Species

9. An organism's scientific name is based on how it is classified. Which of the following levels of classification determine the name**?**

A. Genus and species
B. Phylum and class
C. Order and family
D. kingdom and spies

10. The science of identifying, classifying, and naming living things is called?

A. System
B. Nomenclature
C. Taxonomy
D. Hierarchy

11. The level below kingdom

A. Genus
B. Order
C. Phylum
D. Class

12. The sequence of scientific category from general to specific:

A. Species----- genera----family----order --- class-----phylum kingdom

B. Genera--- family-----order ----class-----phylum kingdom------genus
C. order ---class----phylum-----kingdom-----family---species----genus
D. kingdom----phylum-----class------order----family---genus----species

13. Protists are;

A. All autotrophs cannot make their own food
B. All autotrophs can make their own food
C. Can be either autotrophs and heterotrophs
D. Are not eukaryotic (do not have nucleus

14. A mushroom would best fit into which kingdom?

A. Animal
B. Fungi
C. Plant
D. Protest

15. The main function of the vascular bundles found in many plants is to ...

A. taps energy or food making
B. carry out photosynthesis
C. assist plant in reproduction
D. transport substances around the plant

16. The scientific (and common) names of three animals are: *Canisfamiliaris* (dog), *Canislupis* (wolf) and *Vulpesvulpes* (fox). These three animals all belong to the same ...

A. Class but different genera
B. Genus but different species
C. Species different genera
D. Class different species

17. In a five-kingdom system of classification, bacteria are members of

A. protests
B. fungi
C. plants
D. monera

V. Give short answer for the following question

1. Explain the importance of classification hierarchy.
2. Describe the relationship of hierarchical levels in classification.
3. Explain the major characteristics kingdom animalia and fungi.
4. Writes the unique or distinguishing characteristics of kingdom plantia, Protista and monera.
5. States the kingdom to which each of the following organism belongs

Lizard	amoeba	paramecium	blue green algae
Papaya	spider	termites	mushroom
Sunflower	pigeon	rat	maize
Trypanosome	euglena	mold	pea
yeast	salmonella	Sorghum	bacteria

Self Assessment

Check List Competencies given below are expected to be achieved in this unit by students. You are required to respond by saying Yes or No. Put a tick (√) mark under "Yes" column if you are able to perform the competency or under "No" column if you are unable to perform the competency. This would help to evaluate yourself and you can revise the parts of topics for which the competencies are not met.

No.	Can I	Yes	No
1	*Differentiate between living and non-living things*		
2	*Organize and describe characteristics of living things*		
3	*Justify why movement or locomotion from one place to another cannot be a defining characteristic of all organisms*		
4	*Relate diversity with classification of organisms*		
5	*Justify why scientific names of organisms should be used in science than the local names*		
6	*Analyze and describe the relationships of the hierarchical levels (Kingdom to Species) in the classification of organisms*		
7	*Compare the five Kingdoms of living things by describing their distinguishing characteristics*		
8	*Summarize the commonest examples of organisms belonging to each Kingdom*		
9	*Describe the body plans of insects such as butterfly, amphibians such as frogs, mosses, liverworts, ferns, conifers such as junipers, flowering plants, Paramecium, Algae, and Mushroom*		
10	*Relate each Kingdom of organisms to their major habitat types as aquatic, terrestrial or moist*		

UNIT - 6

6. EARTH IN SPACE

Learning Outcomes

At the end of this unit, learners will able to:

- *describe the shape of the Earth*
- *identify evidences supporting the shape of the Earth*
- *list local and global ideas about the shape of the Earth*
- *name dimensions (circumferences, diameters, and angular distances) of the Earth*
- *recognize all parts of the Earth*
- *describe the organization and contents of the different parts of the Earth*
- *explain different observations about the Earth in terms of the nature and behaviors of the different parts of the Earth*
- *demonstrate movements of the Earth (revolution and rotation)*
- *explain the effects of motions of the Earth.*
- *identify atmospheric and lithospheric systems.*
- *construct the model of Earth and use it to explain phenomena related to its motion*
- *explain their cycle effects of the Earth*
- *describe the measuring techniques for too big (Earth) and to small (continental drift) quantities measurement and estimation*

Main Conents

6.1. Shape and dimensions of the Earth

Learning Competency

At the end of this section, learners will able to:

- *describe the shape of the Earth*
- *identify evidences supporting the shape of the Earth*
- *list local and global ideas about the shape of the Earth*
- *name dimensions (circumferences, diameters, and angular distances) of the Earth*

Introduction

This unit introduces the concept of Earth in Space, parts of the Earth and shape and dimensions of the Earth. The unit also presents Atmospheric and lithospheric Systems & Cycles, (effects, measurement ideas/estimation).
Earth sciences study the major parts of our planet earth by using other branches of science, such as biology, chemistry, physics and geology.

Q. How is Earth science used in everyday life?

Earth science affects our everyday lives. For example, ***meteorologists*** study the weather and watch for dangerous storms. ***Hydrologists*** examine water and warn of floods. ***Seismologists*** study earthquakes and try to understand where they will

strike. ***Geologists*** study the materials, processes, products, physical nature, and history of the Earth.

Q. Why we study earth science?

Because Earth science will affect your life. Everyone needs to know how to prepare for changes in weather, climate, seasons, shape of the earth, and layers of the atmosphere and earth movements.

Activity 6.1

Form a group and perform the following actives.

i. By referring internet explorer or other reference materials discuss about the shape of the earth

ii.. Identify the local and global assumptions and evidences about its shape.

Project work 6.1

Model of the earth

Form a group and Build model of the earth including its body parts and make discussion about shape with your class mates then present your work to the rest of the class.

Q. What Is Earth?

Our Planet Earth is one of the eight planets our Solar System and the only known planet to support life. It is our home planet that everything just right for life to exist.

6.1.1. Shape of the Earth

Q. What are the local ideas about the shape of the Earth?

Science in ancient time's mankind

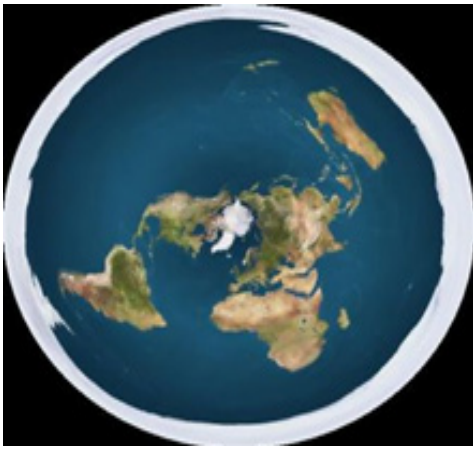


Figure 6.1. Flat shape assumption of the earth

is

has different questions and assumptions about the geometrical shape of our planet earth.Locally most cultures describe the Earth as flat such as;

- The early ancient Greeks, Sumerians, Babylonians, Egyptians and Vikings all believed that the Earth was a flat disc or plane surrounded by water. This was based on the evidence of what they saw around them.
- The ancient Chinese believed that the Earth was a flat square shape surrounded by heavens that were a round egg shape. This was based on their belief in a heaven that was above the Earth.
- Members of the Flat Earth Society claim to believe the Earth was flat.A Flat Earth model depicting Antarctica as an ice wall surrounding a disc-shaped Earth. Members of the Flat Earth Society claim to believe the Earth is flat. Walking around on the planet's surface, it looks and feels flat,

The primary reason that ancient people believed that the Earth was flat was that it looks flat from our vantage point on the ground. The misconception that the Earth must be flat because it looks flat to us arises simply because the Earth is big.

There are two primary reasons that the Greeks knew the Earth were round:

- **Lunar eclipses:** First, they saw that during a lunar eclipse the shadow of the Earth always had a round profile. This happened regardless of the time of night that the eclipse occurred, the season, or the direction that the shadow crept across the Moon's surface.
- **Star patterns:** The second observation is how the pattern of stars changes as you move north and south.

Flat Earth theorists said that if the Earth is a spinning sphere, why can't they feel it?

- An ancient Greek writer, Herodotus, reported the findings of a group of explorers and traders called the Phoenicians; while travelling by boat around Africa, they found that the Sun was not above them but to their right. If the Earth is ***flat***, then the Sun should always be above you.

It was around 500 B.C. that Pythagoras first proposed a spherical Earth, mainly on aesthetic grounds rather than on any physical evidence. Like many Greeks,

he believed the sphere was the most perfect shape. Possibly the first to propose a spherical Earth based on actual physical evidence was

Aristotle (384-322 B.C.), who listed several arguments for a spherical Earth: ***ships disappear hull first when they sail over the horizon***, ***Earth casts a round shadow on the moon during a lunar eclipse***, and ***different constellations are visible at different latitudes*** were used as evidence that the Earth was spherical.

Figure 6.2. if earth were flat, its shadow during an eclipse would be straight on the moon, not covered.

Only a spherical object always produces a round shadow. If the Earth were flat, it would cast a straight shadow.

Today, we know that Earth is sphere shaped, but it is not a perfect sphere. So, the shape of Earth can be categorized as "Oblate spheroid" where ''Oblate" refers to a slight elliptical appearance and 'spheroid' means almost a sphere but not actually a sphere. This describes the true shape of the Earth, which means flatten at the poles and bulges in the middle. The poles are located at the north and south ends of the Earth's axis, called rotation, causes day night to occur.

Evidences about Shape of the Earth

There are many ways to prove that the earth is *spherical*. The following are some of them:

1. Circumnavigation of the earth:

If you travel across the world along a straight path in a fast flying plane without stopping anywhere, you would come back to the same place from where you started. This is called circumnavigation. The fact is valid as the earth has shown circumnavigated for many times and finding the voyage ending to the original point.

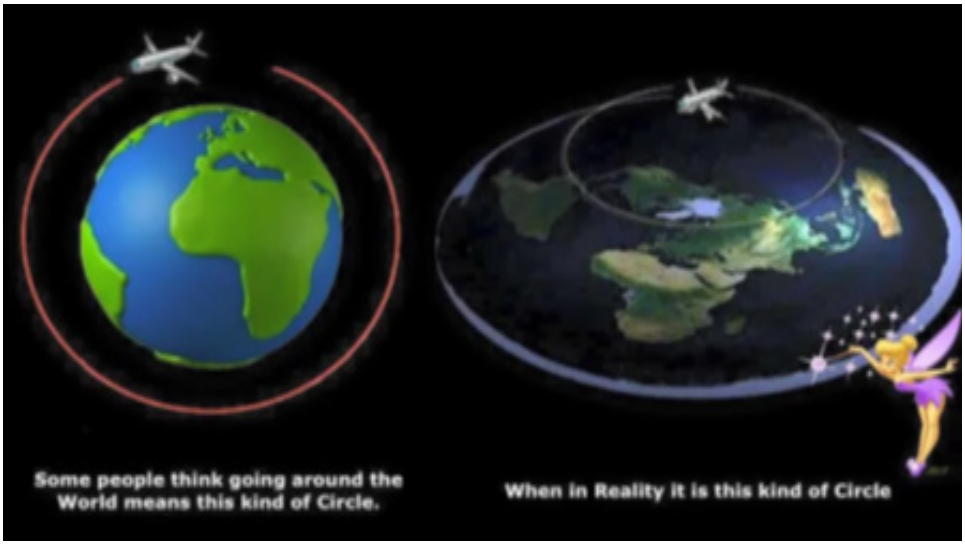


Figure 6.4. different assumptions about the earth when flaying plane

2. Earth's curved horizon –

The earth's horizon when seen from a ship, a plane, or a high cliff appears curved. The curved horizon widens as the observers altitude increases until it becomes circular. If the earth were not spherical, there would be no circular horizon. The curvature of the horizon is influenced by the curvature of the earth's surface.

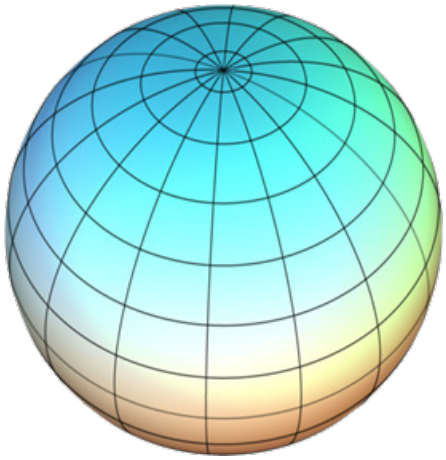


Figure: 6.3. Oblate spheroid Shape of the Earth

3. Ship's visibility:

When two ships on the same line of observation are coming towards the observer while maintaining a considerable distance, the front Ship will be seen before the ship at the back. If the earth's surface were flat, both ships could be seen at the same time.Provides a fact that the water body of sea overlies the surface which is not flat, but spherical in shape, hence the earth is spherical in shape.

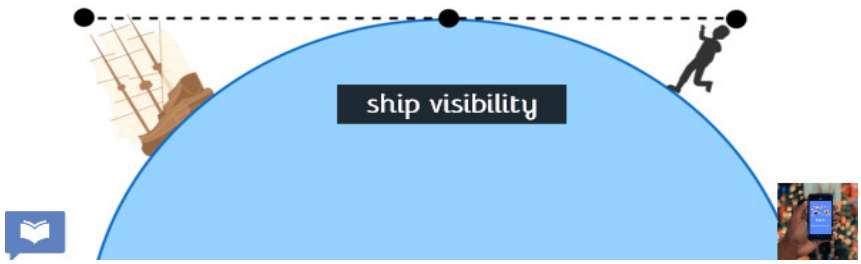


Figure 6.5. Ship's visibility

4. Sun rise and sun set:

The sun rises and sets at different times in different places. As the earth rotates from west to east, places in the east see the sun earlier than those in the west. If the earth were flat, the whole world would have sunrise and sunset at the same time. But we know this is not happen because of spherical the shape of the earth.

5. The lunar eclipse:

The shadow cast by the earth on the moon during a lunar eclipse is always circular. It takes the outline of an arc of a circle. Only a sphere can cast such a circular shadow as shown in figure 6.6

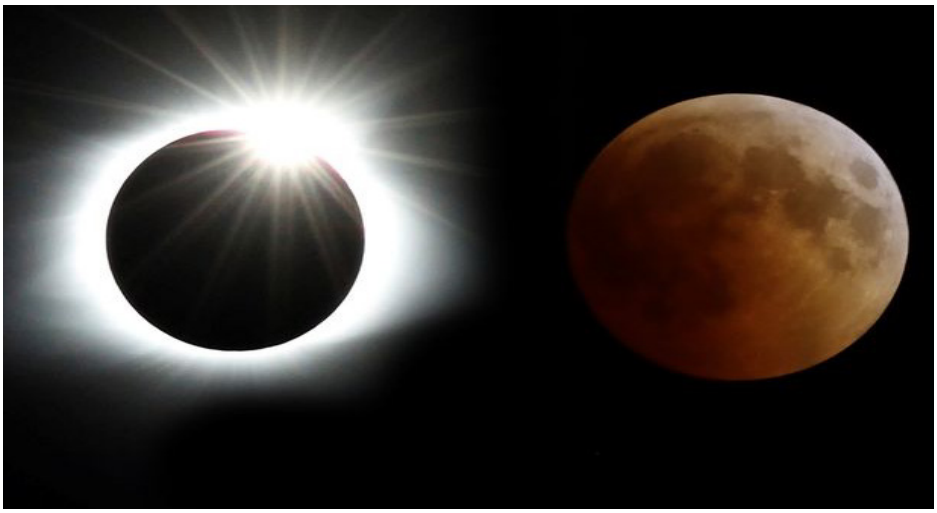


Figure 6.6. The position of the Sun, moon and earth, in an eclipse

6. Driving poles on level ground on a curved earth:

Engineers when driving poles of equal length at regular intervals on the ground have found they do not give a perfect horizontal level.

The centre pole normally projects slightly above the poles at either end because of the curvature of the earth. Surveyors and field engineers therefore have to make certain corrections for this inevitable curvature, i.e. 12.6 cm to 1 km.

7. Space photographs:

Pictures taken from high altitudes by rockets and satellites show clearly the curved edge of the earth. This is perhaps the most convincing and the most up-to-date proof of the earth's sphericity.

8. The changing altitude of the sun-

In the morning and evening the sun observed to be at low level while at noon the sun observed to be at a high level. So long the sun is at constant position in the sky; this provides a clear clue that the earth planet is spherical in shape.

Exercise 6.1.1

I. Choose the best answers for the following questions

1. The Earth's actual shape is most correctly described as

   A. a perfect sphere
   B. a circle
   C. an oblate sphere
   D. an eccentric ellipse

2. Which object best represents a true scale model of the shape of the Earth?

   E. a Ping-Pong ball
   F. an egg
   G. a football
   H. a pear

1. The shape of the earth is

A. egg shaped
B. spherical
C. Angular
D. Flat

II. Short answer questions.

1. Identify evidences supporting the shape of the earth
2. List local and global ideas about the shape of the earth

6.1.2. Dimensions of the Earth

Q. How big is Earth?

Activity 6.2

Form a group and discuss about:-

- circumference, diameters and angular distances of the earth. Then present your discussion to the whole class.

The dimension of the earth can be expressed in terms of radius, diameter, circumference, density, mass, time and volume. Earth, is one of the eight planets and its average distance to the sun is 1 AU (1.496 × 108 km). Its diameter (the distance from one side to the other through Earth's center) is about 12,756 kilometers) and a polar diameter of 12,714 km and its mass is 5.974 × 1024 kg.

Earth's circumference (the distance all the way around the equator) is (40,075 kilometers); however, from pole to pole the meridional circumference Earth is only 40,008 km around. The Earth's diameter is also wider at the Equator, creating a phenomenon called an ***equatorial bulge***.

The orbital and rotational period of planet Earth is ***365.256 days 23.9345 hours***, respectively. (**Source**: ***Ethiopian Space Science and Technology Institute***)

Angular distance: is (also known as angular separation, apparent distance, or apparent separation) is the angle between the two sightlines, or between two point objects as viewed from an observer. Latitude is the angular distance measured with

respect to a central point along a plane passed through the earth at the position of the earth's largest circumference. It denotes a geographical coordinate of a place located on the surface of the earth and is the angular distance of that point (north or south of the equator) measured with respect to the Centre of the Earth. Its value is zero at equator and 90 degrees at poles.

Key Terms

- ***Equatorial diameter:-*** is longer than polar diameter (12,756 km)
- ***Polar diameter:-*** is shorter than equatorial diameter (12,714 km)
- ***Equatorial circumference:-*** is longer than polar circumference (40,075km)
- ***Polar circumference:-*** is shorter than equatorial circumference (40,008 km around)

Exercise 6.1.2

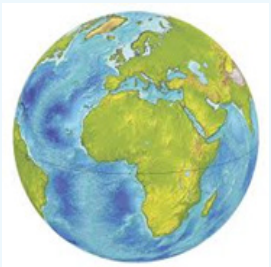
i. Fill the blank space

1. The Earth's diameter is also wider at the Equator, creating a phenomenon called an _____.
2. _____ is the angular distance measured with respect to a central point along a plane passed through the earth at the position of the earth's largest circumference.

ii. Short answer questions

3. What is the Precise measurements of the Earth?

   A. polar diameter
   B. Polar circumference
   C. Equatorial diameter
   D. Equatorial circumference



6.2. Parts of the Earth (Body and Atmosphere)

Learning Competency

At the end of this section, learners will able to:

- *Recognize all parts of the Earth*
- *Describe the organization and contents of the different parts of the Earth*
- *Explain different observations about the Earth in terms of the nature and behaviors of the different parts of the Earth.*

Activity 6.3.

Form a group and discus the following activities and present your discussion to the class.

1. What are the layers of the atmosphere?
2. In which layer we live on? And air plane fly?

Structure of the earth

Structure of the Earth is the layer, solid or mineral part of the Earth. The structure of the earth consists of

1. External structure (Outer zone) and
2. Internal structure (Inner zone)

6.2.1. External structure of the earth (Outer zone)

External structure of the earth consists of layers such as Atmosphere.

Atmosphere

Atmosphere is the thin layer of gases held on the earth by gravitation attraction. Earth's atmosphere is so much more than the air we breathe. It is composed by abiotic (non-living matter) and biotic (living organism). Non-living matter found in the atmosphere includes mixture of gases, water vapor and dust particles. Atmosphere consists of different gases such as carbon dioxide, oxygen, hydrogen, nitrogen and other gases. The living organism includes the smallest or microscopic organisms like bacteria.

Characteristics of atmosphere

Characteristics of atmosphere categorized into two groups as follow

a) According to its composition.

b) According to its vertical structure from the ground level in to interplanetary space.

The atmosphere of Earth is composed of nitrogen (about 78%), oxygen (about21%), argon (0.009%) and carbon dioxide (0.03%)and other gases include neon, helium, Krypton and xenon.

Earth's atmosphere has *five* major and several secondary layers according to contrasting *temperature* conditions in it with *altitude* from ground level are from *lowest to highest* are:

i) Troposphere
ii) Stratosphere
iii) Mesosphere
iv) Thermosphere and
v) Exosphere

I. Troposphere

The troposphere is the lowest layer of Earth's atmosphere- the part we live in. It contains most of our weather - clouds, rain, and snow. It contains about 75% of all of the air in the atmosphere, and almost all of the water vapor (which forms clouds and rain). The decrease in temperature with height is a result of the decreasing pressure.

So, air higher up is cooler than air lower down.

The lowest part of the troposphere is called the boundary layer. The top of the troposphere is called the tropopause. This is lowest at the poles, where it is about 7 - 10 km above the Earth's surface. It is highest (about 17 - 18 km) near the equator.

Air is warmest at the bottom of the troposphere near ground level. Air gets colder as one rises through the troposphere. That is why the peaks of tall mountains can be snow-covered even in the summertime.

II. Stratosphere

Stratosphere is the second layer of the atmosphere as you go upward. This extends upwards from the tropopause to about 50 km. It contains much of the ozone in the atmosphere. The increase in temperature with height occurs because of absorption of ultraviolet (UV) radiation from the sun by this ozone. Temperatures in the stratosphere are highest over the summer pole, and lowest over the winter pole. By absorbing dangerous UV radiation, the ozone in the stratosphere protects us from skin cancer and other health damage.

The Lower boundary of the stratosphere is called the ***tropopause***; the upper boundary is called the ***stratopause*** occurs at an altitude of 50 km

III. Mesosphere

The mesosphere is a layer of Earth's atmosphere. The mesosphere is directly above the Stratosphere and below the thermosphere. It extends from about 50 to 85 km above our planet. Temperature decreases with height throughout the mesosphere. The coldest temperatures In Earth's atmosphere, about -90° C at the "***mesopause***

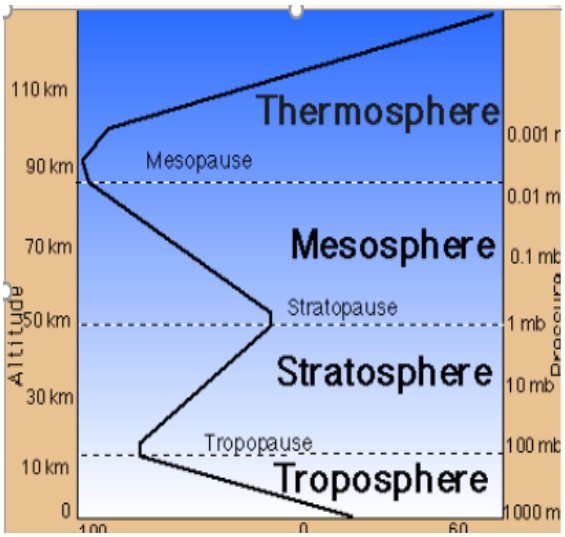
The boundary between the mesosphere and the thermosphere above it is called the ***Mesopause***. At the bottom of the mesosphere is the ***stratopause***, the boundary between the mesosphere and the stratosphere below.

IV. Thermosphere

The thermosphere lies above the mesopause, extends from about 90 km to between 500 and 1,000 km above our planet.it is a region in which temperatures again increase

with height. This temperature increase is caused by the absorption of energetic ultraviolet and X-Ray radiation from the sun. The temperature of the thermosphere varies between night and day and between the seasons.

The boundary between the thermosphere and the exosphere above it is called the **Thermopause**. At the bottom of the thermosphere is the **mesopause**, the boundary between the thermosphere and the mesosphere below.



V. Exosphere

Located between about 700 and 10,000 kilometers above Earth's surface, the exosphere is the highest layer of Earth's atmosphere.

Exercise 6.2.1.

I. Choose the best answer from the given alternatives.

1. The _____ is the outermost layer of Earth's atmosphere.

A. Troposphere
B. Exosphere
C. Stratosphere\
D. Thermosphere

2. What makes up nearly 78 percent of the Earth's atmosphere?

E. Oxygen
F. Nitrogen
G. Carbon dioxide
H. Nitrogen

3. What percentage of the earth's atmosphere does oxygen comprise?

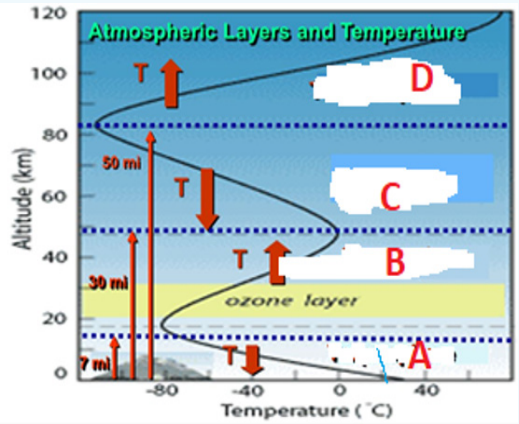
A. 75%
B. 50%
C. 21%
D. 32%

4. In which layer of our atmosphere weather occurs?

A. Troposphere
B. Exosphere
C. Stratosphere
D. Thermosphere

II. Short answer questions

1. The diagram below shows four layers of Earth's atmosphere.



State the name of each layer in the Earth's atmosphere

A. _____
B. _____
C. _____
D. _____

Internal Structure of the earth (Inner zone)

Earth's interior consists of three major zones defined by its chemical composition.

These are

i) Core
ii) Mantle
iii) Crust

i. The core

Earth's core is the very hot, very dense center of our planet. It is composed mainly of an iron and nickel alloy. The core is divided into inner and outer core.

The outer core is a liquid because the temperatures there are adequate to melt the

iron-nickel alloy. However, the inner core is a solid even though its temperature is higher than the outer core

ii. The mantle

The mantle is the thickest layer, lies between Earth's dense, super-heated core and its thin outer layer, the crust. It is a solid layer but acts like a viscous liquid due to temperatures being close to the melting point of key minerals in this layer.

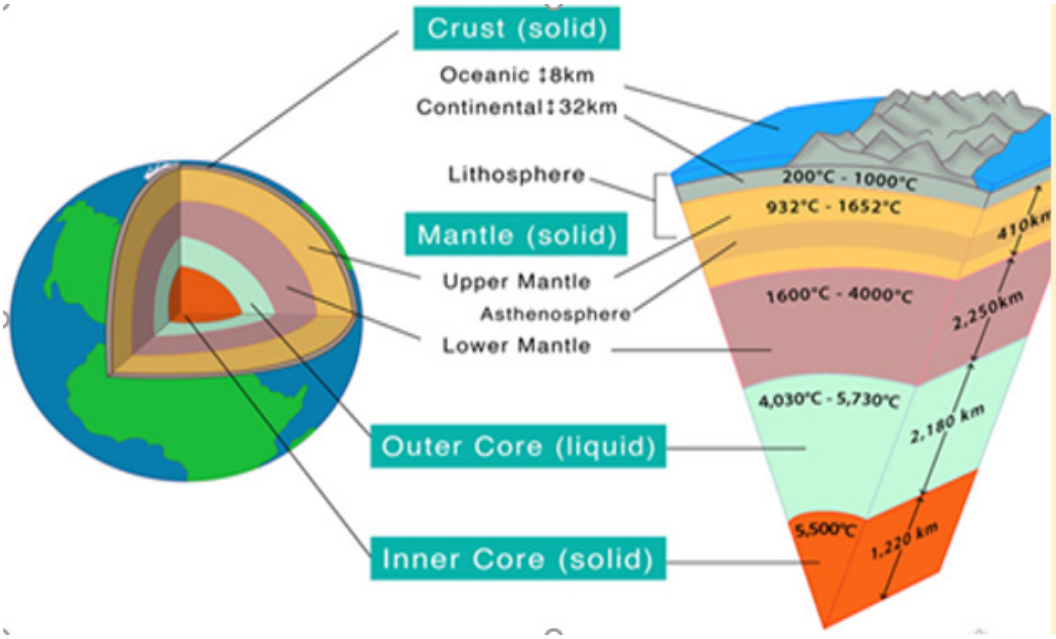


Figure : 6.8. Internal structure of the earth

Below the crust is the upper mantle, with the upper-most portion referred to as the asthenosphere. The upper mantle is liquid rock, and very hot. The lower mantle is the lower liquid portion of the mantle

Note: ***The*** *lithosphere is the solid, outer part of the Earth, including the brittle upper portion of the mantle and the crust.*

iii. The crust:

The Earth crust is the outside and coldest layer of the earth and is made of solid rock,

mostly basalt and granite. It is the thinnest layer and forms the outer shell on which life exists. There are two types of crust; oceanic and continental.

Oceanic crust is denser, 5 to 10 kilometers thick and mainly composed of basalt. However, Continental crust is less dense, thicker, the upper layer of the earth crust and mainly composed of granite.

Project work 6.2:

making a module of solid Earth layers

Using 5 colors of modeling clay and waxed dental floss make in group a module of solid Earth layers and show the model to your teacher.

Directions

- waxed dental floss
- Form a ball to represent the inner core. We chose red to represent the intense heat of the inner core.
- Next, roll out a circle of another color and wrap around the ball and roll gently. This next layer represents the outer core.
- Each subsequent color will need more modeling clay than the last. You will need a color to represent the lower mantle, another for the upper mantle, and the outer layer for the crust.
- Once your ball of 5 layers of modeling clay is complete, use a piece of waxed dental floss to cut the ball down the middle, revealing all the layers underneath.

*Be sure not to press the layers too ***firmly together so that the colors don't mix.***

Exercise 6.2.

I. Fill the blank space

1. The boundary between the mesosphere and the thermosphere above it is called _____.
2. _____is located at the bottom of the mesosphere and the boundary between the mesosphere and the stratosphere below.
3. Lower boundary of the stratosphere is called the _____.
4. Upper boundary of the stratosphere is called the _____.

II. Choose the best answer from the given alternatives.

1. Which layer of the earth is solid?

   E. Inner mantle and inner core
   G. Crust and the inner core
   F. Crust and outer core.

2. Which layer of the earth is liquid?

   H. The outer core
   J. Crust and outer core.
   I. Mantle crust & the inner core

3. Which layer of the earth is both solid and liquid?

   K. Mantle
   L. Crust
   M. Core

4. What do we call the center of the Earth?

   N. Mantle
   O. Crust
   P. Core

5. What is the outermost layer of the Earth that consists of the continents and the oceans?

   Q. Mantle
   R. Crust
   S. Core

6. What is the layer of rock between the Earth's outer core and crust?

   T. Core
   U. Mantle
   V. Crust

7. What do we call the crust that makes up the continents (land)?

A. Tectonic plates
B. Oceanic crust
C. Continental crust

8. The hottest layer of the Earth is:

A. Mantle
B. Inner core
C. Outer core

6.3. Earth's movements

Learning Competency

At the end of this section, learners will able to:

- *demonstrate movements of the Earth (revolution and rotation)*
- *explain the effects of motions of the Earth.*
- *construct the model of Earth and use it to explain phenomena related to its motion*

The Earth is in motion all the time. People cannot feel this motion because they move with it like all other planets. There are two types of movements of the earth, namely:

1. The rotation of the Earth on its own axis
2. The revolution of the Earth around the Sun

Activity 6.4

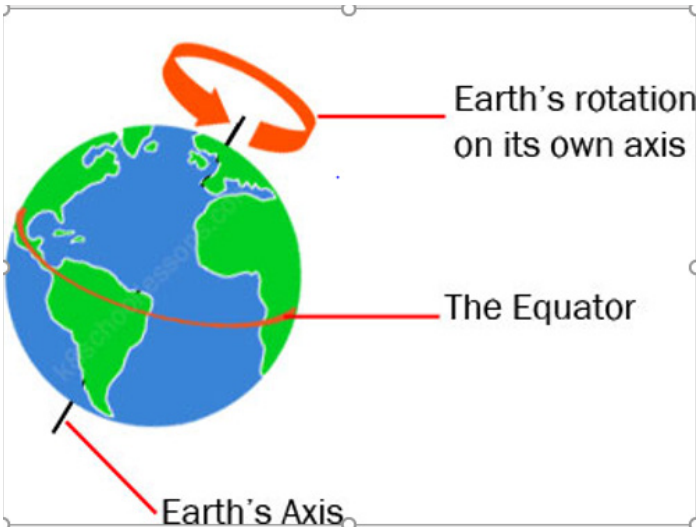
Form a group and discuss the following phenomena.

iii) Why do not we feel when the Earth moves?
iv) What would happen if the Earth didn't rotate?

Share your views with the rest of the class

6.3.1. Rotation of Earth

Earth Rotation is the motion of the earth around its axis of rotation. Imagine a line passing through the center of Earth that goes through both the North Pole and the South Pole. This imaginary line is called an **axis**. Earth spins around its axis, just as a top spins around its spindle. This spinning movement is called Earth's **rotation**. It is rotating on its axis from west to east. An observer in space will see that Earth requires 23 hours, 56 minutes, and 4 seconds to make one complete rotation on its axis. Hence the length of a day on Earth is actually 24 hours.



Effects of motions of the Earth

The rotation of the Earth has the following effects:

- The spinning of the earth on its axis causes days turn into nights.
- A difference of one hour is created between two meridians which are 15 degrees apart.
- A change in the direction of wind and ocean currents. Winds and ocean currents deflect to the right in the Northern Hemisphere and to the left in the Southern Hemisphere as a result of rotation.
- The rise and fall of tided every day.

6.3.2. Revolution of the Earth

Earth Revolution is the motion of the earth around the sun. For Earth to make one complete revolution around the Sun takes 365.24 days. This amount of time is the definition of one year.

Nicolaus Copernicus was a Polish astronomer known as the father of modern astronomy. He was the first modern European scientist to propose that Earth and other planets revolve around the sun, or the Heliocentric Theory of the universe.

The closest Earth gets to the Sun each year is at perihelion (147 million km) on about January 3rd and the furthest is at aphelion (152 million km) on July 4th. Earth's elliptical orbit has nothing to do with Earth's seasons. During one revolution around the Sun, Earth travels at an average distance of about 150 million km. Earth revolves around the Sun at an average speed of about 27 km (17 mi) per second, but the speed is not constant. The planet moves slower when it is at aphelion and faster when it is at perihelion. The reason the Earth has seasons is that Earth is tilted 23 ½ degree on its axis. During the Northern Hemisphere summer the North Pole points toward the Sun and in the Northern Hemisphere winter the North Pole is tilted away from the Sun.

Note: The farthest (maximum distance) position from the sun in orbit of the earth is called aphelion while the nearest position of the earth to the Sun is known as perihelion

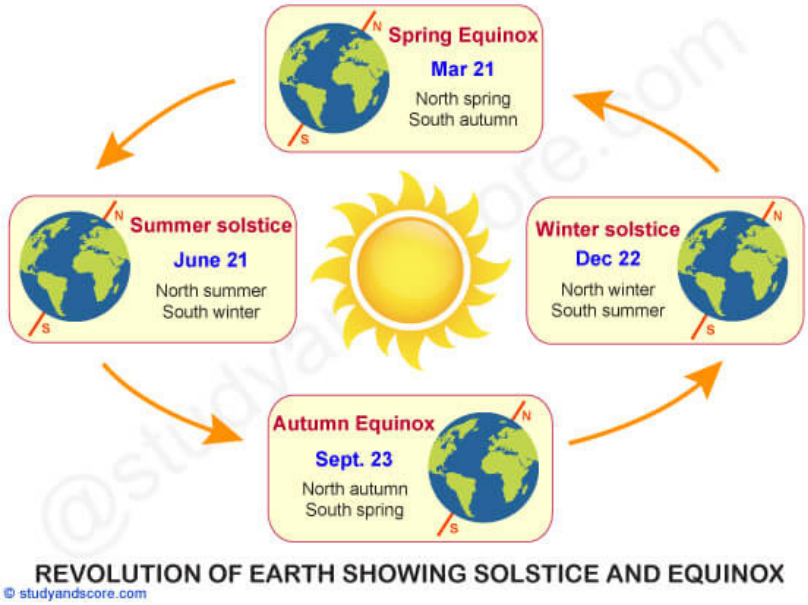


Figure 6.10 ***Revolution of the Earth***

At the equator, Earth spins at just over 1,000 miles per hour. Earth makes a full spin around its axis once every 24 hours, or one day. The axis is an imaginary line through the center of the planet from the North Pole to the South Pole. Rather than straight up and down, Earth's axis is tilted at an angle of 23.5 degrees. Earth has seasons because its axis is tilted. Thus, the sun's rays hit different parts of the planet more directly depending on the time of year.

- From June to August, the sun's rays hit the Northern Hemisphere more directly than the Southern Hemisphere. The result is warm (summer) weather in the Northern Hemisphere and cold (winter) weather in the Southern Hemisphere.
- From December to February, the sun's rays hit the Northern Hemisphere less directly than the Southern Hemisphere. The result is cold (winter) weather in the Northern Hemisphere and warm (summer) weather in the Southern Hemisphere.
- From September to November, the sun shines equally on both hemispheres. The result is fall in the Northern Hemisphere and spring in the Southern Hemisphere.

- The sun also shines equally on both hemispheres from March to May. The result is spring in the Northern Hemisphere and fall in the Southern Hemisphere.

Difference between Rotation and Revolution

The table 6.1 given below provides the basic differences between rotation and revolution.

Rotation	Revolution
Rotation of the Earth is its turning on its axis.	Revolution is the movement of the Earth around the Sun.
The Earth takes 24 hours to complete a rotation with respect to the sun.	The Earth takes a full year (365 days) for one complete revolution around the Sun
The Earth's axis of rotation is tilted by 23.5 degrees. This tilt causes the different seasons of the year.	The path of the Earth moving around the Sun is called an orbit. The Earth's orbit is elliptical.

Exercise 6.3

I. Fill the blank space

1. Earth _____ around the sun.
2. Day and night are the result of Earth's _____
3. Seasons are the result of Earth _____ toward or away from the sun.

II. Choose the best answer from the given alternatives.

1. Which of the following is NOT a factor affecting Earth's seasons and climate?

   A. Earth's orbital revolution around the sun
   B. Earth's axis tilt
   C. Earth's distance from the sun
   D. Earth's wind and ocean current patterns

2. How long the Earth takes to complete one a rotation on its axis?

   A. 24 hours
   B. 12 hours
   C. 1 hour
   D. 6 hours

- Earth science
- Earth
- Inner core
- Geologists
- Lunar eclipses
- Oblate spheroid
- Atmosphere
- Troposphere
- Stratosphere
- Mesosphere
- Exosphere
- Thermosphere
- Geosphere
- lithosphere
- revolution
- rotation
- Crust
- Mantle
- Biosphere
- Hydrosphere
- Core
- Eratosthenes' methods
- Biogeochemical Cycle
- Continental drift

Unit Summary

- *Earth is the only planet in the universe to support life. It is about 150 million kilometers from the sun. This distance, called an astronomical unit (AU), is a standard unit of measurement in astronomy.*
- *Earth is an oblate spheroid. This means it is spherical in shape, but not perfectly round. The geoid describes the model shape of Earth, and is used to calculate precise surface locations.*
- *The equatorial circumference of the Earth is 40,075 km. This is the distance around the equator of the Earth. If you measure the circumference of the Earth, while passing through the poles, the distance is only 40,008 km. This is because the Earth is not a perfect sphere. It's rotating rapidly, which causes the equator to bulge out.*
- *The equatorial diameter of the Earth is 12,756 km. This is the diameter of the Earth measured from one side of the Earth, passing through the center. If you go from pole to pole through the center, the distance is only 12,714 km.*
- *The 4 components of the Earth subsystems are called "spheres." Specifically, they are the "lithosphere" (land), "hydrosphere" (water), "biosphere" (living things), and "atmosphere" (air).*
- *Earth's interior is divided into three major layers: the crust, the mantle, and the core. Each layer has a unique chemical composition, physical state, and can impact life on Earth's surface.*
- *Rotation and Revolution are two motions of the earth. When earth spins or rotates around its axis, that movement of spinning is called Rotation of Earth. And when earth spins or revolves around the sun, that movement is called Revolution of Earth.*
- *The motions of the earth have its own effects. Those are: the main effects of the Earth's rotation are a diurnal cycle of light and darkness, i.e. day and night, rise and fall of the sea level twice a day, sunrise in the east and sunset in the west. Effects of Earth's revolution include the seasons and variation in the length of days and nights.*
- *Earth's surface systems involve many cycles, Cycles that exchange materials among living and nonliving components of the Earth are known as biogeochemical cycles.*

Unit Exercise

Cope and answer the following questions

I. Write True if the statement is Correct and False if the statement if incorrect.

1. Atmosphere is the thin layer of gases held on the earth by gravitation attraction.
2. Earth rotates around the sun.
3. Day and night are the results of Earth's rotation.
4. We live on the core of the Earth.

II. Match the following earth spheres with their related meaning

Column 'A'	Column 'B'
1. Lithosphere	A. all of Earth's water
2. Hydrosphere	B. all living things
3. Atmosphere	C. all of the rocks and "hard parts" of the Earth
4. Biosphere	D. the blanket of gases surrounding the planet

III. Fill the blank space

Use these words to fill in the blanks next to the sentences below.

Words	365.25 days	Revolution	24 hours
	Season	Rotation	Axis

1. _____ the amount of time for Earth to make a complete rotation.
2. _____ the process of Earth spinning on its axis.
3. _____ the amount of time it takes Earth to completely orbit the sun.
4. _____ the process of Earth orbiting the sun.
5. _____ An imaginary line that runs through the center of Earth from the North Pole to the South Pole.
6. _____ Term used to describe a certain time of year.
7. _____ The number of days in a year on Earth.

IV. Choose the best answer from the given alternatives

1. An example of Biosphere connecting to Atmosphere

   A. plants produce oxygen
   B. animals eat plants
   C. animals live in caves
   D. animals drink water

2. What is Earth's outermost system?

   A. Atmosphere
   B. Cryosphere
   C. Hydrosphere
   D. Geosphere

3. The earth's four systems are:

   A. independent from one another
   B. all connected
   C. all part of the atmosphere
   D. not important for life on earth

4. Photosynthesis is an example of an interaction between the biosphere and the:

   A. Atmosphere
   B. Cryosphere
   C. Geosphere
   D. hydrosphere

5. What is Earth's largest system?

   A. Biosphere
   B. Hydrosphere
   C. Geosphere
   D. Atmosphere

6. The Earth is slightly flattened from a perfect spherical shape because of

   A. its rotation
   B. storms on the sun's surface.
   C. the pull of the sun and moon
   D. its molten core

7. As altitude within the troposphere increases, the amount of water vapor generally

A. decreases, only
B. increases, only
C. remains the same
D. decreases, then increases

8. Oxygen is the most abundant element by volume in Earth's

A. Hydrosphere
B. troposphere
C. crust
D. inner core

9. An observer watching a sailing ship at sea notes that the ship appears to be "sinking" as it moves away. Which statement best explains this observation?

A. The Earth is revolving.
B. The Earth has a curved surface.
C. The Earth is rotating.
D. The surface of the ocean has depressions.

10. In which two Earth regions is oxygen the second most abundant element by volume?

A. crust and hydrosphere.
B. troposphere and core.
C. core and crust
D. hydrosphere and troposphere

11. What is the approximate elevation of the stratopause?

A. 10 km
B. 80 km
C. 30 km
D. 50 km

12. The best evidence that the Earth has a spherical shape is provided by

A. photographs of the Earth taken from space satellites
B. the amount of daylight received at the North Pole on June 21
C. the changing orbital speed of the Earth in its orbit around the Sun
D. the cyclic change of seasons

13. This is true for flat earthers beliefs EXCEPT

A. Round earth is a conspiracy
B. Planes fly in straight lines
C. The earth is a flat disc
D. Photographs were photoshopped

V. Short answer type questions.

1. Write the Earth's atmosphere From lowest to highest dissipate in space.
2. What are the three layers of Earth explain?
3. What are the two movements of the earth?
4. Who discovered rotation of Earth?
5. What is the role of the carbon cycle?

Self Assessment

Check List

Competencies given below are expected to be achieved in this unit by students. You are required to respond by saying Yes or No. Put a tick (√) mark under "Yes" column if you are able to perform the competency or under "No" column if you are unable to perform the competency.

This would help to evaluate yourself and you can revise the parts of topics for which the competencies are not met.

No.	Can I	Yes	No
1	*Describe the shape of the Earth*		
2	*Identify evidences supporting the shape of the Earth*		
3	*List local and global ideas about the shape of the Earth*		
4	*Name dimensions (circumferences, diameters, and angular distances) of the Earth*		
5	*Recognize all parts of the Earth*		
6	*Describe the organization and contents of the different parts of the Earth*		
7	*Explain different observations about the Earth in terms of the nature and behaviors of the different parts of the Earth.*		
8	*Demonstrate movements of the Earth (revolution and rotation)*		
9	*Explain the effects of motions of the Earth.*		
10	*Construct the model of Earth and use it to explain phenomena related to its motion*		
11	*dentify atmospheric and lithospheric systems*		
12	*Explain their cycle effects of the Earth*		
13	*Describe the measuring techniques for too big (Earth) and to small (continental drift) quantities measurement and estimation*		

UNIT - 7

7. MOTION, FORCE, ENERGY AND ENERGY RESOURCES

Learning Outcomes

At the end of this unit, learners will able to:

- *describe the term motion*
- *identify types of motion (motion on straight line, circular motion, otary motion and curvilinear motion)*
- *show those types of motion in the class.*
- *explain the term force.*
- *demonstrate the pulling/pushing activity of force.*
- *explain gravitational force.*
- *list all effects of force*
- *demonstrate some effects of force.*
- *relate effects of force with their daily life experience*
- *name measuring device of force*
- *identify different measuring scales on measuring device of force*
- *explain parts of measuring device of force*

- *define energy as a property of matter that can be converted*
- *list all forms of energy*
- *explain which energy converted to other forms of energy.*
- *list sources of energy.*
- *distinguish between renewable and non-renewable forms of energy*
- *describe how energy is used wisely.*
- *list the strategies of conservation of energy*
- *explain resource depletion and environmental degradation.*

Main Conents

7.1. Definition and types of motion

Learning Competency

At the end of this section, learners will able to:

- *define motion as the change of position with time*
- *describe the types of motion.*
- *give examples for each type of motion*

Introduction

In this unit, you will be introduced to the basic concepts of motion, force, energy, forms and conservation of energy, wise use conservation of energy, resource depletion and environmental degradation.

7.1.1. Definition of Motion

When you go to your school, your journey begins from home. Your home is your original position and your school is your final position. While you are going, from home to school, you are increasing the gap between your present position and your home.

This continuous change of position is known as a ***motion***. Notice that your change of position is, observed by considering the distance from your school to home. Your home is taken as a reference frame.

Activity 7.1

Form a group and perform the following task; present your finding to the class.

1. Define motion by your own word and give examples.

2. When you move in bus describe are you at rest or in motion with respect to:

   i) The bus seat
   ii) The ground

Now let us understand motion clearly with the help of a few Examples:

- Our daily activities, like walking, running, closing the door, etc. involve motion. There is a change of position of the object involved in these activities.
- The flow of air in and out of our lungs is also an Example of motion.
- The automobiles that carry passengers from one place to another possess motion. In this case, the position of passengers is changed from one place to another.

Activity 7.2

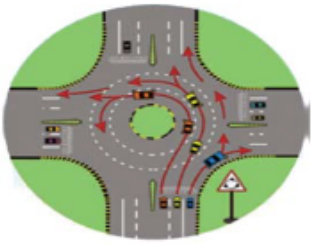
Form a group and perform the following tasks

i) Observe the motions indicated in Fig 7.1.
ii) Have you noticed any difference between the motions in
iii) Fig 7.1 (a-e)? Describe them.
iv) Group these motions, based on their path.

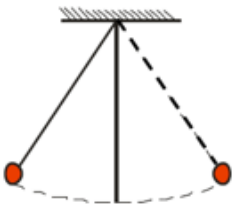
Types of Motion

A. Wrists watch.

B. A car moving on a straight line



C, Roundabout



D. Simple pendulum.

E. Motion of kids swing

Figure: 7.1. different types of motion

- In Fig 7.1 (a) you observe that the motion of second or minute hand of a wrist watch about an axis.
- In Fig 2.1 (b) you observe that a car is moving on a straight road. Its path is a straight line.
- Fig 2.1(c) shows that the path of the moving car is a curved line.
- While Fig 2.1 (c and d) show the 'to and fro' motions of an object.

According to the nature of the movement, or based on the path followed motion is classified into four types as follows:

1) Rectilinear Motion
2) Curvilinear Motion
3) Oscillatory Motion
4) Rotary Motion

1) Rectilinear Motion: Motion in a straight line is called rectilinear motion. In other words, when an object moves along a straight line path, it is called rectilinear motion.

Example: A boy walking on a straight road.

- A car moving in a straight road.
- A falling ball from a certain height.
- A boy pulling a toy towards him. etc.

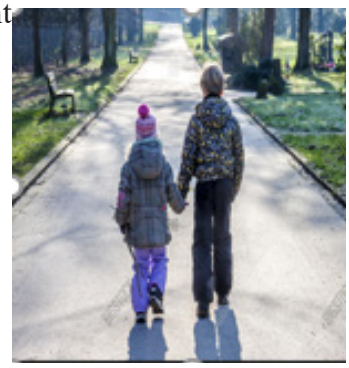


Figure 7.2 a boy and girl walking on a straight road

2) Curvilinear motion: The motion of a particle or object moving along a curved path is called curvilinear motion.

***Examples*:** Motion of a car around a circular path,

- The motion of a ball thrown horizontally from a certain height.
- The motion of the moon around the earth.
- Motion of a basketball into the basket, etc.

Figure 7.3 Motion of a basketball into the baske

Note: Circular motion is a special case of curvilinear motion, in which the body moves along a circular path.

Examples: of circular motion are:

- Movement of the earth on its axis,
- a bicycle or a car moving on circular track of park,
- The motion of the moon around the earth etc.

Figure 7.4 rotating wooden spinning top

3. Rotary Motion: A type of circular motion where an object spins on its own axis, it is called rotational motion.

***Example*:**

- rolling ball,
- Spinning top and
- the motion of the second or minute hand of a wrist watches etc.

3) **4. Oscillatory Motion:** A repeating motion in which an object continuously repeats in the same motion again and again is called ***Oscillatory Motion***. It is also a to and fro, back and forth or up and down motion. **Some of the best Examples of Oscillatory Motion are:**

- A swinging swing
- The motion of a pendulum
- A boat tossing up and down a river
- The tuning forketc

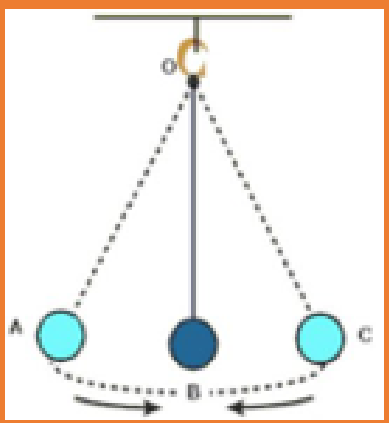


Figure 7.5 motion of a pendulum

Exercise 7.1

I. Choose the best answer from the given alternatives.

1. Which of the following is a type of motion?

A. Rectilinear motion
B. Rotary motion
C. Oscillatory motion
D. All of these

2. The motion of pendulum of a clock is an Example of which motion?

A. A.linear motion
B. Rotary motion
C. Oscillatory motion
D. All of these

3. The spinning of the body about its axis is

A. Rotatory
B. Circular
C. Translational
D. Vibratory

4. Which type of motion is "the pendulum of a wall clock moves at regular intervals" ?

A. Rectilinear
B. Vibratory
C. Rotatory
D. B and C

5. Which type of motion is "a train moving on a track" ?

A. Circular
B. Rectilinear
C. Rotary
D. None of the above

6. The act process or state of the change in place or position of a body with respect to time and relative to the observer is said to be_____.

A. Rest
B. Stationary
C. motion
D. none of the above

II. Short answer questions.

1. Define what a motion is.
2. State at least four types of motion, and give practical examples for each type.

7.2. Definition of Force and Gravitational Force

Learning Competency

At the end of this section, learners will able to:

- *explain the term force.*
- *demonstrate the pulling/pushing activity of force.*
- *explain gravitational force.*

7.2.1. Definitions of force

Activity 7.3

Form a group and perform the following activities Share your opinion to the whole class.

i) What is a force?
ii) Mention some examples of forces from your daily activities.
iii) Explain the following actions.

- A push you exert on a wall,
- A pull exerted to drag a box on a table.

All of us are familiar with the word force as we use it in our everyday life. Let us used to describe interactions between different bodies in nature.

For example when you kick a ball, tear a paper, bend a wire, hold a bag, walk on the floor, close and open a door, you apply a force.

A **force** is a push or pull upon an object resulting from the object›s interaction with another object. Whenever there is an interaction between two objects, there is a **force** upon each of the objects.

Forces influence objects that are at rest or that are already in motion. it can also be defined as an external agent which can change the state of rest or motion of a body

Figure 7.6(a) When a wagon pulled

Figure 7.6(b) When a wagon pushed

Note: ***Both rotary and vibrational motions are periodic motions. Periodic motions can have constant or non-constant velocities and they repeat themselves***

Fundamental forces are the basic forces in nature that cannot be explained by the action of another force. There are four types of fundamental forces. These include: The gravitational force, electromagnetic force, strong nuclear force and weak nucleus force.

7.2.2. Gravitational force

Activity 7.4

Form a group and discuss the following ideas. Present your discussion to the class.

- Throw a ball vertically upward and observe its motion. What will happen to the ball? Will it continue to move upward forever? Or not why?

We live on the Earth. It is difficult to get away from earth. If you jump upwards, you fall back down again. The earth's gravity pulls you down wards.

The earth's gravity causes a force that pulls any object down wards. This force is called weight (gravitational force).

Gravity always pulls you towards the center of the Earth. It doesn't matter where you are on the surface of the earth. Science, a freely falling body in the air moves down irrespective of its mass. This is due to force of gravity.

Example:

- Falling of fruits from trees due to Earth's gravitational pull
- The Earth's gravitational pull keeps us all stationary; otherwise, we all would be flying now.
- Revolution of the Earth around the Sun
- Revolution of the moon around the Earth

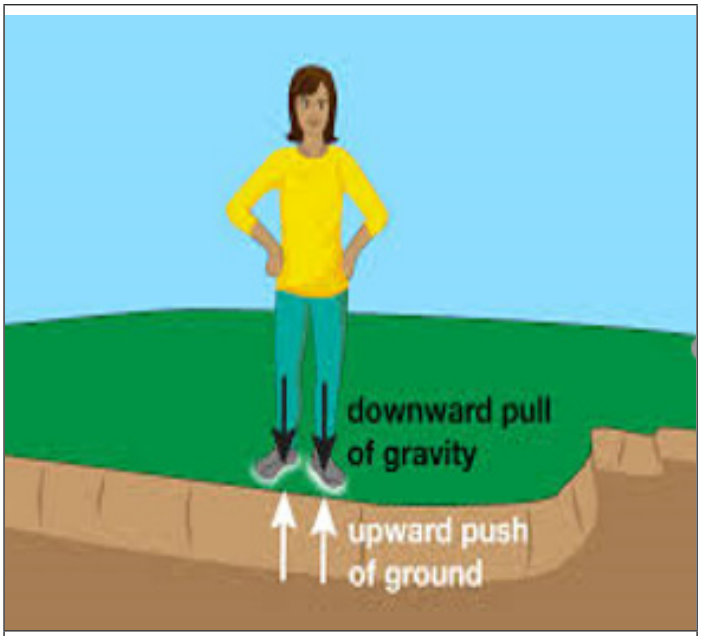
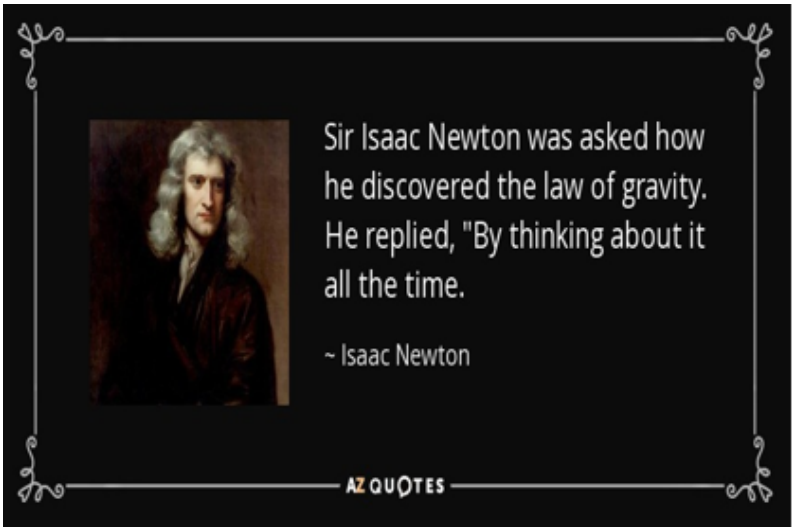
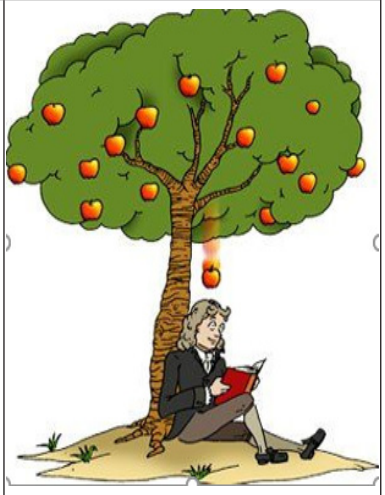


Figure 7.7. Our weight is caused by the pull of the earth's gravity



Sir Isaac Newton was an English mathematician and physicist who lived from 1642-1727. The legend is that Newton discovered Gravity when he saw a falling apple while thinking about the forces of nature. Whatever really happened, Newton realized that some force must be acting on falling objects like apples because otherwise they would not start moving from rest. Newton called this force "gravity" and determined that gravitational forces exist between all objects.



Key word

- Force is a push or pull of an object.
- Pull and push are opposite forces.
- Gravity is attractive force between objects with mass.
- Gravity always a pull never a push.
- Gravitational force is the force of attraction between all masses in the universe; especially the attraction of the earth's mass for bodies near its surface.

Exercise 7.2

I. Fill in the blank spaces with the appropriate word(s).

1. _____ is the force of attraction that acts between all objects in the universe, without exception.
2. Push or pull of an object in a certain direction is known as _____.

II. Choose the best answer from the given alternatives.

1. The force of gravity on a person or object at the surface of a planet is called .

   A. Mass
   B. Gravity
   C. Weight
   D. Motion

2. The force that pulls objects toward Earth is called

   A. mass
   B. gravity
   C. air
   D. wind

3. Which one of the following best describes a gravitational force?

   A. A repulsive force between any two objects with mass
   B. A force of attraction between two objects with mass
   C. A force between any two objects whether/not they have mass or energy
   D. All of the above

III. Short answer questions

1. Define the term Force as a science with appropriate examples with your daily life.
2. Explain gravitational force

7.3. Effects of force

Learning Competency

At the end of this section, learners will able to:

- *list all effects of force*
- *demonstrate some effects of force.*
- *relate effects of force with their daily life experience*

Activity 7.5.

Observe the activities shown in Figure 7.4

1) Explain the effects of forces in each activity.
2) List and show other effects of force in the class in front of the students.

a. When force is applied on flour dough, it changes its shape

c. The force of brakes can stop a moving car

b. When the person kicks the ball the ball Moves in the direction of the force

d. A goal keeper applies a force and stops the ball

Figure 7.8. Different effects of forces

***Force has the following main effects, when it is exerted on an object*:**

- A force can move a stationary object

Example: when a force is applied to a stationary tennis ball, it will make the ball continue its motion in the direction of the applied force.

- A force can change the speed of a moving object.

Example: When we keep on pedaling the pedal of the bicycle, the speed of the bicycle increases. And when we apply the brake, the speed of the bicycle decreases.

- *A force can either stop or slow down the moving object*.

Example: The force of brakes can stop a moving car.

- A force can change the direction of a moving object.

Example: the direction of the moving football can be changed by applying force at an angle.

- A force can change the shape of an object.

Example: When force is applied on flour dough, it changes its shape.

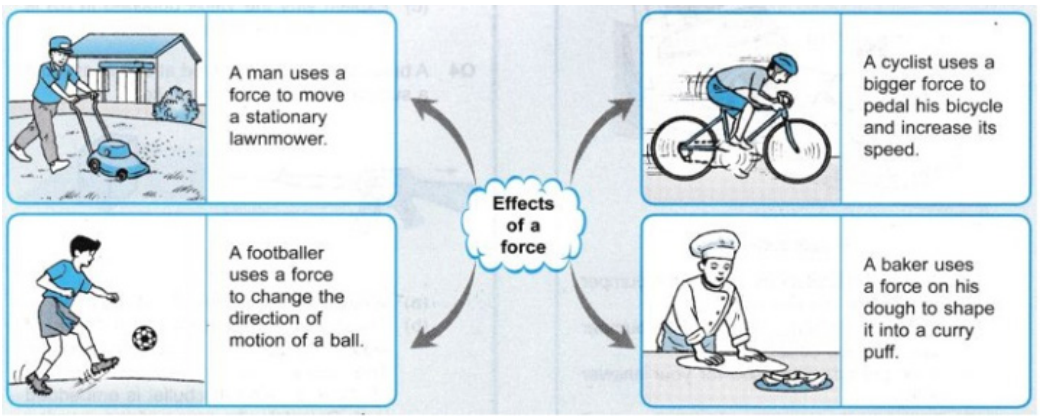


Figure 7.9. Some Effect of force on daily activities

Q. How effect of force is related with the daily life?

We are very familiar with the various effects of force in our everyday life. Like we walk, we run, we play, and we sit or at even times stand. In all of these activities, we

have all seen the changing of the motion of the state. Some additional the examples are:

- Pushing a wheel barrow.
- Opening or closing a door.
- Squeezing wet clothes.
- Gravitational force.
- Brakes applied to stop a moving vehicle.
- A football kicked
- Rubbing a glass rod with a silk.
- Running and Pushing etc

.

Exercise 7.3

I. Choose the best answer from the given alternatives .

1. Which one of the following is the effects of force, when it is exerted on an object ?

A. change the speed of a moving object
B. move a stationary object
C. change the shape of an object
D. All of the above .

2. If two forces from opposite direction are applied on an object and the object is malleable, it will change its shape .

A. Change in color.
B. Change in motion
C. Change in direction
D. Change in shape

3. To squeeze toothpaste or press a lift button we apply

A. heat
B. signal
C. force
D. station

4. A force can act on a stationary object and can cause it to

A. more
B. grow
C. develop
D. stationary

II. Short answer questions

1. List and describe some effects of a force.

7.4. Measuring forces

Learning Competency

At the end of this section, learners will able to:

- *name measuring device of force*
- *identify different measuring scales on measuring device of force*
- *explain parts of measuring device of force*

In science, if we want to know that one force is bigger than another we do not simply guess; we make measurements. How can we measure forces?

To measure the amount of force exerted on an object we use an instrument ***Newton meter (force meter) also called spring balance.*** *But* **Newton meter** is the scientific instrument used to measure a force.

Parts of Spring balance

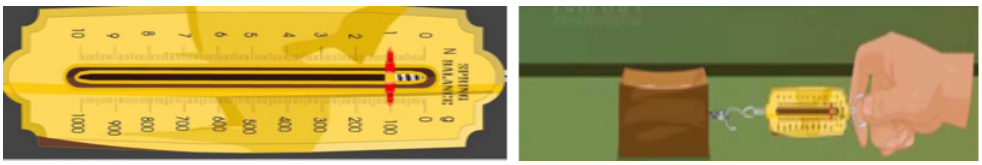


Figure 7.11 Measuring pull of force

Activity 7.6

Discuss the following activity in your group and present your discussion to the class.

- What is the instrument used to measure a force?
- Explain parts of measuring device of force.
- Can we use spring balance to measure mass when a shopkeeper measure banana, orange or others?

- ***Spring balance***: Scale made up of a hook attached to a spring that stretches in proportion to the weight of the object being weighed.
- **Hook:** Curved part on which the body to be weighed is hung.
- **Graduated scale**: The divisions of equal length that are marked on the spring balance and constitute the units of measurement.
- **Pointer**: Pointer connected to the spring that moves along a graduated scale to indicate the weight of the body being weighed.

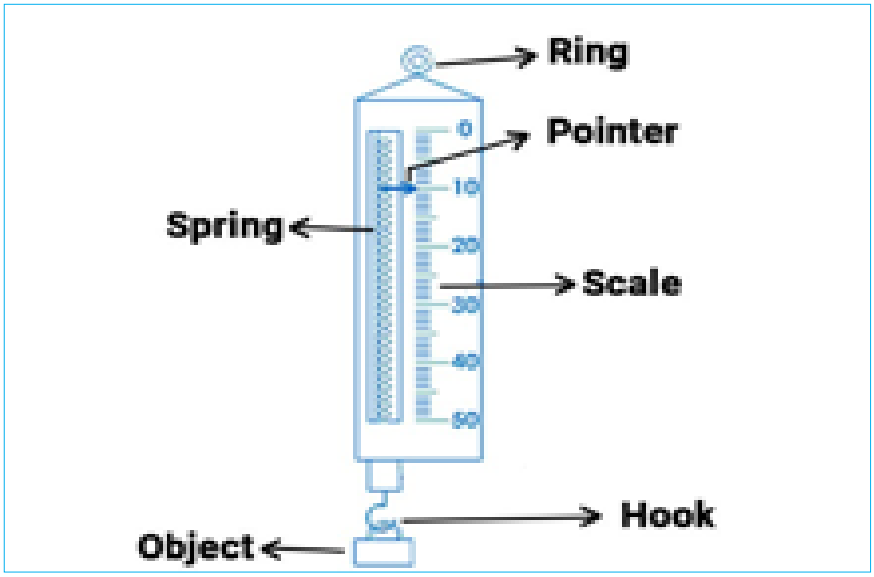


Figure 7.10. Spring balance

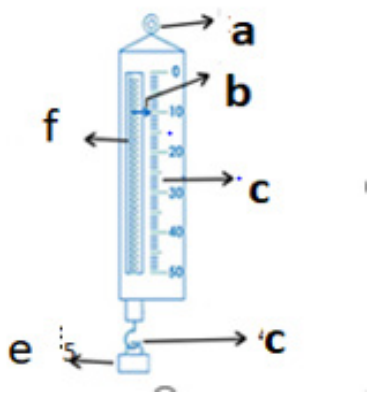
Figure 7.11 shows how you to measure the force needed to pull a block of wood along the bench.

- Check that the force meter reads zero before you start.
- Attach the hook of the force meter to the block.
- Hold the ring at the other end of the force meter and pull the block.
- Read the value of the force from the scale.

Exercise 7.4

I. Fill in the blank spaces with the appropriate word(s).

1. A force is measured using an instrument called _____.
2. _____is a curved part of force meter on which the body to be weighed is hung.
3. The diagram shows parts of newton meter name parts of the arrow that represented by numbers.



1. a) _____
2. b) _____
3. c) _____
4. d) _____
5. e) _____
6. f) _____

7.5. Definition of Energy (Property of matter can be converted)

Learning Competency

At the end of this section, learners will able to:

- *define energy as a property of matter that can be converted*

In unit two of this book you learned important concepts about matter. In this section you will learn the concepts of energy. Matter is the substance of which all material is made.

Energy is a very common word frequently used in our day-to-day life. It has a much wide scope than it will be implied in this unit. Energy in this unit is limited to define as a property of matter only.

Energy is the property of matter, and it comes in many forms, such as heat, sound, light, and motion. It can be transferred between objects, and converted in form. It cannot be created or destroyed.

Project work 7.1

By using internet explorer or other reference materials perform the following tasks in group and present your findings to the class.

i) Define energy as a property of matter.
ii) Explain with examples how

Examples of energy and matter

- A raindrop falling from the sky is made of matter (water), plus it has potential, kinetic, and thermal energy.
- Alit light bulb is made of matter, plus it emits energy in the form of heat and light.

The wind consists of matter (gases in air, dust, pollen), plus it has kinetic and thermal energy.

Exercise 7.5

I. Fill in the blank spaces with the appropriate word(s).

1. _____is the property of mater, and it comes in many forms.
2. _____ is the substance of which all material is made.
3. Alit light bulb is made of matter, plus it emits energy in the form _____ and _____.

7.6. Forms and Conversion of Energy

Learning Competency

At the end of this section, learners will able to:

- *list all forms of energy*
- *explain which energy converted to other forms of energy*

Forms of energy

The world we live in provides us with many different forms of energy.

Examples of these are: *light energy, heat energy, mechanical energy, gravitational energy, kinetic energy, potential energy, thermal energy, and electrical energy, sound energy, chemical energy, nuclear or atomic energy, elastic potential energy and so on.*

We can think energy coming in different forms, some for storing and some for transferring.

Activity7.7

Discuss the following questions in a group and present your opinion to the whole class.

i) List all different forms of energy.

ii) Define conversion of energy and give examples which energy is converted to other forms of energy.

The table 7.1 shows some different forms of energy and their descriptions.

Form of energy	Description
Chemical energy	Energy of a chemical substance.
Elastic energy	Energy of a stretched or squashed object
Electrical energy	Energy carried by electricity
Gravitational potential energy	Energy of an object that has been lifted
Heat energy	Energy spreading out from a hot object
Kinetic energy	Energy of a moving object
Light energy	Energy spreading out from a bright object
Thermal energy	Energy of a hot object
Sound energy	Energy coming from a vibrating source

Energy conversions

Energy can be changed from one form to another. The process of changing energy from one form to another form is called ***energy conversion***. A very common energy conversion is a change from gravitational potential energy to kinetic energy. This occurs whenever an object falls due to the force of gravity. Each form can be converted or changed into the other forms. The notion of energy is that energy is changed from one form into different forms using transducers. ***Transducer*** is a device used to transform energy from one form to another. **For example**:

1. Battery converts chemical energy into electrical energy.
2. A generator converts mechanical energy into electrical energy.
3. A motor converts electrical energy into mechanical energy.

The Table7.2 Summarizing Energy Conversion from one form to another

Original energy	Transducer	Energy transformed
Chemical energy	Battery	Electrical energy
Chemical energy	Motor	Chemical energy
Mechanical energy	Generator	Electrical energy
Solar energy	Solar panel	Electrical energy
Chemical energy	Motor car	Mechanical energy
Electrical energy	Microphone	Sound energy
Electrical energy	Heater	Heat energy

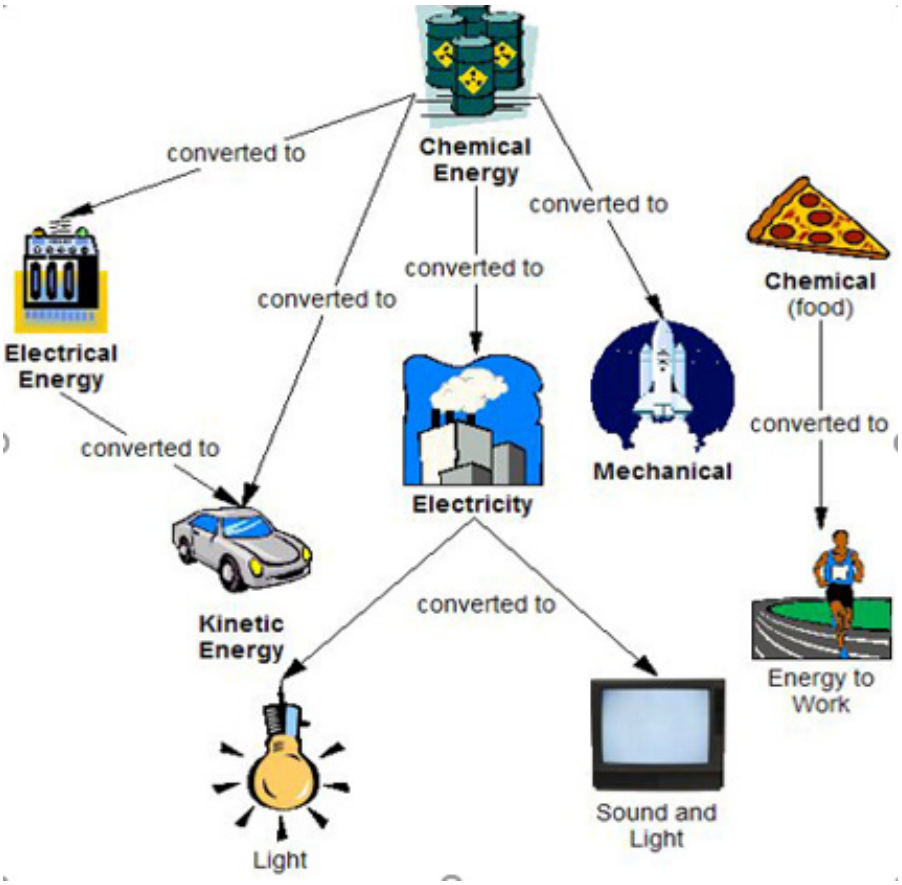


Figure 7.12 energy conversion

Exercise 7.6

I. Choose the best answer from the following alternatives

1. One of the following is not form of energy?

A. Light
B. Sound
C. Kinetic
D. Weight

2. The process of changing energy from one form to another form is called

A. energy conversion
B. energy conservation
C. energy depilation
D. energy degradation

3. Which One of the following is a form of energy?

A. Chemical
B. Solar
C. Electrical
D. All of the these

II. Complete the table

1. Energy can be transferred in different ways. Copy the table and use words from the list to complete the first column.

- Chemical energy
- Electrical energy
- Mechanical energy

Original energy	Transducer	Energy transformed
	Microphone	Sound energy
	Generator	Electrical energy
	Battery	Electrical energy

7.7. Energy Sources (sun, fuel, hydroelectric, wind, nuclear)

Learning Competency

At the end of this section, learners will able to:

- *list sources of energy.*
- *distinguish between renewable and non-renewable forms of energy.*

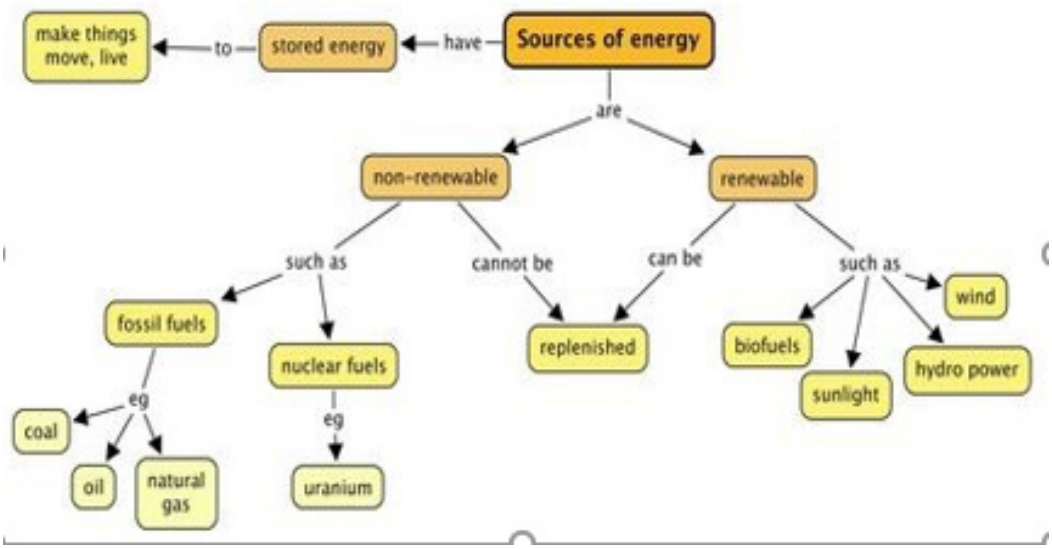


Figure 7.13 Source of energy

Activity 7.8

Discuss the following activities with in a group and present your discussion to the class.

1) List out any five activities from your daily life in which different forms of energy are involved.

2) Differentiate between renewable and non-renewable sources of energy.

In simple terms we can say that anything out of which usable energy can be extracted is a source of energy. There is a variety of sources that provide us energy for different purposes. Some of them are coal, petrol, diesel kerosene, natural gas, hydroelectric power, wind mills, solar panels, biomass etc.

The energy sources can be replenished in a short period of time are referred to as "***renewable***" energy sources, whereas the energy sources that we are using up and cannot be generated in a short period of time are called ***non-renewable*** energy sources. Thus, all the sources of energy can be divided into two categories: renewable sources and non-renewable sources of energy.

There are three main differences between both sources of energy types:

a) availability and renewal times;

b) production and transportation cost;

c) Impact on the environment and human health.

Renewable energy sources:- are the energy sources, which can be turned into use again after being used. It come from natural sources and continually regenerates themselves, which makes them nearly inexhaustible. These energy sources are plentiful, sustainable, naturally replenished and good to the environment.

The major types or sources of renewable energy are:

- **Solar energy from the sun**
- **Wind energy**
- **Geothermal energy from the heat inside the earth**
- **Hydropower from flowing water**
- **Biomass from plants**
- **Ocean energy in the form of wave, tidal,** current energy and ocean thermal energy.

Non- renewable sources: are the energy sources, which cannot be turned into use again. It is a finite resource. It is a natural substance that is not replenished with the speed at which it is consumed. These are formed over thousands of years from the

buried remains of ancient sea plants and animals that lived millions of years ago. Most of these energy sources are *"dirty" fossil fuels,* which are generally *dingier* for the environment.

The major types or sources of non-renewable energy are: petroleum, natural gas, coal, nuclear energy and hydrocarbon gas liquids.

Table 7.3 major differences between renewable and non-renewable resources

Renewable Resources	Non-renewable Resources
Depletion	
Renewable resources cannot be depleted over time	Non-renewable resources deplete over time
Sources	
Renewable resources include sunlight, water, wind and also geothermal sources such as hot springs and fumaroles	Non-renewable energy includes fossil fuels such as coal and petroleum.
Environmental Impact	
Most renewable resources have low carbon emissions and low carbon footprint	Non-renewable energy has a comparatively higher carbon footprint and carbon emissions.
Cost	
The upfront cost of renewable energy is high. – For instance, Generating electricity using technologies running on renewable energy is costlier than generating it with fossil fuels	Non-renewable energy has a comparatively lower upfront cost.

Renewable and non-renewable resources have many similarities They both are resources and they both have to do with the environment. Also, we must use them wisely. Because if not they will disappear. They both grow on Earth, as well.

Exercise 7.7

I. Choose the best answer from the following alternatives

1. Which of the following is a nonrenewable energy resource?

   A. Solar
   B. hydroelectric
   C. wind
   D. coalTop of Form

2. What type of energy is derived from heated groundwater?

   A. solar energy
   B. hydroelectric energy
   C. geothermal energy
   D. nuclear energy

3. Which of the following is a renewable energy resource?

   A. **Solar**
   B. **Biomass**
   C. **Geothermal**
   D. **All**

II. Short answer questions

1. List sources of energy.
2. What is the difference between renewable and non-renewable forms of energy and give four examples for each.

7.8. Wise use & Conservation of energy

Learning Competency

At the end of this section, learners will able to:

- *describe how energy is used wisely.*
- *list the strategies of conservation of energy*

Energy conservation

The key for resolving the country's energy crisis lies with us citizens. Among things

we can do is the conservation of our energy sources. It is said that energy saved is as good as energy generated. Therefore, we should not only judiciously use energy sources but save energy as much as we can. You can start conservation of energy in your home.

Project work 7.2

- By referring internet explorer or other reference materials explain how energy is used wisely and list the strategies of conservation of energy. Present your finding to the class.

Energy conservation is: the practice of using less energy in order to lower costs and reduce environmental impact. So. Energy can be conserved by

- Reducing wastage and losses,
- Improving efficiency through technological upgrades and Improved operation and maintenance

A good rule to follow for conservation use the three (3) R's:

- ***Reduce***: Reduce the amount of trash you produce and the amount of energy that consume. This is the best way to conserve natural resources and reduce pollution.
- **Reuse:** By products that you can use more than once. Try to avoid disposable items that use up natural resources and produce extra trash.
- **Recycle:** Recycling is the process that reuses and changes used materials into things that can be of use. Although it requires energy to recycle things, overall, recycling saves energy as well as landfill space and reduces our need for more natural resources. Lots of things can be recycled:

Example: plastic, metal, glass, paper, and compost etc.

Strategies of conservation of energy

The steps that you can and should take for saving energy at home or in the office are:

- Switch off lights, fans and other appliances when not in use.
- Water taps should not be left open.
- While cooking vegetables the vessel should remain covered.
- For cooking, only the required quantity of water should be used.
- Soak pulses in water for some time before cooking,
- Use of more efficient appliances.
- Use public transport in place of your own vehicle to save fuel.
- Share automobiles rides to office, instead of driving alone to office.

Exercise 7.8

I. Give short answers.

1. What is conservation of energy?
2. Explain how energy is used wisely.
3. List Strategies of conservation of energy

7.9. Resource depletion and environmental degradation

Learning Competency

At the end of this section, learners will able to:

- explain resource depletion and environmental degradation

Activity 7.10

Perform the following tasks in groups and present your conclusion to the class.

i) Explain resource depletion and environmental degradation
ii) Explain causes and effects of resource depletion and environmental degradation

Resource depletion

Resource depletion is the exhaustion of raw materials within a region. Resources are commonly divided between renewable resources and non-renewable resources. Use of either of these forms of resources beyond their rate of replacement is considered to be resource depletion. There are different types of resource depletion. These are Deforestation, mining, aquifer depletion, contamination of resources, slash-and-burn agriculture and overconsumption.

Causes for Resource Depletion	Effects of resource depletion	Solutions to the Resource Depletion Problem
Waste	Water shortages	Avoid plastic
Farming	Oil shortages	Reduce waste
Overpopulation	Economic effects	Stop deforestation
Mining	Health effects	Reduction in consumption
Erosion	Air pollution	Save electricity
Pollution	Loss of forests	Use renewable energies
Deforestation	Global warming	Recycle and reuse
Industrialization	Extinction of animals and plants	Education

Environmental degradation

The environmental degradation is the deterioration of the environment through depletion of resources which includes all the biotic and abiotic element that form our surrounding that is air, water, soil, pant animals, and all other living and non-living element of the planet of earth. The major factors of environmental degradation are

- Human (modern urbanization, industrialization, overpopulation growth, deforestation, etc.) and
- Natural (flood, typhoons, droughts, rising temperatures, fires, etc.) Cause. Environmental pollution refers to the degradation of the quality and quantity of natural resources.

The major Effects of Environmental Degradation are: Impact on Human Health, Poverty, Atmospheric Changes, Loss of Biodiversity and Scarcity of Natural Resources

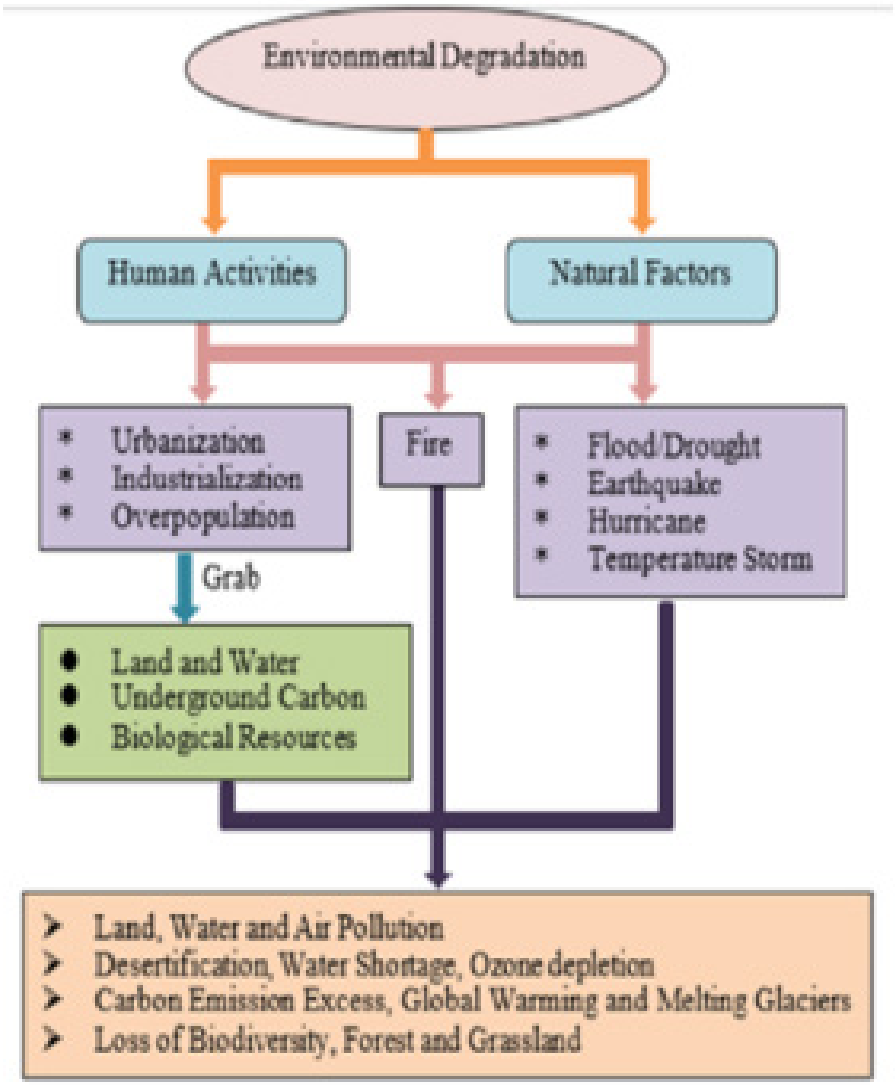


Figure7.14 Different causes of environmental degradation

Key Terms

- Motion
- Rectilinear motion
- Transducer
- Oscillatory motion
- Curvilinear motion
- environmental degradation
- Energy
- Resource depletion
- Force
- Gravity
- Matter
- Gravitational force
- Weight
- Newton
- Meter
- conservation of energy
- Spring balance
- Graduated scale
- Renewable energy
- Non-renewable energy
- Rotary motion

UNIT SUMMARY

- *Motion is a continuous change of position relative to a reference point. There are four types of motion. They are rectilinear, curvilinear, rotary and vibrational motion.*
- *A force is a push or pull upon an object resulting from the object's interaction with another object.*
- *Gravitational force is the force that is exerted by the Earth on every object, which is near or on its surface.*
- *Force acting on an object causes the object to change its shape or size, to start moving, to stop moving, to speed up or to slow down a moving object.*
- *You can use a device called a force meter to measure the size of a force. It contains a spring connected to a metal hook. The spring stretches when a force is applied to the hook. The bigger the force applied, the longer the spring stretches and the bigger the reading. The unit of force is called the newton, and it has the symbol N.*
- *Energy is the property of mater, and it comes in many forms, such as heat, sound, light, and motion. It can be transferred between objects, and converted in form.*
- *Energy exists in many different forms. Examples of these are: light energy, heat energy, mechanical energy, gravitational energy, electrical energy, sound energy, chemical energy, nuclear or atomic energy and so on. Each form can be converted or changed into the other forms.*
- *sources of energy can be classified into: Renewable Sources and Non-renewable Sources.*
- *A renewable source is the natural resources that cause no impact to nature. These resources of energy can be naturally replenished and are safe to the environment. Example: Solar energy, geothermal energy, Wind energy, biomass, Hydropower and tidal energy.*
- *Non-renewable sources of energy cause impact to nature and are a limited supply source. Non-renewable sources can be extracted from the earth, and will run out as time passes. Example: Natural gas, coal, petroleum, Nuclear energy.*
- *Using energy more wisely can reduce air pollution and result in cleaner air. The power plants that supply energy release harmful greenhouse gases into the atmosphere.*
- *Resource depletion is the exhaustion of raw materials within a region. The depletion of natural resources is a big problem. It has several adverse effects on humanity as well as on the whole environmental system.*
- *Environmental degradation is the deterioration of the environment through depletion of resources such as quality of air, water and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution.*

Review Exercise

Part I: True / False type questions

1. Energy can be created.
2. Geothermal energy is renewable
3. A forces that acting an object falling from a tall building is called gravitational force.
4. push or pull of an object in a certain direction is known as motion.

Part II: Complete the following sentences. Write them out in full on the lines provided and underline your answers.

Coal, natural gas and oil are all examples of _____ (renewable/non-renewable) energy resources. When they are burned, they release _____ (energy/electricity). Coal, natural gas and oil are also known as _____ (nuclear fuels/fossil fuels). Wind and solar energy are examples of _____ (renewable/non-renewable) energy sources because they _____ (can/cannot) be replaced. _____ has to be applied to change the _____of a _____object. (moving, direction, force)

Part II: Choose the best answer from the given alternatives

1. Which type of motion repeats itself at regular intervals of time?

   A. Circular motion
   B. Periodic motion
   C. Rectilinear motion
   D. none of the above

2. **Rotation of the Earth is an example of.**

   A. Periodic motion
   B. Rectilinear motion
   C. Circular motion
   D. Both (A) and (B)

3. The best definition of force is _____.

   A. a push or pull of an object.
   B. energy in motion
   C. stored energy
   D. anything that takes up space

4. What type of energy does an oven produce?

A. light
B. heat
C. light and heat
D. none of the above

5. Which of the following is **NOT** the effect of force?

A. Deformation
B. To stop motion
C. To start motion
D. To change mass

6. Which instrument used to measure force?

A. Spring balance
B. Beam balance
C. Newton
D. Thermometer

7. All of the following are examples of things that produce light energy EXCEPT:

A. Candle
B. Compass
C. Desk Lamp
D. Flashlight

8. Which of the following does **NOT** produce light energy?

A. Car
B. phone
C. picture frame
D. computer

9. Energy you get from eating an apple

A. nuclear energy
B. electromagnetic energy
C. sound energy
D. chemical energy

10. The energy source that does the least harm to the environment is

A. Renewable
B. Non-renewable

11. Nuclear energy is:

A. Renewable
B. Non-renewable

12. Which of the following is a source of energy?

A. Sun
B. Waves
C. Wind
D. All

13. Which of these are renewable energy sources.

A. Coal
B. natural gas
C. sunlight
D. None of these

14. Which type of renewable energy uses the movement of air to generate electricity?

A. water
B. sun
C. wind
D. Biomass

15. Most energy sources are used to give us

A. Food and water
B. Electricity and fuel
C. Heat and water
D. Heat and fuel

16. Renewable energy is energy that

A. Can be reused over and over.
B. Can be used up completely.
C. Can be changed into a new energy
D. Cannot be replaced.

17. Non-renewable energy is the energy that

A. Can be used over and over.
B. Can be used up completely.
C. Cannot be changed into a new energy.
D. Can be replaced

18. resource depletion is commonly associated with

A. Water usage
B. Fossil fuel consumption
C. Trees and fishing
D. All

19. Which one of the following is an examples of environmental degradation?

A. Deforestation.
B. Depletion of the ozone layer
C. Water Pollution.
D. All

Part IV: Give short answer questions

1. Explain in and give one example for gravitational force.
2. Why an object thrown upwards comes down after reaching a point?
3. What is meant by weight?
4. Name the motion possessed by these objects- blades of an electric fan in motion, a spinning top, and hands of a clock. Vehicle on a straight road, the earth around the sun and pendulum of a wall clock.
5. Name and define the type of motion exhibit by the object in the given below figure 1.
6. If you want to measure the weight of your school bag using the equipment shown below. Name this piece of equipment. That shown in figure 2.

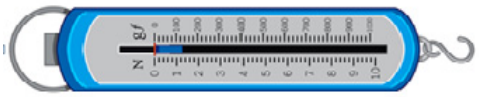


Figure 1

Figure 2

Self Assessment

Check List Competencies given below are expected to be achieved in this unit by students. You are required to respond by saying Yes or No. Put a tick (√) mark under "Yes" column if you are able to perform the competency or under "No" column if you are unable to perform the competency.

This would help to evaluate yourself and you can revise the parts of topics for which the competencies are not met.

No.	Can I	Yes	No
1	*Define motion as the change of position with time.*		
2	*Describe the types of motion.*		
3	*Give examples for each type of motion*		
4	*Explain the term force.*		
5	*Demonstrate the pulling/pushing activity of force.*		
6	*Explain gravitational force*		
7	*List all effects of force*		
8	*Demonstrate some effects of force.*		
9	*Relate effects of force with their daily life experience*		
10	*Name measuring device of force*		
11	*Identify different measuring scales on measuring device of force*		
12	*Explain parts of measuring device of force*		
13	*Define energy as a property of matter that can be converted*		
14	*List all forms of energy*		
15	*Explain which energy converted to other forms of energy.*		
16	*List sources of energy.*		
17	*Distinguish between renewable and non-renewable forms of energy*		
18	*Describe how energy is used wisely.*		
19	*List the strategies of conservation of energy*		
20	*Explain resource depletion and environmental degradation*		