

GENERAL SCIENCE

STUDENT TEXTBOOK

Grade 7

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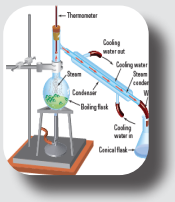

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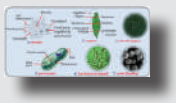

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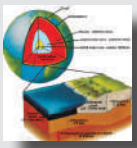

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UNIT ONE

BASIC CONCEPTS OF SCIENCE

Learning Outcomes

At the end of this unit, students will be 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;*
- *relate how science and technology affect one's beliefs, practices, and ways of thinking;*
- *appreciate the contributions of outstanding scientists to science and technology;*
- *discuss the importance of scientific values in decision making and problem solving;*
- *identify the significant contributions of Ethiopian scientists in science;*
- *identify different laboratory tools;*
- *demonstrate safe ways of using apparatus in the laboratory;*
- *practice precautionary measures in the laboratory;*
- *exhibit knowledge of lab safety rules and procedures; and*
- *identify potential hazards and implement appropriate safety procedures when working in the laboratory.*

Main Contents

1.1. The Nature of Science and its Branches

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

Start-up Activity

Be in group of six, discuss with your group members and then present in the class.

1. What do you think science is?
2. What does science deal with?
3. What do you think about the components of science?

Introduction

In lower grades, in Envronmental science subject, you have learned about the definition of science as a branch of knowledge dealt with all living and non-living things in nature. Science consists of three components such as scientific attitude, knowledge and skill. Knowledge of science and facts are verifiable. Existing scientific truth is relative and must be continually tested, evaluated and reconstructed. In this unit, you will learn about the nature of science and its branches, meaning of science, the relationship between science and technology, famous scientist in the world and Ethiopia and common laboratory equipment, uses, safety rules and procedures in science laboratories.

1.1. The Nature of Science and Its Branches

At the end of this section, you will be able to:

- *define science;*
- *describe the main branches of science and explain their relationship;*
- *relate how science and technology affect one's beliefs, practices, and ways of thinking.*
- *appreciate the contributions of outstanding ethiopian scientists to science and technology;*
- *discuss the importance of ethical disciplines in scientific investigations; and*
- *solve the issue of environmental problems in their school compound and its surroundings*

1.1.1. Definition of Science

Activity 1.1.

Be in a group and discuss the following questions

1. What exactly, science is for you?
2. Why science is important?
3. What are things that science does not do?

The word science comes from the Latin word *scientia*, which means 'knowledge'. So, the science is a method of discovering reliable knowledge about nature, which means the learning of already acquired knowledge of the physical world, or developing technology to benefit the human society.

In general, science is a body of organized knowledge obtained about nature through observation, explanation, interpretation and rationalization. Science is a process of thinking and learning about the world around us.

Science 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.

1.1.2. Main Branches of Science

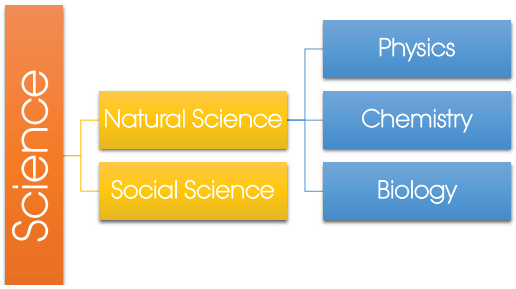
Activity 1.2.

Form a group and then discuss on the following questions

1. Describe the main branches of science and explain their relationship
2. Write the branches of natural sciences by searching from Internet or other sources.

Based on foundation of knowledge, science can be classified as indigenous and conventional sciences. Indigenous science is a science incorporating local people's knowledge and indigenous perspectives. Conventional scientific approaches are commonly recognized as western science. Knowledge in science is not absolute, current knowledge can be changed when a better understanding comes through more observation and investigation of indigeneous knowledge. We humans often ask whom we are, where we come from, how we could live in harmony with the environment. In general science can be classified into two main branches namely natural science and social science.

The main branches of science are given in chart below.



Social science is branch of science that devoted to the study of societies and relationships among individuals within those societies. Example; Geography, History, Economics and etc.

Natural science is the study of nature and natural laws. Natural sciences can be classified into three branches. Such as:

What is Physics?

Physics is the science of systems.

Physics is branch of natural science which describes how the system is placed on the space, the motion of the system, and other physical properties. A person who studies physics is called *Physicist.*

What is Chemistry?

Chemistry is the science of matter and its change.

Chemistry is a branch of natural science that studies the composition, properties, structure and transformation of substances. A person who studies chemistry is called *Chemist.*

What is Biology?

Biology is the science of life.

Biology is a branch of natural science which deals with living organisms, their internal processes, and their relationship to each other and the environment. A person who studies biology is called Biologist.

Exercise 1.1.

Write short answers.

1. What branch of science is most directly concerned with?

   A. the classification of trees?
   B. identifying contaminants in food?
   C. investigating the intensity of light?
   D. the production of plastics?

2. Consider water in a bucket that is kept outdoors. Three students are interested in analyzing this water in the following different aspects:

   I. The first student wants to study the microorganisms that might be found in the water.
   II. The second student wants to investigate the amounts of force required to lift the bucket and to carry it over various distances.
   III. The third student wants to study the tastes, odors and changes of substances when they are dissolved in the water.

   Which one of the areas of studies described above is related to the field of a) chemistry b) biology c) physics

1.1.3. Science and Technology

Science is the systematic study of the structure and behavior of the physical and natural world through observation and experiment and technology is the application of scientific knowledge for practical purposes. Science and technology help each other's advance. Scientific knowledge is used to create new technologies. New technologies often allow scientists to explore nature in different ways and make new discoveries. Scientists use their knowledge to develop technology and technology is use to develop science; so, because of this reason science and technology are an integrated term in today's world.

Activity 1.3.

Form a group and then discuss about the following questions

1. List some applications of science and technology in your daily life.
2. Write some science and technology products in your home, class, or school and environment.

The contributions of science to technology can be seen in the following ways;

1. New knowledge which serves as a direct source of ideas for new technological possibilities;
2. Source of tools and techniques for more efficient engineering design and a knowledge base for evaluation of feasibility of designs;
3. Research instrumentation, laboratory techniques and analytical methods used in research that eventually find their way into design or industrial practices, often through intermediate disciplines;
4. Practice of research as a source for development and assimilation of new human skills and capabilities eventually useful for technology;
5. Creation of a knowledge base that becomes increasingly important in the assessment of technology in terms of its wider social and environmental impacts.

1.1.4. Scientists and Ethical Discipline

Activity 1.4.

Form a group of 5-6 and discuss on the following questions and then present your work to the class.

1. List at least three names of
   a. world scientists.
   b. Ethiopian scientists and write their contribution in science and technology.
2. Can you mention some of the scientists you know?

The Famous World Scientists and their Contributions

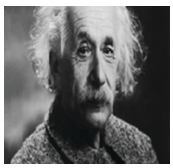
Scientist is practitioner of science; an individual who uses scientific method to objectively inquire into the nature of reality. Some famous world scientists and their most remarkable inventions and discoveries:

He was an astronomer and a mathematician. He was the one to invent the world's first automobile.

Ferdinand Verbiest (1623 - 1688)

He has made a large number of inventions, but the most well-known one is the electric bulb

Thomas Edison (1847 - 1931)



He was one of the greatest scientists of the 20th century. He was the creator of numerous inventions and theories like theory of relativity, photoelectric effect and the Einstein calculator.

Albert Einstein (1879 - 1955)

She was a Polish physicist and chemist working mainly in France, who was famous for her pioneering research on radioactivity. She was the discovery of the elements polonium and radium. She was the first woman to win a Nobel Prize.

Marie Curie (1867-1934)

Stephen Hawking (1942-2018)

He was an English scientist and received numerous awards, including the Special Fundamental Physics Prize in 2012, the Copley Medal in 2006, and the Albert Einstein Award in 1978. Hawking was known for his work on gravitational singularity theorems in the framework of general relativity, and the theoretical prediction that black holes emit radiation.

The Famous Ethiopian Scientists and their Significant Contributions

Here in Ethiopia we have some very renowned scientists. Their work is known and important not just here in Ethiopia but around the world. Some of them are listed herewith:

Dr Aklilu Lemma (1934-1997)

Dr Aklilu was Ethiopian physician and was co-awarded the 1989 Right Livelihood Award. He collected some live snails from above the washing party and asked one of the women to give him some of her Endod suds. Not long after the suds were put in the snail container, the snails all died. This was the start of years of work for Dr Aklilu and finally he discovered and campaigning relentlessly for an affordable preventative against ***bilharzia***."

Professor Gebisa Ejeta

He is an Ethiopian American plant breeder, geneticist and Professor at Purdue University. Professor Gebissa Ejeta developed other strains of sorghum which are also resistant to the parasitic Striga weed, which candestroy a big percentage of a crop. In 2009, he won the World Food Prize for his major contributions in the production of sorghum.

Professor Yalemtsehay Mekonnen

She is a biologist and an academic member of staff at the Department of Biology, Faculty of Science Addis Ababa University. She is the first female professor from AAU. One of her research areas is the assessment of the impact of chemical pesticide hazard on humans.

Professor TilahunYilma

He is known internationally for the vaccine he developed to help get rid of the terrible cattle disease rinderpest, and for his work on HIV/ AIDS vaccines. Rinderpest arrived in Ethiopia in 1888, carried by three infected cattle brought into the country by Italian soldiers. Within a year 90% of the domestic cattle plus many wild animals such as buffalo, giraffe and antelope died. As a result 30–60% of the people starved. In the 1980s rinderpest became a major problem again. Professor Tilahun worked to develop a vaccine using genetic engineering.

Project 1.1

Form a group of 5-6 and 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, they could choose an Ethiopian scientist and create a cartoon strip showing their discovery. Values on focus: imbibe good character traits of scientists.

Activity 1.5

Form a group of 5-6 and then

Discuss the importance of ethical disciplines in scientific investigations and share your ideas with your class.

Ethical Disciplines in Scientific Investigations

Scientific work requires highly ethical disciplines. In your next grade level, (grade 8 general science) under chapter one, you will learn in detail about ethical disciplines in scientific investigations. But here some ethical disciplines in scientific investigations are briefly described as follows:

Honesty: Scientists should not fabricate, falsify, or misrepresent data or results. They should be objective, unbiased, and truthful in all aspects of the research process.

Carefulness: Scientists should minimize errors as much as possible as experimental, methodological or systematic and human errors. They should make faithful estimates of the errors that remain.

Openness and Fairness: Scientists should share data, results, methods, ideas, techniques, and tools.

Respect: Scientists should treat colleagues with respect.

Education: Scientists should teach each other what they have learned in their research. They should educate prospective scientists and ensure that they learn how to conduct good science.

Exercise 1.2

Part I: Write True for correct statement and False for wrong statement

1. Scientists used their knowledge to develop technology and then used technology to develop science.
2. Indigenous science is a science incorporating local people's knowledge.
3. Scientists can fabricate false results to the community.
4. Knowledge in science is absolute.

Part II: Choose the correct answer

1. Who was inventer of electric bulb?
   - **A.** Marie Curie
   - **B.** Albert Einstein
   - **C.** Charles Babbage
   - **D.** Thomas Edison
2. Who discovered an affordable preventing against Bilharzia?
   - **A.** Ferdinand Verbiest
   - **B.** Dr. Aklilu Lemma
   - **C.** Albert Einstein
   - **D.** Professor Gebisa Ejeta

Part III: Write short answer for the following questions

1. Write at least three areas where science contributes to technology.
2. Write some ethical disciplines required in scientific investigations.

1.2. Common laboratory equipment, uses, safety rules and procedures in science laboratories

At the end of this sub-topic, you will be able to:

- *identify different laboratory tools and their uses;*
- *prepare some laboratory equipment/tools from locally available materials;*
- *demonstrate knowledge of lab safety rules and procedures;*
- *practice precautionary measures in the laboratory;*
- *identify potential hazards when working in the laboratory;*
- *implement appropriate safety procedures when working in the laboratory and*
- *demonstrate the appropriate use of personal protective equipment for a given laboratory activity.*

1.2.1. List and Use of Common Scientific Equipment

Activity 1.6

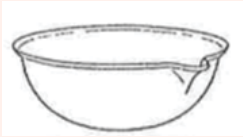
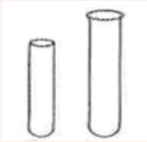
Be in a group and list some common science laboratory equipments and describe their functions, then present in the class.

What is a science laboratory?

A science laboratory is a place where basic experimental skills are learnt only by performing a set of prescribed experiments.

Science laboratory equipment refers to the various equipment and tools that are used by professionals or students working in a laboratory. There are many sciences laboratory equipments. However, some common science laboratory equipment and their functions are described in the table 1.1 below.

Table 1.1. Some common science laboratory equipments and their functions

Name	Picture	Use
Triple beam balance		Obtaining the mass of an object.
Spring balance or newton balance		It is an instrument helpful in measuring the weight of an object.
Evaporating dish		Used to evaporate excess solvents to create a more concentrated solution.
Test tubes		Holds small amounts of liquids for mixing or heating.
Beaker		Holding water (also used to heat liquids)
Tongs		Transport a hot beaker; remove lid from crucible.
Mortar and pestle		Used to grind chemicals to powder.

Thermometer		Used to measure temperature.

1.2.2. Making Laboratory Equipment from Locally Available Material

Since modern laboratory apparatus and chemicals are expensive, the production of laboratory equipment/tools from locally available materials is very essential and economically feasible. It is believed that, using locally available materials, most primary school experimental lessons can be performed in a very short time, often with no or low financial input and without long sessions of preparation. In the section 1.2.1 you have learned, some common science laboratory equpiments. Under this topic, you will learn how to prepare those tools and then you will produce them by using locally available materials. In general, to make science laboratory equipments from locally available materials, the following steps should be taken into consideration:

Step 1: Make a careful study of the modern apparatus in the science laboratory;
Step 2: List and collect necessary locally available materials that can replace some apparatus;
Step 3: Make a design of apparatus in necessary dimensional measurement;
Step 4: Improve the collected materials carefully as you designed in step 3;
Step 5: Test the functioning of the replaced material; and
Step 6: Make any further improvements from the outcome of the test.

Project 1.2

Making funnel by using local available materials

Necessary material: Cutter, Plastic Bottle and Ruler

Procedure

1. Collect 500ml or 600ml plastic bottles
2. Cut the plastic bottle at the height of 6 cm from top to bottom
3. Remove the plastic cap look at figure 1.1.

Figure 1.1. Making a Plastic Funnel

Project 1.3

Be in a group of 5 and then prepare some general science laboratory equipments such as beaker, measuring cylinder, tongs, etc. from locally available materials.

1.2.3. Laboratory safety rules and procedures

Activity 1.7

Form a group:

1. Discuss rules and regulations that should be followed in the science laboratory.
2. Which procedure is correct and which one is wrong? Correct the wrong procedure (s) when you discuss in your group
   - (a) Adding acid to water
   - (b) Adding water to acid
   - (c) Adding solids to hot liquids

Basic laboratory safety rules that provide behavior, hygiene, and safety information to avoid accidents in the laboratory. There are many laboratory safety rules. The most common of them are listed below;

1. Avoid skin and eye contact with all chemicals.
2. Minimize all chemical exposures.
3. Assume that all chemicals of unknown toxicity are highly toxic.
4. Never add water to acid and solids to hot liquids.
5. Never leave containers of chemicals open.
6. Unlabeled chemicals should never be used.
7. Do not taste or intentionally sniff chemicals.

1.2.4. Personal Protective Equipment

Activity 1.8

Form a group:

1. What is personal protective equipment?
2. Mention some personal protective equipment.

Personal protective equipment is specialized clothing or equipment worn for protection against dangerous or infectious materials. Common examples of personal protective equipment include:

Laboratory Coat: is used to protect against splashes and spills.

Footwear: is the shoes used in the laboratory.

Gloves: when handling chemical, physical, or biological hazards that can enter the body through the skin, it is important to wear the proper protective gloves.

Eyewear (Safety goggles): provide the best protection against chemical splashes, vapors, dusts, and mists while working in the laboratory.

Face shield: can be used to protect against impact, dust, particulates, and splashes to the face, eyes, and throat.

1.2.5. Hazard Symbols

Activity 1.9.

Form a group and discuss with your classmate and present in the class.

1. What are the hazard symbols on chemical bottles, electrical gadgets and other materials found in the laboratory?
2. Demonstrate how to handle those materials safely.

Hazard symbols are recognizable symbols designed to warn about hazardous or dangerous materials, locations, or objects including electric currents, poisons, radioactivity, and etc. Depending upon the science laboratory being conducted, a laboratory can be filled with dangerous chemicals, radioactive substances, biological specimens, sharp instruments, breakable glassware, and flammable objects. Thus, those working in laboratory need to be keenly aware of the many dangers associated with these items. In order to maintain a safe workplace and avoid accidents, laboratory safety symbols and signs need to be posted throughout the workplace.

A. **General warning**: It is a warning indicating the presence of hazardous materials in the laboratory.
B. **Biohazard:** It provides warning on laboratory equipment that may contain biohazard materials like blood samples
C. **Flammable material hazard**: Chemicals labeled as flammable have the tendency to ignite and should be store accordingly. Keep the chemicals away from flames, sparks, and oxidizing substances.
D. **Electrical hazard:** It can cause mild tingling and death. Devices labeled as electrical hazards should always be turned off when not in use.
E. **Toxic material hazard:** It is a generic sign for toxic/poisonous substances and can cause severe damage when inhaled, absorbed, or swallowed.
F. **Corrosive material hazard**: Strong chemicals that corrode into your skin and other substances. So, wear protective gear at all times when working with corrosive substance

Figure 1.3.; Some Hazards signs in the Science laboratory

Exercise 1.3

Part I: Choose the correct answer from the given alternatives

1. What is the name of following hazards symbol?

   A. Biohazard
   B. Toxic material hazard
   C. Electrical hazard
   D. Irritant

2. Which one of the following is **not** a personal protective equipment?
   A. Safety goggle
   B. Laboratory coat
   C. Test tube
   D. Glove

Part II: Fill in the blank spaces

1. When you handling chemical, physical, or biological hazards, it is recommended to wear the proper protective_____ .
2. _____ provides warning on laboratory equipment that may contain bio hazardous materials like blood samples.

Part III: Write answer for the following questions

1. Write at least five common science laboratory safety rules.
2. Why is eating or drinking in the laboratory being dangerous?

UNIT SUMMARY

- Science is a body of knowledge, which is systematically organized of nature, society and thought and the processes and practices used to add to that body of knowledge.
- Science is divided two main categories such as natural and social sciences.
- Natural science is the study of nature and natural laws.
- Social science is study of the social world constructed between humans.
- Science, technology and innovation each represent a successively larger category of activities which are highly interdependent but distinct.
- Scientist is an individual who uses scientific method to objectively inquire into the nature of reality.
- Scientists use their knowledge to develop technology and then use technology to develop science.
- Scientific work requires highly ethical disciplines such as honesty, carefulness, fairness, respect, education, etc.
- Basic lab safety rules and procedures provide behavior, hygiene, and safety information to avoid accidents in the laboratory.

Key Terms

- Biology
- Chemistry
- Ethical discipline
- Hazard symbol
- Indigenous science
- Natural science
- Non-indigenous science
- Physics
- Safety rule
- Science
- Scientist
- Social science
- Technology

REVIEW EXERCISE

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

1. Science is merely a collection of facts, concepts, and useful ideas about nature.
2. Natural science is the study of nature and natural laws.
3. Chemistry has no role in solving the problems of mankind.
4. Physics and chemistry do not share common areas of study.
5. Science is not same as technology.
6. Scientists can fabricate false results to the community.
7. Knowledge in science is absolute.

Part II. Match the functions of Laboratory equipments under column "A" with its corresponding specific equipment under column "B".

Column A	Column B
1. Transport a hot beaker; remove lid from crucible.	A. Mortar & pestle
2. Holds small amounts of liquids for mixing or heating.	B. Triple-beam balance
3. Holding water or used to heat liquids.	C. Forceps
4. Used to grind chemicals to powder.	D. Tongs
5. Obtaining the mass of an object.	E. Test tubes
	F. Beaker
	G. Thermometer

Part III. Choose the correct answer from the given alternatives

1. Biology is:

   A. the study of matter.
   B. the study of life and living organisms.
   C. the study of of the motion of system.
   D. the study of the way atoms and molecules react together.

2. Who was known internationally for developing the vaccine for cattle disease Rinder pest?

   A. Professor Gebisa Ejeta
   B. Professor YalemtsehayMekonnen
   C. Professor Ensermu Kalbessa
   D. Professor Tilahun Yilma

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

   A. chemistry and biology
   B. biology and physics
   C. physics and geology
   D. biology and geology

4. Which of the following is **false** about science? Science:

   A. is a limited discipline that studies only naturally occurring events.
   B. does not address the supernatural.
   C. has the answers to all of the questions in the universe.
   D. is the only method that is self-correcting.

5. A famous an Ethiopian scientist who made major contributions in the production of sorghum was:

   A. Dr. Aklilu Lemma
   B. Professor Sebsebe Demissie
   C. Professor Gebisa Ejeta
   D. Dr. Segenet Kelemu

6. World's first automobile was discovered by

   A. Ferdinand Verbiest
   B. John Baird
   C. Stephen Hawking
   D. Marie -Curie

Part IV: Answer the following questions

What new insight about science, technology and scientists did you learn from this unit?

UNIT TWO

MATTER IN OUR SURROUNDINGS

Learning Outcomes

At the end of this unit, students will be able to:

- *use particles theory's postulates to explain properties and behavior 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; and*
- *demonstrate scientific inquiry skills along this unit.*

Main Contents

2.1. Characteristics and nature of matter
2.2. Physical and chemical properties of matter
2.3. Classification of substances
2.4. Changes around us: Physical and chemical changes
2.5. Separation of mixtures and its application

Start-up Activity

8. Look any materials in your classroom. Of these materials you have observed, which are matter?
9. What is matter?

Introduction

In grade six, you have learned about the general concepts of physical and chemical properties of matter. In this unit, you will learn about characteristics and nature of matter, physical and chemical properties of matter in detail, classification of substances and separation of mixtures and its application. Basically, this unit explains the concept matter, and its composition and changes of matter. Matter is anything that occupies space and has mass. Water, air, sugar, milk, soil, animals, plants and human beings are some examples of matter.

2.1. Characteristics and Nature of Matter

At the end of this section, you will be 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;*
- *explain diffusion and every day effect of diffusion;*
- *describe representation of the arrangement, relative spacing, and relative motion of the particles in each of the three states of matter;*
- *explain compression in terms of distance between particles;*
- *use the terms melting, condensing, and freezing/solidification to describe changes of state; and*
- *use the particulate nature of matter to explain melting, freezing/ solidification, evaporation and condensation.*

2.1.1. Meaning and Properties of matter

Activity 2.1

Form a group and discuss on the following questions

1. Give examples of both matter and non-matter.
2. What are the properties of matter?

In introduction section, you have learned that matter is anything that has mass and occupies space. Things that do not have mass and cannot occupy space are said to be non-matter. Light, sound and heat are examples of non-matter.

Matter possesses different properties. Properties are the characteristics that give a substance's identity and enable us to distinguish one kind of substance from another. No two substances have exactly the same set of properties. To identify a matter, scientists observe two distinct types of properties: physical and chemical properties. You will learn these properties under section 2.2.

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

Activity 2.2

Form a group and discuss on the following questions:

1. What is a particle?
2. What is particle theory of matter?
3. List down some characteristics of particle of matter.

Scientists explain the properties and reactions of chemicals using ideas about particles. Everything around us is made up of tiny pieces of particles. Particle is the smallest portion of matter and it is the building blocks of matter. The relationship between particle and matter is explained by particle theory of matter.

Particle theory of matter states that all matter consists of many, very small particles which are constantly moving or in a continual state of motion.

Historical Note

Democritus' was the first person to develop the idea of particle theory and he suggested that matter is made up of tiny particles too small to be seen.

There are five main ideas in the particle model (postulates of particle theory of matter):

1. All matter is made up of tiny particles.
2. The particles of matter are always moving in constant random motion.
3. The particles have empty spaces between them.
4. Adding heat to matter makes the particles move faster.
5. All particles of one substance are identical.

Illustrations of the particle theory by using diffusion

Diffusion is defined as the movement of atoms, ions, and molecules from a region of high concentration to a region of low concentration, or 'down their concentration gradient'. The role of diffusion is applicable in many where. For example, diffusion concept used when water diffuses or flows, when we pour a color on a glass of water and when inhaling and exhaling air, etc.

Experiment 2.1

Title: Illustrations of diffusion of particles by using perfume.

Objective: *To infer the particulate nature of matter from demonstration/ investigation*

Procedures:

1. Bring perfume to the class room.
2. One voluntary student will spray the perfume in one side of the classroom and then other two students will stand on other side of the class (corner of the class) and smell the odor.

Questions

1. What new odour did you smell?
2. How these odors reach you?
3. Why the particles of the gas quickly move in all directions?

Properties of Solids, Liquids and Gases; and State Change

Matter exists in three states or phases. The solid, liquid and gas are the three states of matter in which any substance can exist, depending on the conditions of temperature and pressure. The particle theory (kinetic theory) of matter can help us to understand these three states of matter and their properties. The properties of solids, liquids and gases are summarized in the table below.

Table 2.1. Properties of solids, liquids and gases

Solids	Liquids	Gas
have a definite volume and shape.	do not have a definite shape, but have a definite volume.	do not have a definite shape and volume.
The particles in a solid are held together strongly.	The particles in a liquid are separated by spaces.	The particles in a gas are separated by much larger spaces.
are difficult to compress.	are difficult to compress or very slightly compressible.	highly compressible.
has high density.	are often denser than gases.	are often low densities.

Change in State

The change of the substance from one state to another state under a given conditions such as temperature and pressure is called change of state of the substance. As a temperature changes, there will be the change of state. As a solid is heated, the particles vibrate faster and faster until they have enough energy to break away from their fixed positions.

During the change of state, particles physical behavior is changed through different processes. The transformation of a solid into a liquid is known as melting and its reverse (from liquid to solid) known as freezing. The change from a liquid to a gas is known as evaporation whereas from a gas to a liquid is known as condensation. The transformation of a solid directly into a gas is known as sublimation while a change from a gas to a solid is known as deposition.

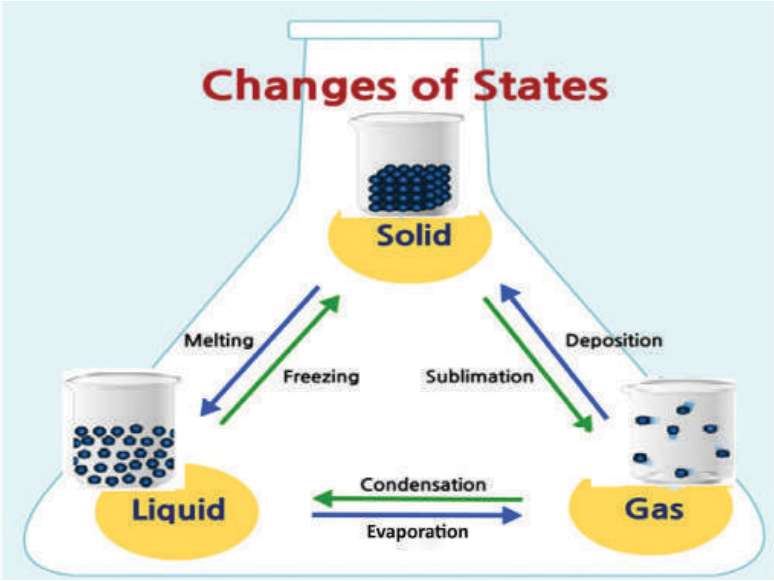


Figure 2.1. Change in physical state

Exercise 2.1

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

1. Everything on earth is matter.
2. Gases have definite volume and shape.
3. Particles of one substance differ from the particles of other substance.

Part II: Choose the correct answer from the given alternatives

1. Which statement about the particle theory of matter is **true**?
   - **A.** Solid particles are held strongly in one place as a result they are at rest.
   - **B.** The particles in a liquid have more kinetic energy than the particles in a gas.
   - **C.** The particles that make up matter are too small to see without a microscope.
   - **D.** When a solid melts its particles no longer exist.

2. Which of the following is **not** matter?

A. Chalk
B. Heat
C. Television
D. Mobile

3. The process of change from solid to gas is known as:

A. freezing
B. condensation
C. sublimation
D. melting

2.2. Physical and chemical properties of matter

At the end of this section, you will be able to:

- *identify and describe physical Properties;*
- *use physical properties of matter to identify substance;*
- *conduct experiments to identify properties of substances and make group report;*
- *distinguish between physical and chemical properties and give examples; and*
- *identify chemical properties.*

Activity 2.3

Discuss the following questions in groups and then present to the class.

1. What is a physical property?
2. How can you physically identify
   (a) common salt from sugar?
   (b) alcohol from water?

A. Physical Properties

Physical properties are the characteristics of a substance that shows itself without forming a new substance. No two substances have exactly the same set of properties. In general, physical properties of matter can be classified as physical properties detected by sense organ and measurable physical properties.

1. Physical properties detected by sense organs

Some physical properties of the substance that we can identify by our sense organs are: color, odour, taste and texture.

Color: The color of a substance results from its interaction with light. For example, chalk is white, water is colorless, and gold is yellow and so on.

Odour: refers to the property of a substance perceived by the sense of smell. For example water is odourless, flowers are fragrant, and orange smells fruity.

Caution! ***Care has to be taken in smelling substances 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! ***Tasting can be used to identify substances only if the substance to be tasted is not harmful.***

Activity 2.4

Discuss the following activity in groups and present your ideas to the class.

What apparatus is used to measure the melting point and boiling point of a substance?

2. Measurable Physical Properties

Measurable physical properties are the properties of a substance that can be measured using an appropriate apparatus. Some measurable physical properties 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, 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. For example, the boiling point of water is 100°C.

Density: is the mass per unit volume of a substance.

$$Density = \frac{Mass\ of\ Substance}{Volume\ of\ substance}$$

$$\rho = \frac{m}{v}$$

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.

Experiment 2. 2

Title: Determining the physical properties of a substance

Objective: To determine the density of substances.

Materials required: Three fifty cent coins, nails, beam balance, water and measuring cylinder.

Part A: Determination of the Density of a Substance

Procedures:

1. Using a beam balance, measure the mass of the three fifty cent coins. Record the mass.
2. Take a measuring cylinder which is large enough for the coin to enter in to it and

Pour water into the measuring cylinder to the 50 mL mark.
drop the three coins into the measuring cylinder turn by turn and see the change in the volume of the water after dropping all the coins as shown in figure 2.2 and take the reading.

Figure 2.2. Determination of density

Observations and analysis:

1. What is the total mass of the three coins?
2. What is the density of a single fifty cent coin?
3. What is the total volume of the three coins?

Experiment 2.3

Title: *Identifying unknown substances based on their physical properties.*

Objective: *To investigate the physical state, color and solubility of substances.*

Materials Required: *Five unknown substance, water, five small beakers, spatula and glass rod.*

Procedures:

1. Examine each of the five substances and record your observation regarding their state and color.
2. Take the five small beakers and add 50 mL water to each beaker. Then add a spatula full of each of the substances to each beaker. Stir the mixture in each of the five beakers with a glass rod and observe the results.

Observation and Analysis:

Copy the following table in your exercise book and record your observations.

Substance	State	color	Solubility in water
A			
B			
C			
D			
E			

Write a report about your observation and present it to the class.

Experiment 2. 4

Title: Identification of metals on the basis of physical properties

Objective: *To identify metals by observing their physical properties.*

Materials Required: *copper, iron, aluminum, and a magnet.*

Procedure:

1. Take a magnet and check if the above metals are attracted by magnet. Which metals are attracted by the magnet and which one of them are not?
2. Examine each metal carefully. Copy the following table in your exercise book and record your observations. Your record should include color, state and whether the metal is light or heavy, magnetic or non-magnetic.

Metals	Observed physical properties			
	Color	State	lightness	Magnetic properties
Cupper				
Iron				
Aluminum				

Observations and Analysis:

i. Which metal can be identified by its reddish-brown color?
ii. Which metal is not attracted by magnet?
iii. Which metal has the highest density?

Write a report and present to the class.

B. Chemical properties

Chemical properties are characteristics of the substance that is observed during a reaction in which the chemical composition or identity of the substance is changed. It describes the ability of a substance to form new substance. Examples of chemical properties include burning of a substance and rusting of iron.

Exercise 2.2

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

1. Rusting is the physical property of iron.
2. Two different substances can have the same set of properties.
3. If the identity of some particular substance is completely altered, it shows chemical properties.

Part II: Choose the correct answer

1. Which property of a substance is measurable?
   - A. Density
   - B. Color
   - C. Taste
   - D. Odor
2. The temperature at which a solid changes to its liquid form is:
   - A. boiling point
   - B. melting point
   - C. freezing point
   - D. condensation
3. The physical property of a substance that has no fixed numerical value at a given condition is:
   - A. density
   - B. boiling point
   - C. melting point
   - D. taste

Part III: Given the following physical properties of substances: odour, color, taste, melting point, boiling point and density.

a) Which of these physical properties have constant values under specific condition, such as temperature and pressure?
b) Which physical properties can be recognized directly by our sense organs?
c) Which of these properties are measured using instruments?
d) What will happen to ice kept in a cup for three days?

2.3. Classification of substances

At the end of this section, you will be 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 compile a list of general properties;*
- *investigate the properties of non-metals and compile a list of general properties;*
- *describe and classify mixtures into homogenous and heterogeneous;*
- *use models/ particles diagram to show differences between homogenous and heterogeneous; and*
- *describe the relationship among elements, compounds, mixtures, homogenous mixture and heterogeneous mixture.*

Why do scientists need to classify substances?

Scientists need to work with pure substances and apply techniques of purification to get these substances. Understanding the science of a substance would be simpler if it is a pure substance.

Activity 2.5

Discuss the following question in a group and then present to the class.

Name at least 10 kinds of substances that you see or know. Classify the materials you listed as pure substances or mixtures.

There are various ways of classification of substances in science. At this level, we classify substances based on their composition and properties, as pure substances and mixtures.

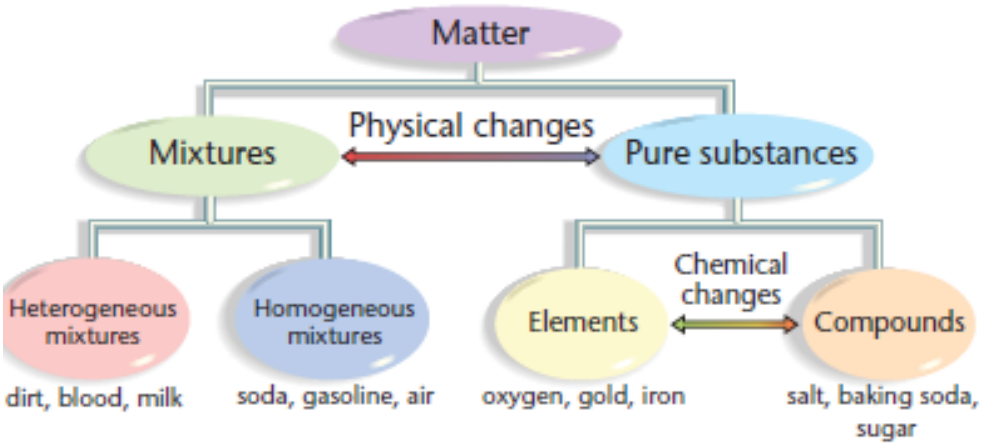


Chart 1. Classification of Substances

1. Pure substances

A pure substance is a form of matter that has constant composition and uniform properties throughout the sample. For example, a block of iron is a pure substance containing only one kind of component. Water is also a pure substance containing two components (hydrogen and oxygen) combined chemically in a definite ratio. Some other common examples of pure substances are oxygen, copper, gold, sugar, table salt and carbon dioxide. Pure substances are classified as elements and compounds depending on the constituent of elements.

Elements and Compounds

Activity 2.6

Discuss the following question in a group and then present to the class.

Consider the following substances: iron, water, oxygen, sugar, copper, gold, table salt, chlorine, tea, suphur, air, tap water, carbon, carbondioxide, hydrogen, salt solution and mercury.

1. Which of them are elements?
2. Which of them are compounds?
3. Which of them are mixtures?

A. Elements

Element is a pure substance that contains only one type of particle (atom), which is the smallest particle of an element. At present, there are 118 known elements. Among these elements, 92 of them occur naturally while the rest are man-made or artificial elements.

How elements might be classified into groups?

Elements are classified as metals, non-metals and metalloids.

Metals

are elements characterized by their shiny appearance (luster), electrical conductivity, malleability, ductility and flexibility. All metals are solids at room temperature except mercury, which is a liquid. They have high melting points and boiling points. Some examples of metals are gold, iron, silver, copper, aluminum, sodium and lead.

Non-metals

are elements that are not shiny, and are non-conductors of heat and electricity. They are not malleable and ductile. Non-metals generally exist as solids or gases at room temperature. Bromine is the only liquid non-metallic element. Non metals have relatively low melting points and boiling points. Carbon, sulphur, fluorine, iodine and phosphorous are some common examples of nonmetals. Most of the non- metals are gases at room temperature such as oxygen, nitrogen chlorine, and etc.

Metalloids

are elements that exhibit some properties of metals and some properties of non-metals. Example: boron, silicon, germanium, arsenic, antimony, tellurium and polonium.

Exercise 2.3

Make discussion for the elements given below and present your answer in the class. iron, oxygen, copper, gold, sulphur, carbon, hydrogen, silver, chlorine, phosphorus, nitrogen, iodine, zinc, aluminum, lead, fluorine, calcium, antimony, silicon, palladium and sodium.

1. Classify the elements as metals, non-metals or metalloids.
2. Write different properties that metals and non- metals show.

B. Compounds

A compound is a pure substance composed of two or more elements that are combined chemically in a definite proportion by mass. A compound can be decomposed into two or more elements by a chemical means. For example, carbon dioxide is a compound since it can be decomposed into carbon and oxygen by a chemical means.

Compound is the chemical combination of two or more elements chemically combined together to give new substances with new properties. This is because each element in a compound does not retain its identity. The properties of a compound are completely different from the properties of elements that make up the compound.

Elements chemically combined with other elements to form compounds. Sodium chloride is formed by the chemical combination of sodium and chlorine elements. Such types of compounds that are formed by the combination of two different elements are called **binary compounds**. Examples of binary compound are sodium chloride, calcium oxide (lime), Carbon dioxide. Most binary compounds contain metallic and nonmetallic elements.

Can you mention other examples of binary compounds?

2. Mixtures

Mixtures are combinations of two or more components in varying proportions and the components retain their identities. Mixtures, unlike compounds, are formed by the physical combination of components. Thus, a mixture does not have constant composition. They can be separated by physical means. Examples: Tap water, ink, salt solution, sugar solution, milk, soil, petroleum, alloys, air, and etc.

Table 2.2. The differences between compound and mixture

Compound	Mixture
A compound has a fixed composition.	Mixture has variable composition.
A compound has a new set of properties.	The components of a mixture retain their properties or identities.
A compound has a definite formula.	A mixture does not have a definite formula.
Formed as a result of chemical change.	Formed as a result of physical change.
Its components can only be separated by chemical means.	Its components can be separated by physical means.

Experiment 2. 5

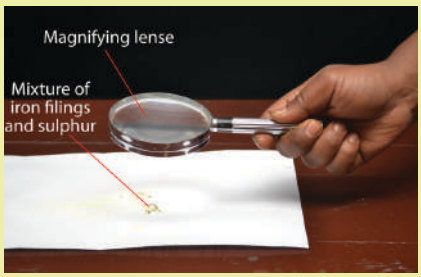
Title: Distinguishing compounds and mixtures.

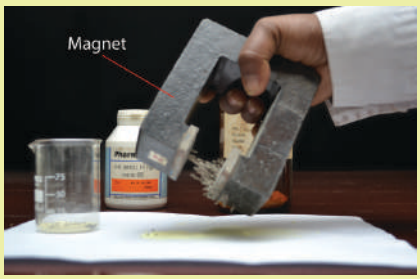
Objective: *To investigate the difference between a compound and a mixture.*

Materials Required: *Magnet, iron filings, powdered sulphur, test tube, Bunsen burner, magnifying glass, tong and beam balance.*

Part I: Procedures:

1. Mix 10 g of iron filings with 6 g of powdered sulphur. Examine the mixture using a magnifying glass as shown in figure 2.3(a).
2. Place half of this mixture on a sheet of paper. Bring one end of a magnet close to the mixture as shown in figure 2.3(b).
3. Observe the components of the mixture with a magnifying glass.





a. magnifying lenses b. magnet

Figure 2.3. Separating iron from a mixture of iron and sulphur

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: Procedures:

1. Place the remaining half of the mixture in a test tube. Heat the test tube strongly for a few minutes as shown in figure 2.4.
2. Put off the flame and remove the test tube. After the reaction stops, break the test tube by plunging the hot end into a beaker of cold water.
3. Take the product formed and powder it. Examine the product under a magnifying glass. Bring a magnet over it.

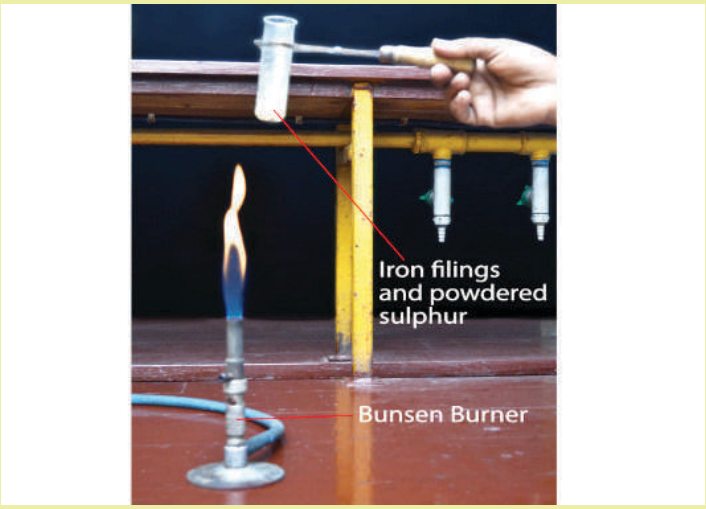


Figure 2.4. The reaction between iron and sulphur

Observations and Analysis:

1. Under a magnifying glass, are the iron filings and sulphur seen separately? Is it possible to attract the iron or sulphur by a magnet? Why?
2. Which part of the experiment (Part I or II) indicates a compound? Give your reason. Which part of the experiment (part I or II) indicates a mixture?

Classifications of Mixtures

Mixtures are classified into two. They are: homogeneous and heterogeneous mixtures.

A. Homogeneous mixture (solution)

What is homogeneous mixture? How it differs from heterogeneous mixtures?

A homogeneous mixture is a mixture in which the composition of the mixture is the same throughout the sample.

B. Heterogeneous mixture

A mixture that does not have a uniform composition throughout the sample is known as a heterogeneous mixture.

Table 2.3. Differences between homogeneous and heterogeneous mixtures

Homogenous mixtures	Heterogeneous mixtures
It has a uniform composition throughout.	It does not have a uniform composition throughout.
It has no visible boundaries of separation between the components.	It has visible boundaries of separation between the components.
Its components cannot be seen by our naked eyes or by microscope.	Its components can be identified by our naked eyes.
It consists of only one phase.	It contains more than one phase.

Exercise 2.4

Part I: Based on the instruction given below, perform the following questions

1. Identify whether the following are pure substances or mixtures.

   (a) Sea water
   (b) Gold
   (c) Chalk
   (d) Oil
   (e) Blood
   (f) Alcohol (ethanol)

2. Classify each of the following as an element, a compound or a mixture.

   (a) Milk
   (b) Ink
   (c) Salt
   (d) Air
   (e) Pure water
   (f) Sugar
   (g) Wood
   (h) Paper

3. Which of the following are homogeneous mixtures, and which of them are heterogeneous mixtures?

   (a) Milk
   (b) Blood
   (c) Soil
   (d) Alloys
   (e) Mixture of salt and sugar
   (f) Sugar dissolved in water
   (g) Mixture of alcohol and water

Part II: Write short answer for the following questions

1. Give two reasons to support why water is a compound but not a mixture.
2. Explain why we classify bottled water, ink, milk, soil and air as mixtures.

2.4. Changes Around Us

At the end of this section, you will be able to:

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

2.4.1. Physical and chemical changes

Activity 2.7

1. What are physical and chemical changes?
2. Observe and record changes occurring in your home and identify whether they are physical or chemical changes.
3. Classify the following changes into physical or chemical change and give your reasons.
   a) Burning of charcoal
   b) Melting of ice
   c) Evaporation of water
   d) Fermentation

The substances in our environment constantly undergo changes. The decay of plants and animals, falling of fruits from trees, rusting of iron, are some of the changes that occur in our environment.

Can you mention other examples of changes you have observed in your daily life?

Most of the changes in substances are classified into physical or chemical changes.

Physical changes

What is a physical change?

A change in which a substance undergoes a change in its physical properties is called a physical change. Physical changes do not alter the composition or identities of the substances.

Physical changes can be classified into three. These are:

I. The changes of state,
II. Solution (dissolution), and
III. Mechanical changes

I. Change of State

We know that matter exists in three physical states or forms: solid, liquid and gaseous states. Change of state is the physical process where matter moves from state to another. Changes like melting, freezing, dissolving and evaporating are state changes. Consider the following changes of states of water.

$$\text{Ice} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{liquid water} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{gas/ steam}$$

By heating or cooling water, it is possible to convert liquid water in either direction. These changes of state indicate that the change is reversible.

II. Solution

The process of dissolving a substance in water to form a solution is a physical change. For example, when common salt is dissolved in water, a clear salt solution is formed. If this mixture is heated, the water is evaporated, and the original salt remains as a residue. Thus, in the process of dissolution, no new substances are produced.

III. Mechanical changes

Mechanical change is the change which involves change in shape and size of objects. Mechanical changes brought about by breaking, hammering, powdering, tearing and cutting of substances are physical changes. Some

example of mechanical changes are powdering of chalk, breaking of the stones in to pieces, tearing of paper, grinding of corn in to powder, breaking of sticks in to small pieces.

Chemical change

Activity 2.8

Among the following, identify chemical changes.

1. Burning of wood
2. Ripening of tomato
3. Boiling water
4. rusting of iron
5. melting of ice

What is a chemical change?

Chemical changes are changes that result in the formation of new substance with entirely new properties. When the substance is chemically changed, the new substance formed would have different composition from the original material. Examples of chemical changes are: burning of paper, digestion of wood, fermentation of grapes, souring of milk, "*tella*" or *"tej"*, decaying of food, etc. Chemical change takes place due to chemical reaction.

Table 2.3. Difference between chemical and physical change

Chemical changes	Physical changes
New substances with new properties are formed.	No new substance is formed (identity of the substance does not change).
It is a change in the chemical property of the substance.	It is a change in the physical property of the substance.
It is difficult to reverse the change.	The change is easy to reverse (It is a reversible process).
Energy change (heat change) is involved.	Energy changes (heat changes) are not necessarily involved.

Experiment 2.6

Title: Melting of sulphur

Objective: *To determine whether the melting of sulphur is a physical or a chemical change.*

Materials required: *Test tube, watch glass, bunsen burner, tong, powdered sulphur*

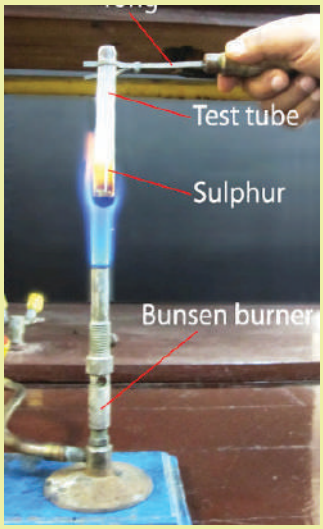


Figure 2.5. Melting of sulphur

Procedure:

1. Put powdered sulphur to half of a test tube of 25ml.
2. Heat the test test gently until all the sulphur melts as shown in figure 2.5.
3. Observe the color of the molten sulphur
4. Pour the molten sulphur on a watch glass and allow it to cool.
5. Let the watch glass stay for some days, and observe the change again

Observations and Analysis:

i. Name all the colors of sulphur you observed before and after the experiment.
ii. Is there a change? What type of it?

Exercise 2.5

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

1. Cutting a block of wood into pieces is a chemical change.
2. Formation of manure from leaves is a physical change.
3. Iron and rust are the same substances.
4. Condensation of steam is not a chemical change.

Part II: Classify the changes involved in the following processes as physical or chemical changes or both.

(a) Photosynthesis
(b) Dissolving sugar in water
(c) Burning of coal
(d) Melting of wax
(e) The compression of a spring
(f) Souring of milk
(g) Beating aluminum to make aluminum foil
(h) Formation of clouds in the atmosphere
(i) Freezing of ice cream
(j) Evaporation of alcohol
(k) Burning a thread of candle
(l) Digestion of food
(m) Melting of iron

2.4.2. Useful and Harmful Changes

Activity 2.9

Make a group and discuss on the following question

1. Give examples of useful and harmful changes.
2. Are all changes useful? Explain with examples.

Many physical and chemical changes are very important in our life. The changes that benefit human beings and makes living environment better is said to be important changes. An example of useful changes are production of clothes, soaps, vehicles, medicine and drugs; growth of plants; construction of buildings; ripening of edible fruits etc.

Harmful changes are changes that adversely affect either human beings and/or living environment. Some harmful changes include earth quakes, volcanic eruption, emission of different gases from vehicles, spoiling of food, rusting of iron, and etc.

2.5. Separation of Mixtures and its Application

At the end of this section, you will be 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 separatory funnel;*
- *name apparatuses used in decantation, filtration, simple distillation, using separatory funnel;*
- *assemble apparatuses used in decantation, filtration, simple distillation, separatory 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;and*
- *compare and evaluate the different ways of separating mixtures from products in community.*

2.5.1. Methods of separation of mixtures

Activity 2.10

Make a group and discuss on the following questions.

1. List the methods of separation of mixture used in your daily life.
2. What method is used to separate fine flour and coarse particles, oil and water, water from sand, and home prepared coffee?

Separation techniques are methods of obtaining pure substances. Most of the substances around us exist in the form of mixtures. However, these mixtures can be separated into their components using various separation techniques. The methods used to separate mixtures are mainly physical processes.

There are many physical methods used to separate mixtures. Some of them are: magnetic separation, decantation, using separatory funnel, filtration, evaporation and distillation.

A. Magnetic separation

Magnetic separation is used to separate magnetic and non magnetic substances in a mixture. If you bring a magnet close to a heterogeneous mixture, the magnetic components are attracted by the magnet and easily attached to it. For example, mixture of sand and iron fillings, sulfur and iron fillings. The iron filings (magnetic component) are attracted by the magnet, while the sand and sulfur do not.

B. Decantation

What technique is used to prepare home-made drinking coffee ("Jebena buna") shown in figure 2.6?

Figure 2.6. Separations by Decantation

Pouring boiled coffee from the pot ('Jebena') to the cup is the method of separation using decantation. This method of separation is used when one component of a mixture is a liquid and the other one is an insoluble solid denser than the liquid component. A mixture of sand and water can also be

separated using decantation. During the decantation process, first the mixture is allowed to stand in a container for some time. The insoluble solid settles down to the bottom of the container. This is called ***sedimentation.***

Experiment 2.7

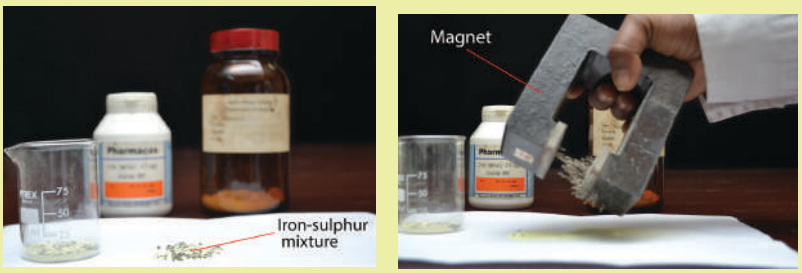
Title: Separation of a mixture using a magnet

Objective: *To separate a mixture of iron filings and sulfur using a magnet.*

Materials Required: *Magnet, iron filings, powdered sulphur, beaker, sheet of paper, spatula.*

Procedures:

1. Take two spatulas of each of iron filings and powdered sulphur, and mix them thoroughly, in a beaker.
2. Place some of this mixture on a sheet of paper as shown in figure 2.7(A).
3. Bring a magnet close to the mixture as shown in figure 2.7(B).



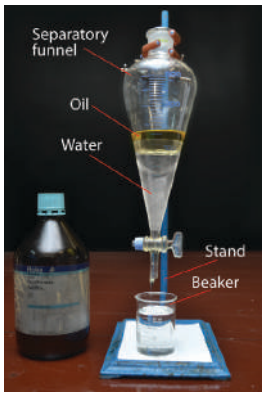
A*Figure 2.7. A) mixture of iron and sulphur B)Magnetic separation the mixture*

Observations and Analysis:

i. Which component of the mixture is attracted to the magnet?
ii. What can you conclude from the experiment?

C. Separation by using separatory funnel

Separatort funnel is used to separate immiscible mixtures. Immiscible liquids



do not mix and thus they form two layers. A mixture of oil and water can be separated using a separatory funnel. When the mixture is poured into a separatory funnel, the oil and water separate into two distinct layers as shown in figure 2.8. Since water is denser than oil, it is collected at the bottom of the funnel.

Figure 2.8. Separating a mixture of oil and water

D. Filtration

Activity 2.11

Form a group and discuss the following concepts

Consider a mixture of water and sand. How can you separate this mixture into individual components?

A filter paper is used to separate insoluble solid from the liquid. It has a lot of fine holes that allow only the liquid to pass through, but not the solid particles.

The liquid which passes through the filter paper is called the filtrate, and the solid which remains on the filter paper is known as the residue. Filtration can be used to separate mixtures like soil and water, sand and salt solution, powdered chalk and water, etc. In practical application, filtration is a key step in the purification of the tap water you drink.

Figure 2.9. Filtration

Experiment 2.8

Title: Filtration

Objective: *To separate a mixture of sand and water by filtration.*

Materials Required: *Beakers, filter paper, funnel, flask, sand.*

Procedure:

1. Put sand in beaker containing water, and stir to dissolve it.
2. Pour the mixture into the funnel fitted with a filter paper and collect the filtrate in the flask.
3. Observe the result.

Observations and Analysis:

i. Does the sand dissolve in water?
ii. Which substance is collected in the flask?
iii. Which substance remains on the filter paper?

E. Evaporation

Activity 2.12

Perform the following activity in groups, and present your findings to the class.

Take a beaker with full water; keep it at a place exposed to sunlight. Wait for a day to observe a change.

1. What happened to the level of the water in the beaker? Increased, decreased or remains the same? Explain it.
2. What can you conclude from your observation?

Evaporation is a method used to separate a soluble solid from a liquid in a solution. For example, sea water is a solution of salts. When it is heated on an evaporating dish, the level of the liquid slowly decreases because some of the water changes into vapor. This vapor will then escape into the atmosphere,

leaving behind the salts.

F. Simple distillation

What is distillation?

Distillation is a method of separating the components of a liquid mixture or a soluble solid from a liquid in a solution. It consists of both evaporation (boiling) and condensation processes. In the distillation process, the separation of a mixture is based on the difference in the boiling points of the components.

During distillation, when the mixture is heated in the distillation flask, the liquid with low boiling point is vaporized first. This vapor is passed through a cooling tube, called a condenser, where it is condensed into a liquid as shown in Figure 2.10. The liquid is then collected in a receiver. This clear liquid is known as a distillate.

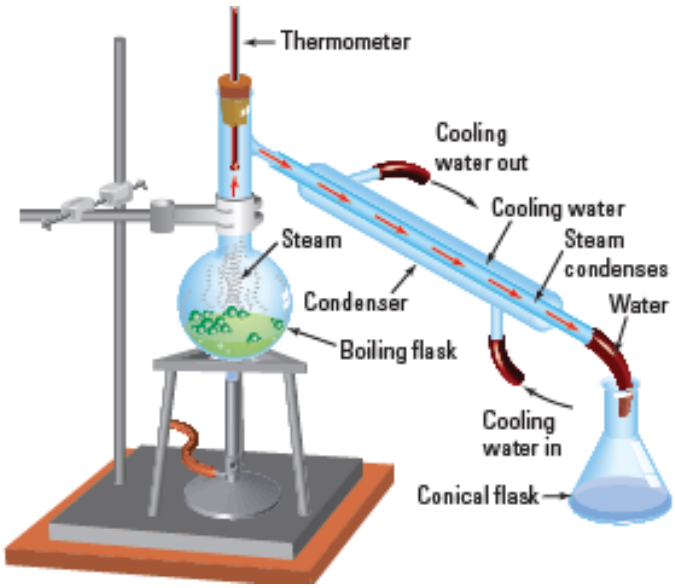


Figure 2.10. Simple distillation

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, and the mixture of benzene and oil are some examples of miscible liquids.

Separation of mixtures 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.

Experiment 2.10

Title: Simple distillation

Objective: *To separate water from salt solution.*

Materials Required: *Distillation flask, condenser, wire gauze, bunsen burner, conical flask, beaker.*

Procedures:

1. Dissolve about 40 g of common salt in 150 mL of pure water.
2. Set up the distillation apparatus.
3. Add 100 mL of the salt solution into the distillation flask.
4. Put a porous material or sand (boiling chips if there are any) in the flask.
5. Heat the distillation flask gently and observe the results.

Observations and Analysis:

i. What is collected in the receiver (conical flask) and what remains in the distillation flask?
ii. Where evaporation and condensation take place in this experiment?
iii. Why the condenser is connected with tap water in a simple distillation set up?

2.5.2. Separating of mixtures using locally available materials

There are number of ways that mixture can be separated by using local materials. These are:

i. hand pickling process
ii. winnowing process
iii. sieving process

Project 2.1

Make a group and perform the following project then present it to the class.

Part I: Separating mixtures by using locally available materials

1. How river water can be purified by using locally knowledge? Write steps to be followed and present it to the class.
2. How "Areke" can be prepared by locally? What materials are required to prepare? Ask your parents/ nearby shops where liquor prepared/ and write procedures and present it to the class.
3. Discuss with your parents/guardians and elders in your neighborhood on the techniques of separating mixtures like:

   i. wheat from its residue. iii. flour from ground residue.
   ii. mixture of beans and peas.

Part II: Write the short note and present your findings to the class in the form of an oral presentation, a poster display, or multi-media presentation.

The following processes are local method of separating mixtures. Write procedure for each separation process.

a. hand pickling process b. winnowing process
c. Sieving process

Exercise 2.6

How would you separate the following mixtures? Describe the separation techniques in each case.

1. Sand from water
2. Alcohol from water
3. Components in muddy water
4. Hot water and butter
5. Kerosene (Nafta) and water
6. Common salt and clay
7. Two miscible liquids
8. Sand from salt
9. Crushed ice and crushed glass
10. Table salt and charcoal
11. Sugar and sand
12. Oil, water and sand

UNIT SUMMARY

- A substance is a form of matter possessing constant properties under specific conditions.
- Properties of substances are subdivided into physical and chemical properties.
- Physical properties of a substance describe the characteristics of the substance that are related to physical changes.
- Substances can be identified based on their physical properties such as state, color, odor, taste, hardness, density, melting and boiling points.
- Chemical properties describe the characteristics of a substance related to chemical changes.
- Substances can be classified as pure substances and mixtures.
- Elements and compounds are pure substances, and have constant composition and uniform properties.
- An element is a substance that cannot be broken down into simpler form by chemical means. Elements are classified into metals, non metals and metalloids.
- A compound is a substance composed of two or more elements chemically combined in a fixed proportion.
- A mixture is a substance which consists of two or more pure substances that are mixed together physically. Mixtures are classified into homogeneous and heterogeneous mixtures.
- Substances undergo two types of changes: physical and chemical changes. Physical changes are changes that do not result in the formation of new substances with new properties. Chemical changes are the changes in the composition of substances.
- Mixtures can be separated into their components using different methods

such as magnetic separation, filtration, decantation, evaporation and distillation.

Key Terms

- Change in state
- Chemical change
- Compounds
- Decantation
- diffusion
- Distillation
- Elements
- Evaporation
- Filtration
- Heterogeneous mixture
- Homogeneous mixture
- Magnetic separation
- Metalloids
- Metals
- Mixture
- Non-metals
- Physical change
- Properties
- Sedimentation
- Substance

REVIEW EXERCISE

Part I: Write true for the correct statements and false for the wrong statements.

1. A physical change is a change in the composition of a substance.
2. A homogeneous mixture always contains only one phase.
3. Atoms combine chemically to form elements.
4. Two different substances cannot be similar in all physical properties.
5. The ability of iron to conduct electricity is a chemical property of iron.
6. The temperature at which a solid melts is the same as the temperature at which its liquid solidifies.

Part II: Choice the correct answer from the given alternatives.

1. Which one of the following is **not** a pure substance?
   - **A.** Diamond
   - **B.** Water
   - **C.** Oxygen
   - **D.** Milk
2. Which of the following is a compound?
   - **A.** Iron
   - **B.** Blood
   - **C.** Alloy
   - **D.** Sugar
3. Which one of the following does not involve a change of state?
   - **A.** Freezing
   - **B.** Expansion
   - **C.** Melting
   - **D.** Boiling
4. Which one of the following processes does not help in separation of mixtures?
   - **A.** Filtration
   - **B.** Burning
   - **C.** Distillation
   - **D.** Sieving
5. The apparatus used to separate two immiscible liquids is
   - **A.** separatory funnel
   - **B.** condenser
   - **C.** filter funnel
   - **D.** filter paper

6. The two stages that take place during distillation are
   - **A.** filtration followed by evaporation
   - **B.** evaporation followed by condensation
   - **C.** condensation followed by evaporation
   - **D.** filtration followed by condensation

7. The process of settling of suspended particles is known as
   - **A.** decantation
   - **B.** distillation
   - **C.** sedimentation
   - **D.** magnetic separation

8. The substance that cannot be further decomposed by ordinary chemical means is
   - **A.** water
   - **B.** sugar
   - **C.** gold
   - **D.** air

Part III: Give short answers for each of the following questions.

1. Identify whether the following statements describe a physical or a chemical property of a substance.
   - **(a)** Charcoal burns in air to form carbon dioxide.
   - **(b)** Ethyl alcohol boils at 78°C.
   - **(c)** Sulphur is a yellow solid at room temperature.
   - **(d)** Mercury is a silvery-white liquid metal.
   - **(e)** Silver is the best conductor of electricity.
   - **(f)** Iron rusts in the presence of moisture and air to form an oxide.

2. Identify the following changes as physical change or chemical change?
   - **(a)** Hammering aluminum into thin sheets
   - **(b)** Dissolving table salt in water
   - **(c)** Melting gold to make jewelry
   - **(d)** Burning of wood
   - **(e)** Grinding of maize
   - **(f)** Tearing of paper

3. Given samples of the following pairs of substances, name two physical properties that could be used to distinguish between the materials in each pair.
   - **(a)** Copper and lead
   - **(b)** Copper and silver
   - **(c)** Water and benzene
   - **(d)** Sulphur and iron
4. What is the difference between a physical and a chemical change?
5. How could you distinguish a compound from a mixture? Give three characteristics for each.
6. How would you distinguish between homogenous and heterogeneous mixtures? Give three examples for each case.

UNIT THREE

ELEMENTS, COMPOUNDS AND CHEMICAL REACTIONS

Learning Outcomes

At the end of this unit, students will be able to:

- *identify and write symbols of common elements or compounds;*
- *compare elements to compounds and how they are represented by symbols and formulae;*
- *name compounds from the given formula and write formula for the compound from the given name of the compound;*
- *use symbols and chemical formula as a way of communicating information about elements and compounds;*
- *state and apply the law of mass conservation for writing balanced equations;*
- *interpret chemical formula of compounds in terms of the elements present and the ratios of their atoms; and*
- *identify the use of chemical reaction for every day situation of life.*

Main Contents

3.1. Elements and their representation

3.2. Compounds and their representation

3.3. Simple chemical reactions and equations

3.4. Uses of chemical reactions in every day situation.

Start-up activity

Discuss the following and present your opinion to the class.

1. What is an element?
2. Write the name of commonly used elements.

Introduction

Under chapter two, you have learned that substances can be classified as pure substances and mixtures. Pure substances are further classified as elements and compounds. This unit deals with the elements, compounds, chemical reactions and uses of the chemical reactions in everyday life. The unit also gives emphasis for the concepts how the names of elements and compounds can be represented by using chemical symbols and formulae.

3.1. Elements and Their Representation

At the end of this section, you will be able to:

- *define element;*
- *identify symbols of some common elements;*
- *write chemical symbols for common elements;*
- *explain of importance of using symbols.*

Common Elements

You have learned that there are about 118 known 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). It is the simplest form of matter. For example, the six common elements that found in the living things are hydrogen, carbon, sulphur, oxygen, nitrogen and phosphorous.

Chemical symbols

Activity 3.1

Discuss the following and present to the class.

1. What is chemical symbol and its representation?
2. Can you mention the names of elements you are familiar with?

In science, each known 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 they are much easier. 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.

Chemical symbol is a shorthand way of representing names of elements or atoms of an element. Symbols are specific for a specific element. No two elements can have the same symbol.

A chemical symbol is usually the first letter of the English or Latin name of the element. Examples: Nitrogen (N), Aluminium (Al), hydrogen (H), oxygen (O), and etc. Chemical symbols are sometimes called atomic symbols.

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

The names of some elements such as carbon, calcium, chlorine and copper begin with the same letter "C". Therefore, we cannot use the letter "C" as a symbol for all these elements. Hence, two letters are used for all these elements except one. The first letter "C" is assigned as a symbol for carbon. The other elements are represented by two letter symbols. Thus, the symbols for these elements will be Ca for calcium, and Cl for chlorine.

The first letter of a symbol is always capitalized, but the second letter is small.

The symbols for the 18 elements derived from their English names are given in table 3.1.

Table 3.1. Symbols of 18 elements derived from English names.

Name of Element	Symbol	Name of Element	Symbol
Hydrogen	H	Neon	Ne
Helium	He	Magnesium	Mg
Lithium	Li	Aluminum	Al
Beryllium	Be	Silicon	Si
Boron	B	Phosphorous	P
Carbon	C	Sulphur	S
Nitrogen	N	Chlorine	Cl
Oxygen	O	Argon	Ar
Fluorine	F	Calcium	Ca

Table 3.2. The symbols and Latin names of some elements

Element	Latin word	Symbol
Silver	Argentum	Ag
Sodium	Natrium	Na
Iron	Ferrum	Fe
Lead	Plumbum	Pb
Mercury	Hydrargyrum	Hg
Tin	Stannum	Sn
Gold	Aurum	Au
Potassium	Kalium	K

Importance of using symbols

- Symbols are much easier and quicker to write the name of an element.
- The same symbols are used throughout the world so that chemists all over the world can understand them.
- Symbols stand for a specific element.

Exercise 3.1

Part I: Write a short answer for the following questions

1. What is a chemical symbol for Aluminum?
2. What is the problem if only first letter is taken as the symbol for all elements?
3. For some elements their symbols and names are not related or correspond. Why?

Part II: Fill the missing symbols and names of the elements in the following table.

Name of element	Oxygen		Carbon		Zinc	Barium
Symbol		K		P		

3.2. Compounds and Their Representation

At the end of this section, you will be able to:

- *define compounds;*
- *define meaning of formula and valence number;*
- *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; and*
- *identify the elements and number of atoms in given a chemical formula.*

Compounds

Activity 3.2

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

What do the notations, Co and CO represents? Explain their differences.

You have learned that compound is a substance which consists of two or more elements chemically combined together. In order to represent a compound, we combine the symbols of the elements to make a chemical formula.

Chemical Formulas

Chemical formula is the short hand representation of the compound by using symbols of elements. Therefore, it is the symbolic representation of composition of the compounds. Formulas can be classified as formulas of elements and formulas of compounds.

The formula of an element differs from a compound in that elements contain one kind of symbol and can be written in diatomic form whereas the formula of a compound contains the symbols of two or more different elements.

Example

- formula of an element: H_2, Br_2, O_2, and etc.
- formula of a compound: NaCl, HCl, KBr, and etc.

Formulas of Diatomic Elements

Do you know the elements that exist as diatomic molecules?

Molecule of an element is an atom or a group of atoms that exists freely in nature. Accordingly elements may exist as monatomic, diatomic or polyatomic molecules.

The hydrogen molecule is a diatomic molecule because it contains only two atoms. It is represented by the formula H_2. The symbols of other diatomic elements are given in table 3.3.

Table 3.3. Chemical symbols and formulas of diatomic elements

Name	Chemical symbol	Chemical 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

Molecules containing more than two atoms are called polyatomic molecules. Ozone (O_3), Phosphorus (P_4) and Sulphur (S_8) are examples of polyatomic molecules.

Valence Number

Activity 3.3

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

1. What is valence number?
2. What are the use of valence number in writing chemical formula?

The combining power of an element is its relative capacity to combine with other elements. This combining power of an element is called valence number. Different elements have different combining powers. It is easy to write the formula of a compound if we know the combining power of the elements or polyatomic ions involved.

In compounds containing hydrogen, whose valence number is 1 combines with element chlorine whose valence number 1; the formula becomes HCl.

One atom of oxygen with valence number 2 combines with two atoms of hydrogen forms water, H_2O.

What is the formula of 1 nitrogen atom and 3 hydrogen atoms?

The valence numbers of most common elements are either 1, 2, or 3. Some elements have more than one valence number, which has different combining powers under different conditions. Table 3.4 illustrates the elements with different valence numbers.

Table 3.4. Valence numbers of some common elements

Element	Valence number 1		Valence number 2		Valence number 3	
	Name	Symbol	Name	Symbol	Name	Symbol
Metals	Lithium	Li	Beryllium	Be	Aluminum	Al
	Sodium	Na	Magnesium	Mg	Iron (III)	Fe(III)
	Potassium	K	Calcium	Ca		
	Copper (I)	Cu (I)	Zinc	zn		
	Silver	Ag	Iron (II)	Fe (II)		
			Cupper (II)	Cu(II)		
Non-metals	Hydrogen	H	Oxygen	O	Nitrogen	N
	Chlorine	Cl	Sulphur	S		
	Bromine	Br				
	Iodine	I				

Exercise 3.2

Answer the following questions.

1. Which of the following elements exists as a diatomic molecule?

   A. Carbon **C.** Bromine

   B. Sulphur **D.** Neon

2. 2.What is the valence number of:

   (a) Sulphur in H_2S? **(c)** Phosphorus in PH_3?

   (b) Carbon in CH_4 ?

Formulas of Binary Compounds

Activity 3.4

Discuss the following questions and share your answer to the class.

How to write formulas of compounds in which the metal and non-metal have the same combining power?

Binary compounds contain atoms of only two different elements. Examples of binary compounds are sodium chloride (NaCl), hydrogen bromide (HBr), copper (II) oxide (CuO), and etc. The formulas of binary compounds in which the metallic and nonmetallic elements have the same valence numbers are simply represented by the symbols of the elements. This is because the combining powers of the elements are balanced.

For example:

- The formula of potassium chloride is KCl because the valence numbers of both K and Cl is 1.
- The formula of calcium oxide is CaO because the valence numbers of both Ca and O is 2.

The method of writing formulas of binary compounds is shown in the following steps:

Step 1. Write down the symbols for the elements in the compound.

Let us consider some examples:

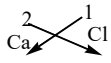
Sodium Oxide	Na	O
Calcium Chloride	Ca	Cl
Aluminum Oxide	Al	O

Step 2. Write the valence numbers above the symbols

i. $Na^{1}O^{2}$ ii. Ca^{2} Cl^{1} iii Al^{3} O^{2}

Step 3: Now criss cross the valence numbers and put the numbers below the symbols.

$\Rightarrow Na_2O$, thus, the formula of sodium oxide is Na_2O.



$\Rightarrow CaCl_2$, thus, the formula of calcium chloride is $CaCl_2$.

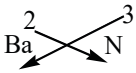
$\Rightarrow Al_2O_3$, thus, the formula of aluminum oxide is Al_2O_3

Note: If the valence numbers of the elements in the compound are equal, simplify and write the simplest formula of the compound. For example, the formula of magnesium oxide is MgO and not Mg_2O_2.

Example: Write the formulas for the following binary compounds.

a. Barium nitride
b. Potassium iodide
c. Magnesium oxide
d. Aluminum chloride

a. Barium has a valence number 2 and nitrogen has a valence number 3. To balance their combining powers, criss cross their valence numbers as follows:

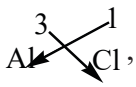


, thus, the formula of barium nitride is Ba_3N_2.

b. Since both potassium and iodine have valence numbers 1, the formula of potassium iodide is KI.

c. Since both magnesium and oxygen have valence numbers 2, the formula of magnesium oxide is MgO.

d. Aluminum has a valence number 3 and chlorine has a valence number 1. To balance their combining powers, criss cross their valence numbers as follows:



, thus, the formula of aluminum chloride is $AlCl_3$.

What is the formula of the compound formed by magnesium and fluorine?

Naming Binary Compounds

Activity 3.5

Make a group and discuss on the following questions.

How the binary compounds are named?

The two constituent elements of binary compounds are usually metals and nonmetals. For example, NaBr, CaO and $AlCl_3$. There are also binary compounds which consist of non-metallic elements only. For example, H_2O, CO_2 and NH_3 .

Rules for Naming Binary Compounds

1. **For binary compounds that consist of metals and non-metals, the metal is named first followed by the non metal.**

2. **The suffix -ide replaces the last letters of the name of the non-metal as shown table.**

Table 3.5. Names of non metallic elements in binary compounds

Non- metallic element	Name in binary compounds
Fluorine	Fluoride (F^-)
Chlorine	Chloride (C^{l-})
Bromine	Bromide (Br^-)
Iodine	Iodide (I^-)
Oxygen	Oxide (O^{2-})
Nitrogen	Nitride (N^{3-})
Sulphur	Sulphide (s^{2-})
Hydrogen	Hydride (H^-)

Examples: potassium iodide (KI), Magnesium nitride (Mg_3N_2), Calcium hydride (CaH_2) etc.

3. If the binary compound consists of non-metallic elements only, we name the first element in the formula followed by the name of the second element with the suffix -ide.

Examples: Hydrogen chloride (HCl), Hydrogen bromide (HBr), etc.

4. If the metal has variable valence numbers, the valence number of the metal used in the formula should be placed in parenthesis using capital Roman numerals after the name of the metal.

Examples: Copper (I) Oxide (Cu_2O), Iron (II) Chloride ($FeCl_2$), iron (III) chloride ($FeCl_3$), and etc.

5. Some compounds are named by using Greek numbers like mono, di-, tri-, tetra-, penta-, etc for one, two, three, four or five numbers respectively.

Consider the following examples:

CO – Carbon monoxide
P_2O_3 – Diphosphorus trioxide
NO_2 – Nitrogen dioxide
N_2O_4 – Dinitrogen tetroxide
SO_2 – Sulphur dioxide

Example:

Name the following binary compounds.

a. $SiCl_4$ b. N_2O_5 c. NF_3

Solutions:

(a) Because there are four chlorine atoms, the name of the compound is silicon tetrachloride.

(b) There are two nitrogen atoms and five oxygen atoms. Thus, the name of the compound is dinitrogen pentoxide.

(c) Since there are three fluorine atoms, the name of the compound is nitrogen trifluoride.

Traditionally, many of compounds are called either by their common names or by names that do not specifically indicate the number of H atoms. Examples:

H_2O - Water NH_3 - Ammonia
PH_3 - Phosphine H_2S - Hydrogen sulphide

Exercise 3.3

1. The valence number of a metallic element M is 3. What is the formula of its oxide?
2. Name the following binary compounds

a. Ca_3N_2	d. SO_2	g. $MgBr_2$	j. P_2O_5
b. $AlCl_3$	e. NO	h. CO_2	k. SO_3
c. MgS	f. PCl_3	i. CaI_2,	

Polyatomic Ions

Polyatomic ion is an ion that contain more than one atom. It is a group of atoms that exists in several compounds but does not exist on its own. For example, Nitrate, NO_3^- is polyatomic ion that consists of nitrogen and oxygen atoms but cannot exist itself unless combined with other elements or groups of elements like sodium nitrate ($NaNO_3$). Polyatomic ions are sometimes called radicals. Polyatomic ions and their valence numbers are given in table 3.6.

Table 3.6. Valence numbers of some polyatomic ions.

Valence number 1		Valence number 2		Valence number 3	
Name	Symbol	Name	Symbol	Name	Symbol
Hydroxide	OH^-	Carbonates	CO_3^{2-}	Phosphate	PO_4^{3-}
Nitrate	NO_3^+	suphates	SO_4^{2-}		
Hydrogen carbonate	HCO_3^-				
Hydrogen sulphate	HSO_4^-				
Ammonium	NH_4^+				

Writing chemical formulas and naming simple chemical compounds containing polyatomic ions

To write chemical formula by using atoms with groups or polyatomic ions, different compounds are formed according to the combining power of groups and atoms as written below.

I. When two combining groups (element and poly atomic ion) have the same combining power, the formula will become simply writing symbol of an element and poly atomic ion.

Example $KOH, NH_4Cl, NH4NO_3, KHCO_3, KOH$ (potassium hydroxide), NH_4Cl (ammonium chloride), NH_4NO_3 (ammonium nitrate), $KHCO_3$ (potassium hydrogen carbonate), and etc.

II. When two combining groups (element and poly atomic ion) have different combining power, the formula will be written using their valency number or combining power.

Example: KOH, NH_4Cl, NH_4NO_3, $KHCO_3$, and etc.

For example, to write the formula of aluminum sulphate:

Step1. $Al \quad SO_4$

Step2. $Al^3 \quad SO_4^{\,2}$

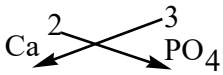
Step3. $Al_{\,3} \quad SO_{4\,2} \Rightarrow Al_2(SO_4)_3$

☞ Thus, the formula of aluminum sulphate is $Al_2(SO_4)_3$.

Example 1:

Write the chemical formula for calcium phosphate.

Calcium has a valence number 2 and phosphate ion has valence number. To balance their combining powers, crisscross their valence numbers as shown below.

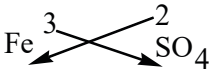


Thus, the formula of calcium phosphate is $Ca_3(PO_4)_2$.

Example 2:

Write the chemical formula for iron (III) sulphate.

Iron (III) has a valence number 3 and sulphate ion has a valence number. To balance their combining powers, crisscross their valence numbers as shown below.

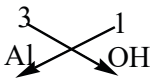


Thus, the formula of iron (III) sulphate is $Fe_2(SO_4)_3$.

Example 3:

Write the chemical formula for aluminuim hydroxide.

Aluminum has a valence number 3 and hydroxide ion has a valence number 1.



Thus, the formula of aluminuim hydroxide is $Al(OH)_3$.

Exercise 3.4

Answer the following questions .

1. Name the following compounds

   a) Li_2SO_4 b) $(NH_4)_3PO_4$ c) $Ca(NO_3)_2$ d) $Fe(NO_3)_2$
   e) $CaCO_3$ f) $Mg(OH)_2$ g) $BaSO_4$ h) $(NH_4)_2SO_4$

2. Write chemical formulas for the following compounds.

   a) *Potassium hydroxide*
   b) *Ammonium Sulphate*
   c) *Magnesium carbonate*
   d) *Magnesium phosphate*

Interpreting formula

Symbols and formulas describe both qualitative and quantitative aspects of the substances.

Qualitatively a symbol represents the identity (kind) of the element. For example, the symbol N represents an atom of nitrogen.

Quantitatively a symbol represents the number of atoms of the elements. For examples, H stands for one atom of hydrogen and Na stands for one atom of sodium.

Qualitatively a formula represents the kinds or types of elements involved in forming a compound. For example, a water molecule, H_2O, contains the elements hydrogen and oxygen.

Quantitatively a formula stands for one molecule (formula unit) of an element or a compound. Examples; CO_2 represents one molecule of carbon dioxide, P_4 indicates one molecule of phosphorous.

A number written in front of a symbol or a formula is called a *coefficient*. It shows the number of atoms or molecules or formula units of the substances.

Examples:

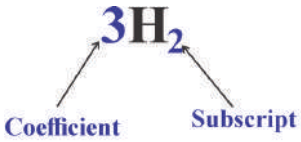
- 3Fe represents 3 atoms of iron
- 2H means 2 atoms of hydrogen (Note that: 2H differs from H_2)
- $5N_2$ means 5 molecules of nitrogen.

Note that the coefficient multiplies the whole atoms of the elements in the formula, not only the first element. For example, $2HNO_3$ represents two molecules of nitric acid which contains 2 atoms of hydrogen, 2 atoms of nitrogen and 6 atoms of oxygen.

Subscripts are used in writing formulas. A *subscript* is a number written at the bottom right hand side of a symbol. In the formula of an element, the subscript

qualitatively shows the element is in a molecular form. For example Cl_2 is a chlorine molecule, P_4 is a phosphorus molecule and S_8 is a sulphur molecule.

Quantitatively a subscript in a formula stands for the number of atoms in the formula. For example, H_2 indicates a molecule of hydrogen which contains 2 hydrogen atoms. The general notation is shown below using hydrogen molecule as an example.



For the formula $3H_2O$, the coefficient 3 shows as there are 3 molecules of water. The subscript 2 shows that there are 2 atoms of hydrogen in a water molecule and 1 oxygen atom in a water molecule. This information is called quantitative information.

Exercise 3.5

1. Fill the blank spaces in the table given below.

No	Chemical symbol or formula	Qualitative meaning	Quantitative meaning
a	$2Cl_2$		
b	$4Cl$		
c	$3S_8$		
d	$5MgF_2$		

2. Quantitatively, the formula $5Br_2$ represents;

A. 5 atoms of bromine
B. 2 molecules of bromine
C. 5 molecules of bromine
D. 10 molecules of bromine

3. Interpret the formulas of;

(a) CaO

(b) $Ca(NO_3)_2$

Project 3.1

Search different materials, such as a science books, and or the internet, or any other materials and discover the formulae of common compounds such as baking soda, vinegar (acetic acid), lime and interpret them in terms of the elements present and the ratios of their atoms.

3.3. Simple chemical reactions and equations

At the end of this section, students will be 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; and*
- *create and use models of particles to demonstrate balanced equations.*

Simple chemical reaction

Activity 3.6

Discuss in a group and present to the class

1. Describe the various chemical changes that occur in your daily lives.
2. What are evidences that indicate as chemical reactions occurred?

A chemical reaction is a process in which a substance is changed into one or

more new substances. The substances that take part in a chemical reaction are called reactants. The substances formed as a result of a chemical reaction are called products. In a chemical reaction reactants are transformed into products as shown below.

Reactants ⟶ Produts

Always reactants are written on the left side of the arrow and products are written on the right side of the arrow. For reaction that have more than one reactant, the following representation is used.

A + B ⟶ C + D

The plus sign, "+"means "combines with" or "reacts with", The arrow is directed from reactant(s) to product (s) to mean "produces" or "gives" or "yields".

For example, when carbon burns in air (oxygen) it produces carbon dioxide.

Examples of chemical reactions are:

The reaction between hydrogen and oxygen gives water.

Hydrogen + Oxygen → Water (dihydrogen oxide)

$H_2 + O_2 \rightarrow H_2O$

The reaction between calcium and oxygen produces calcium oxide.

Calcium + Oxygen → Calcium oxide

$Ca + O_2 \rightarrow CaO$

Can you write an equation that shows the reaction between sodium and oxygen?

Examples of chemical changes that are brought as a result of chemical reactions are rusting of iron, fermentation, digestion of food, photosynthesis, etc.

Can you give other chemical changes that bring chemical reaction?

There are a number of evidences that show whether chemical reaction has taken place or not. These are, change in color, change in temperature (heat) formation of gases and change in composition.

The Law of Conservation of Mass

The law of conservation of mass states that in all chemical reactions the total mass of the reactants is equal to that of the products. This means atoms cannot be created or destroyed in a chemical reaction. Hence mass is conserved during a chemical reaction. The law of conservation of mass is also known as the law of conservation of atoms. Mass is conserved during a chemical reaction i.e. no atoms are lost or gained but they are simply rearranged.

For example, consider the reaction between magnesium and oxygen to give magnesium oxide as shown below.

$$2Mg + O_2 \rightarrow 2MgO$$

For this reaction before the reaction takes place, the mass of magnesium and the mass of the oxygen are 24g and 32g respectively. The sum of the mass of the magnesium and oxygen is 56. After the reaction takes place, the mass of product MgO is 56 g.

$$2Mg + O_2 \rightarrow 2MgO$$

24g 32g 56g

In this reaction, there 2 magnesium atoms on and two oxygen atoms on the both sides of equation. This implies that atom is conserved. The following experiments illustrate this concept.

Experiment 3.1

Title: Simple chemical reaction.

Objective: *To study simple chemical reaction by burning magnesium in air.*

Materials and Chemicals required: *bunsen burner, match, tong, crucible and magnesium ribbon.*

Procedures:

1. Hold a magnesium ribbon with a tong and heat it on the Bunsen burner
2. Collect the product on the crucible.
3. Record your observations.

Figure 3.1. Burning of magnesium in air

Observations and Analysis

1. What is the importance of heat for the reaction?
2. What are the reactants?
3. Compare and contrast the properties of the reactants with the product.

Simple Chemical Equations

The representation of a chemical reaction with symbols and formulas of the substances is known as a *chemical equation*.

A chemical equation describes both a qualitative and a quantitative statement of the substances involved in each of the reactant or product.

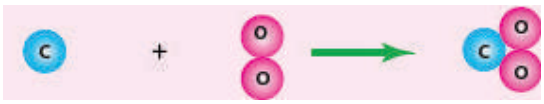
To write the chemical equation for a reaction the word equation is written first.

Example:

Chemical reaction: Burning of carbon

Word equation: Carbon + Oxygen → Carbon dioxide

Chemical equation: $C + O_2 \rightarrow CO_2$



1 atom carbon + 2 atoms oxygen → 1 molecules of carbon dioxide

For the above reaction, one atom of carbon reacts with one molecule of oxygen to form one molecule of carbon dioxide. This chemical equation obeys the law of conservation of mass or matter since it is balanced.

Steps in Writing Simple Chemical Equation

To write a chemical equation for a given reaction the following three steps are very important.

Step1. Write a word equation for the reaction.
Step2. Change the word equation to a chemical equation i.e., write the correct symbol or formula for each reactant and product.
Step3. Balance the equation so that it obeys the law of conservation of mass.

For instance, the chemical equation for the reaction between sodium and oxygen is illustrated as follows;

Step 1: Sodium + Oxygen → Sodium oxide . . . (Word equation)
Step 2: $Na + O_2 \rightarrow Na_2O$ /Chemical Equation . . . (Not balanced)
Step 3: $4Na + O_2 \rightarrow 2Na_2O$ . . . (Balanced chemical equation)

Activity 3.7

Perform the following task in group and present to the class.

Why the chemical equation must be balanced? Give examples of balanced chemical equation.

Note that a chemical equation must represent the experimental facts.

Balancing Chemical Equation

A balanced chemical equation indicates the total number of atoms on the reactant side equal to the total number of atoms on the product side. This follows from the law of conservation of mass.

Chemical equations are balanced by putting the appropriate coefficients before the symbols or formulas of the substances involved in the reaction. There are different methods of balancing chemical equations. Inspection method is the simplest method used to balance simple chemical equations.

Balancing by Inspection Method

This method is a trial and error method of balancing chemical equation. The following rules are to be followed to balance chemical equation by using inspection method.

1. ***Write the word equation for the reaction.***
2. ***Change the word equation to chemical equation.***
3. ***Check those atoms of elements that are not equal on both sides of the equation and balance them by writing appropriate numbers in front of the symbols and formulas.***

Note: Do not change subscripts of any of the reactants or product!

Example 1

Balance the equation for the reaction of hydrogen with oxygen to form water.

Step1: Hydrogen + Oxygen → water

Step2: H_2 + O_2 → H_2O

Oxygen is not balanced because there are 2 atoms of oxygen on the left hand side whereas there is only 1 atom of oxygen on the right hand side.

Step 3: To balance the equation:

i. Put 2 in front of H_2O to balance oxygen as follows.

$$H_2 + O_2 \rightarrow 2H_2O$$

ii. Now put 2 in front of H_2 to balance hydrogen.

$$2H_2 + O_2 \rightarrow 2H_2O \text{ (balanced)}$$

Check:

Reactants	Products
4H atoms	4H atoms
2O atoms	2O atoms

Example 2

Write the balanced chemical equation for the reaction between magnesium and hydrochloric acid to produce magnesium chloride and hydrogen gas.

Magnesium + hydrochloric acid →magnesium chloride+hydrogen gas.

$$Mg + HCl \rightarrow MgCl_2 + H_2$$

To balance the equation: Put 2 in front of the HCl. The rest are already balanced.

$$Mg + 2HCl \rightarrow MgCl_2 + H_2$$

Exercise 3.6

Write the balance chemical equation by using inspection method.

1. The reaction between zinc metal with hydrochloric acid to form zinc chloride and hydrogen gas.
2. When carbon reacted with a limited amount of oxygen forms carbon monoxide.
3. The reaction between sodium and oxygen to produce sodium oxide.
4. Burning of sulfur in air to yield sulfur dioxide.
5. The reaction between aluminum and oxygen produces aluminum oxide.
6. Sulphur and oxygen to form sulphur trioxide.
7. Iron and sulphur to form iron (II) sulphide

3.4. Uses of Chemical Reactions in Every Day Situation

At the end of this section, you will be able to:

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

Uses of chemical reaction

There are many chemical reactions that take place in our body and in our daily life. But we cannot recognize them. Simple examples of chemical reactions are:

- digestion of food in our stomach is facilitated by hydrochloric acid.
- fermentation in brewing produces carbon dioxide and ethanol/ alcohol.
- combustion of charcoal (carbon) for cooking purpose of food
- soaps and detergents used to wash clothes and bathing.

- breathing is the process of inhaling oxygen and exhaling carbon dioxide to sustain in life; and many more uses of chemical reactions in everyday situations.

Project 3.2

The aim of this project work is to enhance students' knowledge in the area of uses of chemical reactions in every day situation. Discuss in group and give examples of useful chemical reactions using indigenous knowledge and present your finding to the class.

UNIT SUMMARY

- A chemical symbol is a short hand notation for the chemical name of an element.
- The first letter of a symbol is always capitalized, but the next letter is not.
- A chemical formula is the symbolic representation of a substance giving the ratios of different kinds of atoms in it.
- The formula of an element consists of one kind of symbol.
- The formula of a compound consists of two or more kinds of symbols.
- Molecules containing only two atoms are called diatomic molecules.
- Molecules containing more than two atoms are called polyatomic molecules.
- The combining power of an element or polyatomic ion is called valence number.
- A polyatomic ion is a group of atoms that exists in several compounds but does not exist on its own.
- The valence numbers of most common elements or polyatomic ions are either 1, 2 or 3.
- Binary compounds contain atoms of two different elements only.
- The formulas of compounds can be written if the symbols and valence numbers of the constituent elements or polyatomic ions are known.
- Qualitatively a symbol represents the identity of the element.
- Quantitatively a symbol represents the number of atoms of the elements.
- Qualitatively a formula represents the kind of elements involved in making a compound.

- A formula stands for one molecule or formula unit of a molecule or a compound.
- A number in front of a symbol or a formula is called a coefficient.
- A subscript is written on the bottom right hand side of a symbol.
- A chemical reaction is a process by which a substance(s) is/are changed into one or more new substances.
- The substances that take part in a chemical reaction are called reactants.
- In a chemical reaction reactants are transformed into products.
- The method of representing a chemical reaction with the help of symbols and formulas of the substances is known as a chemical equation.
- A balanced chemical equation is an equation in which the total number of atoms of each element on the left hand side is equal to the total number of atoms of the same elements on the right hand side.
- Inspection method is used to balance simple chemical equations.

Key Terms

- Binary compound
- Chemical equation
- Chemical formula
- Chemical reaction
- Coefficient
- Diatomic molecule
- Inspection method
- Law of conservation of mass
- Polyatomic ion
- Polyatomic molecule
- Products
- Reactants
- Subscript
- Symbol
- Valence number
- Word equation

REVIEW EXERCISE

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

1. A symbol stands for one atom of an element.
2. Polyatomic ions can exist in nature by themselves.
3. In a chemical reaction atoms are neither created nor destroyed.
4. N_2 and 2N have the same meaning.
5. A compound contains two or more elements that are chemically combined together.

Part II: Choose the correct answer from the given alternatives.

1. The chemical symbol for phosphorus is

   A. Po
   B. P
   C. Pt
   D. K

2. Which of the following is the correct name of BaB_{r2}?

   A. Boron bromide
   B. Barium bromide
   C. Barium dibromide
   D. Barium (I) bromide

3. Aluminum has a valence number of 3 and sulphur has a valence number of 2. What is the chemical formula for aluminum sulphide?

   A. $Al_2 S$
   B. AlS_3
   C. $Al_3 S_2$
   D. $Al_2 S_3$

4. The name of NO_2 is

   A. Nitrogen monoxide
   B. Nitrogen dioxide
   C. Nitrogen oxide
   D. Mononitrogen oxide

5. Quantitatively the formula $3N_2$ represents

   A. 3 atoms of nitrogen
   B. 2 molecules of nitrogen
   C. 3 molecules of nitrogen
   D. 6 molecules of nitrogen

6. All of the following elements can exist as diatomic molecules except

A. hydrogen
B. oxygen
C. sodium
D. chlorine

7. The Latin name of sodium is

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

8. Consider the following balanced chemical equation;

$$3Mg(OH)_2 + 2H_3PO_4 \rightarrow Mg_3(PO_4)_2 + 6H_2O$$

What is the coefficient of water (H_2O)?

A. 1
B. 2
C. 3
D. 6

III. Give short answers for the following questions.

1. Write chemical formulas for the following compounds.

(a) Magnesium iodide
(b) Sulphur trioxide
(c) Copper (II) oxide

2. Name the following compounds

(a) MgH_2
(b) Al_2O_3
(c) NO

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

(a) Aluminium + Iodine → Aluminium iodide
(b) Potassium + Water → Potassium hydroxide + Hydrogen
(c) Sodium + Oxygen → Sodium Oxide

UNIT FOUR

CELL AS THE BASIS OF LIFE

Learning Outcomes:

At the end of this unit, students will be 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 multi-cellular 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 and*
- *define photosynthesis and write its chemical equation.*

Main Contents

4.1. Microscope
4.2. Cell

Start-up Activity

Discuss on the following questions in group and present to the class.

1. Are there any organism that you cannot be able to see by your naked eyes?
2. Do you know any instrument that helps to see them?

Introduction

Today we take it for granted that all living organisms are made of cells. Although, some living organisms consist of only one cell and others have several billion cells, even the most complex organisms like human beings begin life as a single cell. Only a few hundred years ago, cells had not been discovered. The discovery of cells had to wait the development of reliable microscope that could magnify things that cannot seen by our naked eyes. As a result, the invention of microscope led to discover of cell. In the following sections you will learn more about the purpose and invention of microscope, types and basic parts of microscope. Furthermore in section 4.2, you will learn cells and their structures and functions in relation with their shape and size. And also you will learn more about unicellular and multicellular organisms, and the level of cellular organization. In addition to these, the unit elaborates more about relation between cellular respiration and photosynthesis as well as the role of mitochondria for respiration and chloroplast to photosynthesis.

4.1. Microscope

At the end of this section, you will be able to:

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

4.1.1. Purpose and invention of Microscope

Activity 4.1

Discuss the following questions in a group and present your group idea to the class

1. What instrument you can use to observe organisms that cannot be seen by our naked eyes?
2. What is microscope?
3. Who invented a microscope and when?

Invention of Microscope

Scientists use different tools to help to study living organisms. Many organisms are too small to be seen by our naked eyes and Scientists need to be able to see them. One of these instruments is microscope. Discovering the secret of cells revealed with the help of microscope. Today we commonly get used to think of living things as being composed of cells. However, the word "cell) was not used until the 17th century. The first observation of cell was made in 1665 by the English scientist Robert Hooke by using a microscope of his own invention. In 1673, Anton van Leeuwenhoek, a Dutch merchant pioneered the invention of one of the best microscopes of the time. He was the first to observe, draw, and describe a variety of cells including bacteria, other one-celled organisms, egg and sperm cells.

How do you define microscope?

A microscope is an instrument that is used to observe objects too small to be seen clearly with the naked eye.

4.1.2. Types of microscope

Activity4.2

Discuss the following questions in a group and present to the class.

1. Have you ever had a chance to see and use a microscope?
2. How many types of microscope do you know?
3. Do you think that the reading eye glass magnify an object? It you say 'yes', share your experience for your class.

There are two main types of microscope. These are: -

1. Simple light microscope; and
2. Compound light microscope.

1. Simple light microscope

Simple microscope is one of the microscopes that use a single lens for magnification. The hand lens is an example of a simple microscope (Fig 4.1). The magnification power of the common hand lens is usually between 10x and 20x. It means that the object that you are looking through these simple microscopes will appear 10x larger than from its actual size.

2. Compound light microscope

This is a microscope with magnifying powers of two convex lenses, the eye piece (ocular lens) and the objective lens which are used to produce a magnified image of small objects.

The total magnification is the product of the eye lens and objective lens magnification. For example, if the magnification of the eye lens is 10x and the magnification of the objective lens is 4x, then the total magnification is 40x. Compound microscope can be monocular and binocular microscopes (Fig 4.1).

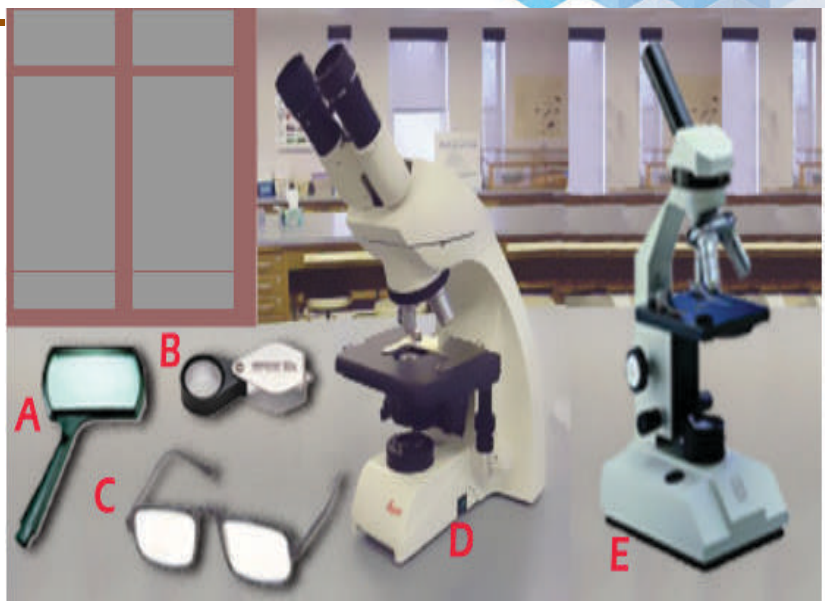


Figure. 4.1 A. and B are hand lens C. Eye glass D. Binocular E. Monocular compound microscope

4.1.3. Basic Parts of Compound Light Microscope

Activity 4.3

Discuss on the following questions in group and present to the class. Your teacher will provide you the samples of simple and compound light microscopes;

1. List the parts of each microscope.
2. Compare and contrast the differences in structure of those two microscopes.

Compound microscope has two main parts. These are:

a) **Mechanical part**: consists of metal stand and stage which have heavy base plate and a vertical rod fitted to it that provides support and stability to other parts of the microscope.

b) **Optical part**: consists of the mirror and lens of the microscope**.** These

parts are involved in passing the light through the object (specimen) and magnifying its size.

Table 4.1. The parts of compound microscope

Parts	Function
Ocular (eyepiece lens)	A convex lens used to magnify image (10x).
Body tube (barrel)	Supports the eyepiece and the nosepiece.
Coarse adjustment knob	Moves the tube up and down and produce a rough focus of the image.
Fine adjustment knob	Moves the tube up and down by very small amount and produce a sharp focus of the image.
Arm	Used to carry the microscope.
Nosepiece	Contains the high- and low-power objectives.
Objective lens	A convex lens used to magnify the image low-power (4x), medium-power (10x), higher power (40x) and oil immersion (100x) magnification power.
Stage	Supports the glass slide and contains the specimen being observed.
Stage clips	Hold the slide in place.
Iris diaphragm	Adjusts the amount of light passing through the stage.
Light source (lamp or mirror)	Illuminates the specimen.
Base	The bottom of the microscope, used for support.

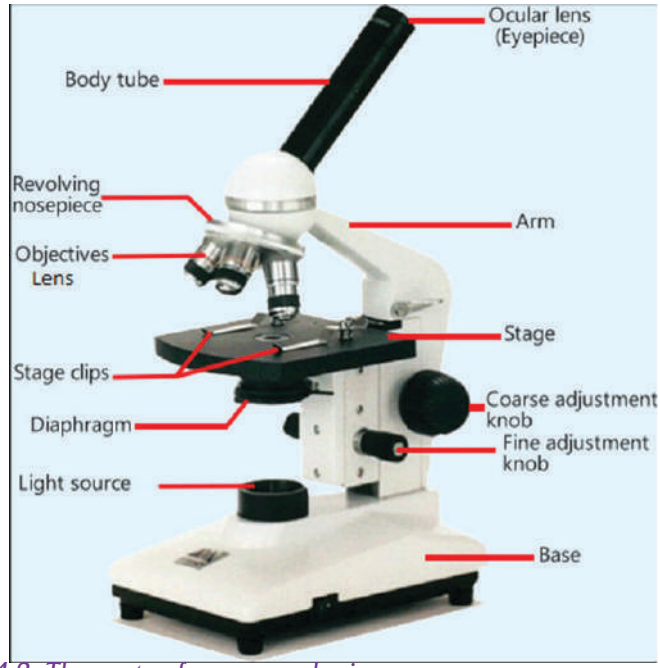


Figure 4.2. The parts of compound microscope

Exercise 4.1

Part I: Choose the correct answer from the given four alternatives.

1. Which of the following is **not** the function a microscope?

   A. Enlarge the size of the image.
   B. Magnify the image.
   C. Enables to see something not seen by our naked eye.
   D. Increase the actual size of an object.

2. A simple microscope consists of:

   A. two lens
   B. one lens
   C. three lenses
   D. more than one lens

3. The magnification of hand lens is;

   A. 4x
   B. 10x to 20x
   C. 40x
   D. 20x

4. Monocular compound microscope has;

   A. one eyepiece lens
   B. two objective lens
   C. two eyepiece lens
   D. three objective lens

4.2. Cell

At the end of this section, you will be able to:

- *explain how cell was discovered;*
- *draw and label the basic structures and functions of a cell;*
- *explain why cell shape and structure vary;*
- *distinguish between unicellular and multicellular organisms;*
- *differentiate among cell, tissue, organ and organ system with examples;*
- *examine and weigh the importance of photosynthesis; and*
- *examine and weigh the importance of cellular respiration.*

Activity 4.4

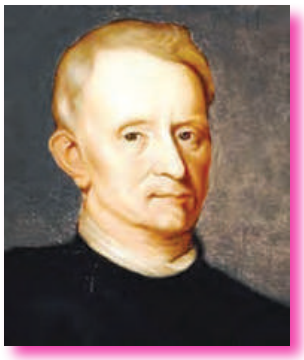
Form a group of five students and discuss the following questions:

1. Discuss and list down the structural components of a house which can be wooden (mud-walled or brick-walled), how each component play a role for build a house, and explain the structural and functional difference of each component and finally, relate these ideas with the cell.

2. List down the commonly known external and internal organs of human body. How these various body organs are assembled together to form our body by correlating it with a house structure.
3. Take a particular human body part, for instance, liver, and discuss in groups if it is made up of further smaller parts or not; present your response to the class.

4.2.1. The Discovery and Definition of Cell

Great Scientists



In **1665**, a scientist, Robert Hooke observed a thin section of cork under a microscope and he saw hexagonal compartments like those of a bee-hive. He named those compartments 'cells'. This term is derived from the Latin word '*cella*' which means 'small room'.

In **1673**, Anton van Leeuwenhoek assembled various lenses to construct a microscope. He was the first to observe live bacterial and protozoan cells under the microscope.

In **1838,** the two scientists Matthias Schleiden and Theodore Schwann formulated a cell theory about cellular structure which stated, 'All the living organisms are made up of cells and the cell is the fundamental component of living organisms. In **1885**, Rudolph Virchow stated that all cells are formed from pre-existing cells.

Cell is defined as the smallest, structural, functional, and biological units of all living organisms. It can replicate itself independently.

All living organisms are made up of a unite structure called cells. Hence, cells are known as the building blocks of life. Cells are extremely minute in size. We cannot see cells with the naked eye.

Cells in our world come in two basic types, ***prokaryotic*** (without a true nucleus) and ***eukaryotic*** (with a true nucleus). "Karyose" comes from a Greek word which means "kernel," as in a kernel of grain. In biology, we use this word root to refer to the nucleus of a cell. "Pro" means "before," and "eu" means "true," or "good." So "Prokaryotic" means "before a nucleus," and "eukaryotic" means "possessing a true nucleus."

4.2.2. The Structures of Cell and their Functions

The cell is structural and functional unit of life implies cell contains different structures and the cell structure comprises individual components with specific functions essential to carry out life's processes is known as **organelles**. Organelles in a typical (generalized) **eukaryotic cell** may be grouped into four main parts, i.e. cell wall, cell membrane, cytoplasm and nucleus.

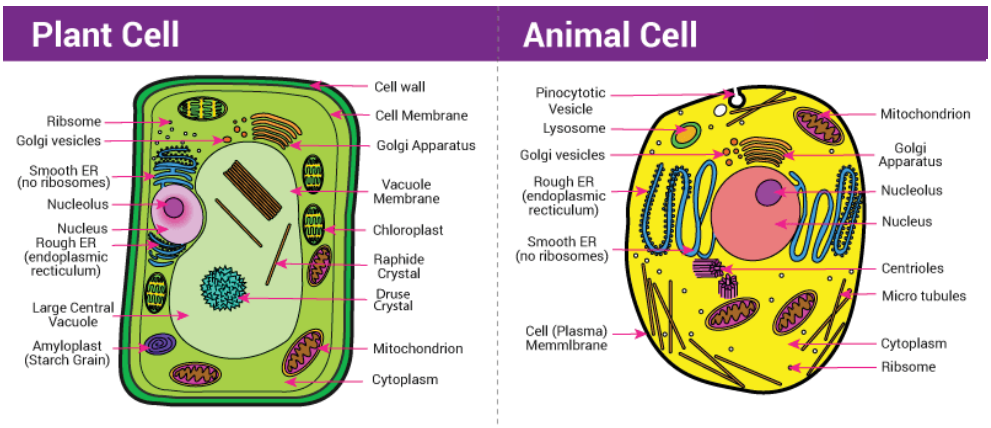


Figure 4.4.Structures of plant and animal cells

Activity 4.5

Discuss the following questions in group and then:-

1. List down the cellular structures of plant and animal cell.
2. Draw the table by using pencil on hard white paper.
3. Fill the table by structures that are common for both animal and plant cell and the structures that are found only in one cell but not found in another cell. Bring your work to the class and compare with your friends.

1. Cell wall

Cell wall is a tough, rigid layer that surrounds some types of cells. The major function of the cell wall is to provide rigidity, tensile strength, structural support, protection against mechanical stress and infection. It contains plasmodesmata that facilitate free passage of materials in and out of the cell.

2. Cell membrane (plasma membrane)

Cell membrane is an organelle that found in all plants and animal cells that is used for controlling the movement of substances in and out of the cell. Also, it supports and protects the cell as well as covers all other organelles that found inside a cell.

3. Nucleus

The cell nucleus is an organelle that found in all eukaryotic organisms at center of the cell which controls all activities of the cell and it contains the hereditary material of the cell.

4. Cytoplasm

The cytoplasm is a thick, clear, jelly-like substance present inside the cell membrane. Some cytoplasmic organelles with specific functions are described as follows:

a. Plastids: are the site of manufacture and storage of important chemical compounds used by the cell. They often contain pigments used in photosynthesis, and the types of pigments present can change or determine the cell's color. The pigments that it contains are:

   i. Chloroplasts: Found only in plant cells and the site of photosynthesis takes place.
   ii. Chromoplast: They are heterogeneous organelles responsible for pigment synthesis and storage in specific photosynthetic eukaryote. These pigments give colors for flowers and fruits.
   iii. Leucoplast: They are colorless non-pigmented organelle, in contrast to other plastids such as the chloroplast.

b. Mitochondria: are "the powerhouse of the cell and main site of respiration" because they generate most of the cell's supply of adenosine triphosphate (ATP), used as a source of chemical energy.

c. Endoplasmic Reticulum : (ER) is a network of membranes and functions as channels and flattened sacs throughout the cytoplasm of the cell. There are two types of ER. When ribosomes are attached, it is called rough ER and when there are no ribosomes attached, it is called smooth ER. The rough endoplasmic reticulum is where most protein synthesis occurs in the cell. The function of the smooth endoplasmic reticulum is to synthesize lipids, form channels that transport newly synthesized products and substrates, collect and storing synthesized materials in the cell.

d. Ribosomes: are organelles that help in the synthesis of proteins. They facilitate the synthesis of proteins and called cell's 'protein factories'.

e. Lysosomes : are organelles originating in part from the Golgi apparatus. They contain digestive enzymes, and they are the sites where macromolecules (proteins, polysaccharides, nucleic acids, and lipids) are hydrolyzed into their monomers.

f. Folgi bodies (Golgi apparatus): The Golgi complex (also known as the *Golgi body* or *Golgi apparatus*) was first described in 1898 by the Italian microscopist Camillo Golgi, who found a way to specifically stain this organelle. The Golgi complex processes, sorts, and modifies proteins.

g. Vacuoles: are fluid-filled membranous sacs and only found in plant cells and unicellular animals. Plant cells have large central vacuoles (filled with fluid called cell sap) and animal cells have small temporary vacuoles. Vacuoles store nutrients like protein, oils and water.

Exercise 4.2

Match the organelles of cell in column B with their functions in column A.

Column A	Column B
1. Outer membrane made of a phospholipid bilayer that controls cellular traffic.	A. Nucleus
2. A rigid covering found in plant cells that controls cell pressure.	B. Mitochondria
3. Fluid-filled sacs for storage, digestion, and waste removal in plant cells.	C.Endoplasmic reticulum
4. The energy producer of the cell and second largest organelle.	D. Cell wall
5. The site where photosynthesis takes place.	E. Cell membrane
6. Has smooth and rough types and serves as the cell's transport system.	F. Ribosome
7. The information center and activities director of the cell.	G. Lysosome
8. A membrane structure made of layers that package proteins.	H. Chloroplast
9. The digestive organelle for proteins, lipids, and carbohydrates.	I. Golgi apparatus
	J. Vacuole

4.2.3. Cell Shape and Size

Activity 4.6

Be in a group and then your teacher will show you a chart of cells with different shape and size.

Discuss why the cells come with varied shape and size. After your discussion, reflect your answers to the class.

Living organisms are made up of different types of cells that have different shape and sizes. Shape and size vary from cell to cell according to their functions and composition. For example, a nerve cell is long and branched, meant for the transmission of signals throughout our body while a muscle cell is small and spindle-shaped.

Considering an ***animal cell***, we can generalize the shape of cell as round (spherical) or irregular. ***Plant cells*** are much more rigid and ***rectangular in shape***. The size of a cell can be as small as **0.0001** mm (*mycoplasma*) and as large as six to twelve inches (*Calera taxifolia*). Generally, the unicellular organisms are microscopic, like bacteria. But a single cell like an egg is large enough to touch. Whether regular or irregular in shape, they all consist of the same organelles and help us to perform the daily activities efficiently.

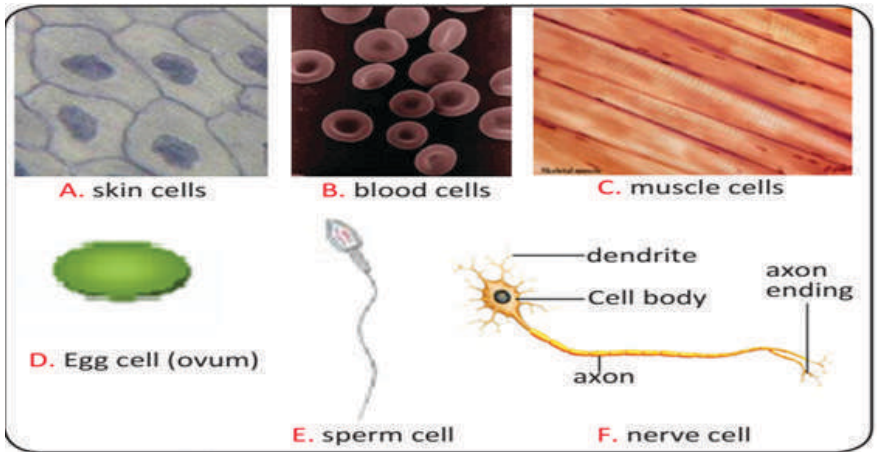


Figure 4.5. Size and shape of different cells

Majority of cells are microscopic in their size. There is diversity in size among cells that form the same organism. If we take the same example, in our body, different cells are varying in their size. Eggs of animals including that of humans are exceptionally big size as compared to other microscopic cells. For instance, an ostrich egg cell is the largest of any living bird.

Figure 4.6. An ostrich egg cell

Table 4.2. Type, size and shape of different cell

Cell type	Size in micrometer(μm) (1μm)or1/millions of mm	Cell shape
Red blood cell	9	Round
Human egg cell	100	Oval
Amoeba cell	90	Shapeless
Most of our cells	10 - 30	Different shape
Frog egg	2mm	Circular

4.2.4. Unicellular and Multicellular Organisms

Activity 4.7

Discuss in your previous group on the following questions.

1. Do all living things have the same number of cells?
2. What is the difference between unicellular and multicellular organisms?
3. What is a reason to describe organisms as unicellular or multicellular?

Finally share your group discussion for the class.

A. Unicellular organisms

Cells are the lowest level of organization in every life form. From organism to organism, the number of the cell may vary with in different organisms. Humans have more number of cells than bacteria. If an organism is made up of a single cell, it is called a ***unicellular organism*** (uni: one; cellular: cell).

But every organism starts their life from a single cell which further divides into thousands and millions. As the size of the organism increases, so does the number of cells that they have. However, this number will not determine the efficiency of an organism i.e., function and efficiency of a cell in a unicellular organism and multicellular organism will be the same.

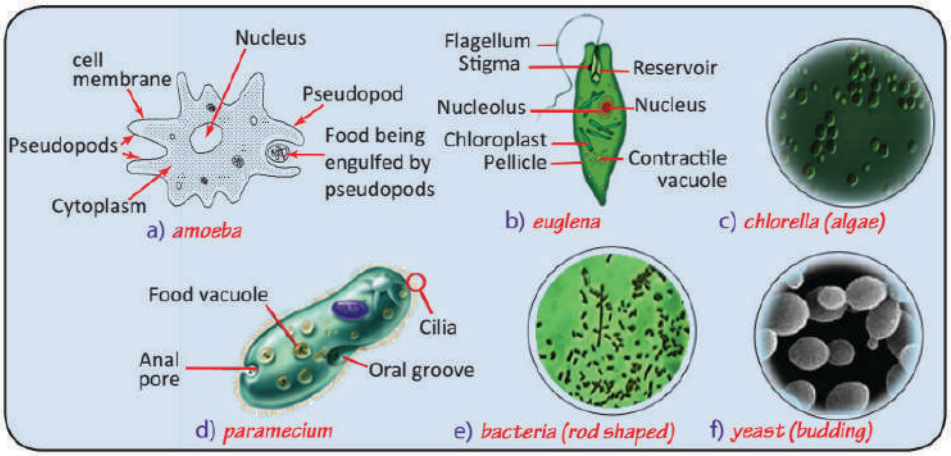


Figure 4.7. Examples of some unicellular organisms

B. Multicellular organisms

The organisms which are made up of more than one cell are called **multicellular organisms** (*multi:* many; *cellular:* cell). Among the multicellular organisms, the number of the cell varies. Some might have billions of cells while others have trillions (like the human). In multicellular organisms different cells are specialized to perform different functions only outer cells are specialized to face the environment while inner cells are devoted to other functions. Almost all plants and animals are multicellular organisms. Multicellular body can attain a large size by increasing the number of small cells and their lifespan is long due to limited load of work for each cell type.

In general, chart 4.1 shows both unicellular and multicellular organisms.

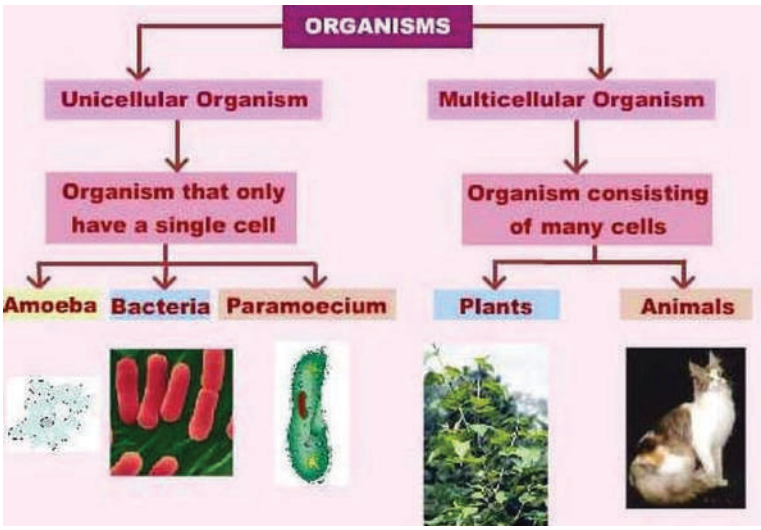


Chart 4.1 Unicellular and multicellular organisms

Table 4.3. Comparison between unicellular and multicellular organisms

Unicellular organisms	Both	Multicellular organisms

• They are made up of one cell
• They can survive as a single cell
• Each organism performs all life functions within it.
• They take in materials directly from surrondings.
• Materals move freely around the cell
	• They are made up of cells
	• They prform all six life functions:
	  • move
	  • grow
	  • repoduce
	  • excrete
	  • get nutrients (energy)
	  • gas exchange (breathing)
		• They are made up of more than one cell.
		• They cannot survive as a single cell.
		• Each cell is specialized to perform life functions.
		• They have transport systems to move different materials throughout the body.

4.2.5. Cell, Tissue, Organ, and Organ System

Activity 4.8

Discuss on the following questions and present to the class.

1. Define the words like cell, tissue, organ and system.
2. Give examples of cells, tissues, organs, and organ systems.
3. What is the first and most basic biological level of organization?

Biological Levels of organization

Levels of organization are structures in nature, usually defined by part whole relationships, with things at higher levels being composed of things at the next level of organizations. An organism is made up of four levels of organization: cells, tissues, organs, and organs systems (see chart 4.2). These levels reduce complex anatomical structures into groups; this organization makes components easier to understand.

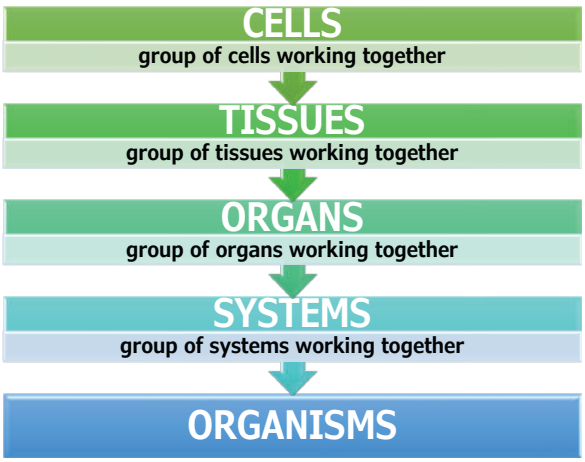


Chart 4.2 Cellular levels of organizations

In the previous section, you have learned that all organisms are made up of small structural and functional units known as cell, the basic unit of all living things. A group of cells that is similar in shape, size and that carries out the same function is called a **tissue**. Some examples of plant tissues include epidermal tissue, conducting tissue, photosynthetic tissue (mesophyll tissue), and etc.

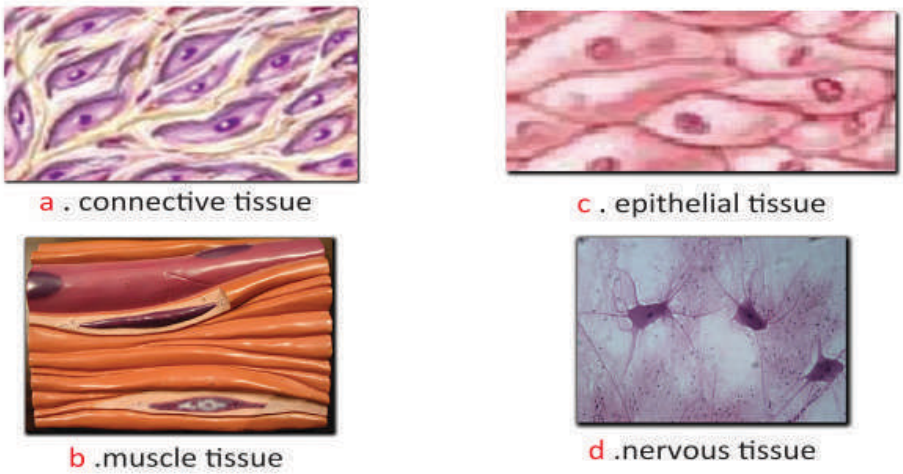


Figure 4.8. Different type of animal tissue

Organs can work within several systems of your body. Organs are a part of every system. Your heart is classified as an organ and it is a part of the circulatory system (circulates blood through your body). Many organs also have specific cells or tissues that have different jobs. Your kidneys are not only a part of your excretory system (the waste removal system) but also they have specific parts that serve as the endocrine system (your gland system).

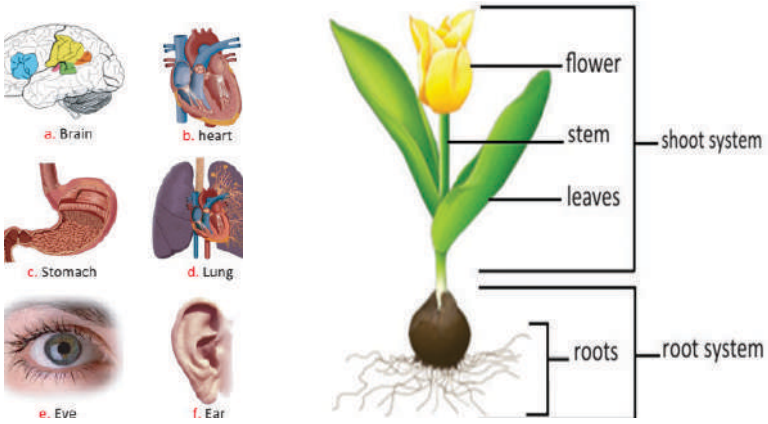


Figure 4.9. Some examples of animals and plant organs

A system is a group of organs that work together and provide an organism with an advantage for survival. It is the most complex organization in your body.

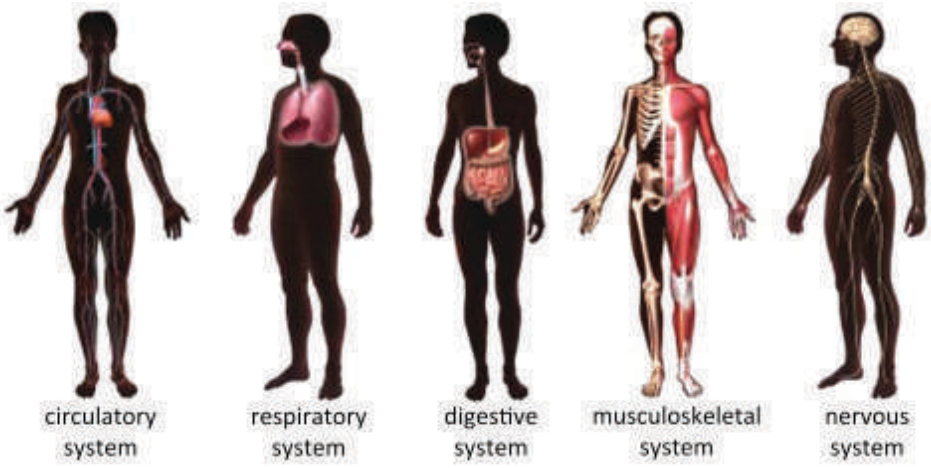


Figure 4.10. Major organ systems of the human body

4.2.6. Photosynthesis and chloroplast

Activity 4.9

Discuss the following questions in group and reflect your group idea to the class.

1. How the energy in the food we eat is released to our body?
2. What is the role of oxygen we inhale?
3. What is the relationship between the food we eat and the oxygen we breathe in?
4. What is the photosynthesis? What is the role of chloroplast?

All living organisms need food as a source of raw materials to build new cells and tissue as they grow. The process by which living organisms particularly green plants and algae, some bacteria, making their own food by using sun light is called ***photosynthesis***. Leaf is a main organ of photosynthesis. Photosynthesis only takes place in the chloroplast of green plants. Chlorophyll, the green pigment inside the chloroplasts uses the sun's energy to make food. In photosynthesis, chlorophyll captures the energy from sun light.

Photosynthesis can be summarized as a following chemical equation:

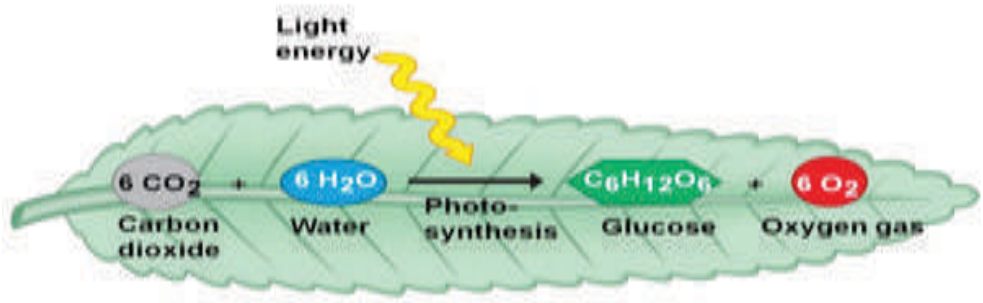


Figure 4.11. Chemical equation of photosynthesis

4.2.7. Respiration and Mitochondria

What is the source of energy for animals including human beings?

As you have learned in section 4.2.6, the sources of energy for all animals come from green plants by the processes of photosynthesis. Animals use biproducts of photosysnthesis such as glucose that is found in the food (that animals eat) and oxygen (that plants breath out as a wastage), and use this oxygen in order to burn food inside mitochondria and produce energy. This process in called respiration.

Respiration is also defined as a chemical reaction that takes place within cells to release energy from food that we eat.The processes of respiration take place in side cell organelle called ***mitochondria***.

The summary equation for aerobic respiration is:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + \text{energy released}$$

Exercise 4.3

Choose the correct answer for the following questions

1. The function of cell membrane is:
   - A. protect plant cell.
   - B. control the movement of materials in and out of cell.
   - C. control all activities of cell.
   - D. store materials.

2. One of the following is **not** found in plants.
   - A. nervous tissue
   - B. organ system
   - C. organ
   - D. tissue

4. One is different from the others.
   - A. Amoeba
   - B. Housefly
   - C. Paramecium
   - D. Euglena

6. Which one of the following is an example of prokaryotic organism?
   - A. Euglena
   - B. Algae
   - C. Plasmodium
   - D. Bacteria

7. Different organs working together for specific function to form:
   - A. organ system
   - B. cells
   - C. organism
   - D. tissue

8. The responsible organelle for respiration is:
   - A. chlorophyll
   - B. leaf
   - C. chloroplast
   - D. mitochondria

10. One of the following photosynthesis byproduct is used as a raw material for respiration.
   - A. carbon dioxide
   - B. water
   - C. oxygen
   - D. light

12. Oxygen that we in heal (breath in) is comes from:
   - A. air
   - B. atmosphere
   - C. green plant
   - D. other animals

UNIT SUMMARY

- Microscope is an instrument that used to observe too small objects that cannot be seen by our naked eyes.
- There are two main types of microscope. These are simple light microscope and compound light microscope.
- Simple light microscope use single (one) lens for magnification of objects while compound light microscope use two or more lenses to enhance the magnification of objects.
- A cell is the smallest, structural and functional unit of life.
- All cells have different organelles those have different functions.
- Living organisms are made up of different types of cells which have different shape and size.
- Unicellular organisms are made up of only one single cell whereas multicellular organisms made up of many cells.
- Photosynthesis is the process of food making by green plant and the site where it takes place is called chloroplast.
- Respiration is the process in which organisms especially animals obtain their energy from the food in the presence of oxygen inside the organelle called mitochondria.

Key Terms

- Cell
- Chlorophyll
- Chloroplast
- Microscope
- Mitochondria
- Multicellular
- Organ
- Organelle
- Organ system
- Photosynthesis
- Respiration
- Tissue
- Unicellular

REVIEW EXERCISE

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

1. Microscope is an instrument that magnifies small objects.
2. All living things are made up of cell.
3. All cells in living organisms have similar shape and size.
4. Different organs working together to form tissue.
5. Chloroplast is an organelle that captures sun light.
6. The respiration and photosynthesis are the two inter linked processes

.

Part II: Choose correct answer from the given alternatives

1. The discovery of microscope able scientists to describe:
   - A. organism
   - B. tissue
   - C. cell
   - D. organ
2. Apiece of glass used to converge or diverge light is known as:
   - A. stage
   - B. nosepiece
   - C. fine adjustment
   - D. lens
3. One of the following is found in both plant and animal cells.
   - A. Cell wall
   - B. Cell membrane
   - C. Chloroplast
   - D. Plastids
4. Which one of the following is an example of plant tissue?
   - A. Connective tissue
   - B. Nerve tissue
   - C. Parenchyma tissue
   - D. Epithelial tissue
5. The cell organelle that is described as a power house of the cell is:
   - A. cell membrane
   - B. mitochondria
   - C. chloroplast
   - D. nucleus

6. Which one of the following is the correct sequence of level in cell organization?

   A. Cell →Organ →Tissue →Organ system
   B. Cell → Tissue → Organ → Organ system
   C. Tissue → Organ → Organ system → Cell
   D. Tissue → Cell → Organ system → Organ

Part III: Label the parts of a microscope.

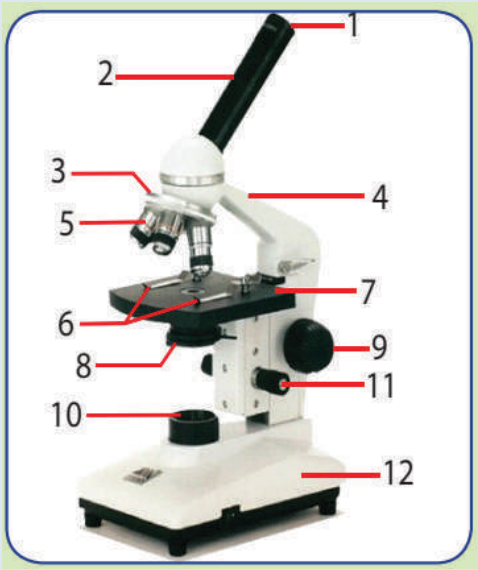


Figure 4.12. Parts of a microscope

UNIT FIVE

LIVING THINGS AND THEIR DIVERSITY

Learning Outcomes

At the end of this unit, students will be able to:

- *distinguish between living and non-living things by describing the features that characterize living things;*
- *discuss if the movement i.e. locomotion can characterize all living things;*
- *define classification and its purpose;*
- *list down the hierarchical levels in the classification of organisms;*
- *describe the distinguishing characteristics of kingdom animalia, plantea, protista, monera and fungi;*
- *list common examples of kingdom animalia, plantae, protista, monera and fungi;*
- *describe the body plan of common animalia, plantae, protista, monera and fungi; and*
- *describe habitat of animalia, plantae, protista, monera and fungi.*

Main Contents

5.1. Living things
5.2. Kingdoms of life.

Start-up Activity

Form a group of 5 to 6 students and discuss on the following questions.

1. Explain how living things are differs from non-living things
2. Explain the importance of classifying (sorting) things. Finally reflect your group discussion to the class.

Introduction

There are about 30 million kinds of organisms known to science and more remain to be discovered, named and classified. Of the 30 million known kinds, only about 2 million have been identified, named and classified. These organisms are not only enormous in number, but also present diversity of size, structure, mode of reproduction, modes of life, and ecological and geographical distribution over earth. This great diversity of life on earth today have attempted biologist to categorize similar organisms in order to better understand them and indicate their relationship to other living organisms. This endeavor gave rise to the science of taxonomy, which is a science of naming, describing and classifying of living things.

Hence, it is not possible for anyone to study such enormous in numbers of organisms. But if they are grouped in some convenient way, the study would become easier as the characters of a particular group or a family would apply to all the individuals of that group. This grouping of similar living things is known as classification. Scientists classify the variety of living organisms by using different criteria like the similarity and difference on their external (morphological) body structures that the organisms share in common.

Carl Linnaeus develops binomial nomenclature (naming organisms by two names) in order to solve the problem of language barrier among different scientists as well as scientists designated scientific name for each recorded organisms.

In this unit, you will deal more about the characteristic of living things, the importance of classification as well as the hierarchy of classification. Furthermore, you will also deal with the major characteristics of organisms in each five kingdoms and the members that can be found in each kingdom with their habitats and habits.

5.1. Living Things

At the end of this section, you will be 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; and*
- *analyze and describe the relationships of the hierarchical levels (Kingdom to Species) in the classification of organisms.*

When you look at the world around you, how do you categorize or group what you see? One of the broadest groupings is 'living' and 'non-living' things. This may sound simple, but it is sometimes difficult to decide whether something is truly alive or not. In order to say something is living it must perform the life functions such as respiration, reproduction, excretion, growth, sensitivity and nutrition. However , the movement or locomotion from place to place is not the common characteristics for all living things because the plants are a living, but they cannot move from places to places.

5.1.1. Characteristics of living things

Activity 5.1

Discuss the following questions in group and present your group discussion to the class.

1. What is advantage of movement, respiration, reproduction and sensitivity for living things?
2. Explain how these characters are used to classify organisms?
3. Why movement (locomotion), is not a common characteristics of living things? Justify.

There are the six characteristics of living organisms, such as, nutrition, respiration, excretion, growth, reproduction and sensitivity.

1. Nutrition

Living things take in materials from their surroundings that they use for growth or to provide energy. Nutrition is the process by which organisms obtain energy and raw materials from nutrients such as proteins, carbohydrates and fats.

2. Respirations

Respiration is the release of energy from food substances in all living cells. Living things break down food within their cells to release energy for carrying out the following processes.

3. Excretions

All living things excrete. As a result of the many chemical reactions occurring in cells, they have to get rid of waste products which might poison the cells. Excretion is defined as the removal of toxic materials, the waste products of metabolism and substances in excess from the body of an organism.

4. Growths

Growth is seen in all living things. It involves using food to produce new cells. The permanent increase in cell number and size is called growth.

5. Reproduction

All living organisms have the ability to produce offspring.

6. Sensitivity

All living things are able to sense and respond to stimuli around them such as light, temperature, water, gravity and chemical substances.

5.1.2. Classification and scientific names of organism

Activity 5.2

Discuss the following questions in a group and present to the class.

1. What is classification? Why living things are classified?
2. What criteria scientists use to classify living things?
3. Why scientific names of organisms should be used in science than the local name?

If you will have been in a library, you will know how much easier it is to find a book on a particular subject if the books are arranged in subject groups. When the librarian has a new book to add to the library, he or she will group it with books on a similar topic, according to a classification system.

Classification can be defined as grouping organisms according to their structural similarities. In short, classification means sorting things based on defined characteristics. The science of classification is called **taxonomy** and a system we use grouping living things into categories is called **taxa**.

Scientists classify living things for the following reasons:

a) *to simplify their study,*
b) *to bring order out of chaos or confusion and*
c) *to try understanding how life originated.*

What is scientific name?

Scientific name is binomial (two names- generic and species) name given for single species. It is universally used for a particular species or a particular group of organisms.

Scientists use scientific name rather than local name to identify different living organism in order to solve communication barrier among scientists and peoples of the world. There are thousands of languages in the world or even in local level; this makes difficult to know about the organism. For example, an animal Hyena (English name) is called by different names, that is *Ambooma* in Sidaamu Afoo, *Jibe* in Amharic, *Waraabeessa* in Afaan Oromoo, and etc. So, an individual who knows only one of these language cannot understand what the other said. It becomes impossible for one scientist to know about what organism another scientist is talking about. This problem is solved by classification given with scientifc name.

Simple rules for writing scientific names

1. The first name is the name of the genus to which the organism belongs. Its first letter is written with a capital letter.
2. The second name is the name of a species to which the organism belongs. Its first letter is written with a small letter.
3. The two names are underlined when hand written or in italics when printed.
4. Scientific names are usually taken from Latin language.

Some examples of scientific name: *Homo sapiens* (man), *Felis catus* (cat), *Bos taurus* (cow), *Canis lupusfamiliaris* (dog), *Ensete ventricosum* (ensete) and etc.

5.1.3. Hierarchy in the classification of organisms

Activity 5.3

Discuss the following questions in a group and present to the class.

1. List down the administrative hierarchy of Ethiopia from broad to specific. From that you list which rank include all the others.
2. Identify the broad and specific ones and correlate it with scientific hierarchy.

Hierarchy (ranking) is formed in the classification that starts from Kingdoms, Animalia or Kingdom Plantae; further groups and sub-groups are formed depending upon basic similarities and differences. This is called the 'hierarchy of classification.' The hierarchical levels in the biological classification from highest level to the lowest level: Kingdom, Phylum (Division in plants), Class, Order, Family, Genus and Species.

Table 5.1. The hierarchy in classification of living organisms

Hierarchy	Organisms		
	Mango	Honey bee	Human
Kingdom	Plantae	Animalia	Animalia
Phylum	Anthophyla	Arthropoda	Chordata
Class	Dicotylednae	Insecta	Mammalia
Order	Sapindales	Hymenoptera	Primates
Family	Anacardiaceae	Apidae	Hominidae
Genus	Mangifera	Apis	Homo
Species	indica	mellifera	sapiens

Note: *For easy and frequent memorization of hierarchy in classification, use this mnemonic example as: King Philip Came over For Good Spaghetti (KPCOFGS).*

Exercise 5.1

Part I: Choose the correct answer

1. In classification of organisms one includes all the others.

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

2. One of the following is not considered as a common characteristic for all living organisms.

   A. Growth C. Reproduction
   B. Respiration D. Movement

3. In a binomial nomenclature of organisms the first name indicates:

   A. genus C. species
   B. kingdom D. class

Part II: Define the following terms

1. Classification
2. Species
3. Binomial nomenclature

5.2. Kingdoms of life

At the end of this section, you will be 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;*

- *identify the parts of flower; and*
- *relate each kingdom of organisms to their major habitat types as aquatic, terrestrial or moist.*

Activity 5.4

Be in a group and discuss on the following activity.

Your teacher will provide you various charts consisting of worms, insects, fish, frogs, snake, crocodile, birds, human, lion, plants, mushroom, paramecium, amoeba, and bacteria etc.

Then,

1. Categorize the given organisms into five kingdoms.
2. From the provided charts, identify which organisms are neither animals nor plants. Why? Present your group work to the class.

A. Two Kingdom classification (Corolus Linnaeus, 1707-1778)

Carl Linnaeus (1707 -1778) divided the living organisms into two kingdoms: Plantae and Animalia.

However, this system of classification has the following are some shortcomings:

i. certain organisms share the characteristics of both plants and animals. For instance, Euglena and sponges.
ii. fungi are a group of organisms which have features of their own. They lack chlorophyll and they are heterotrophic like animals.
iii. many primitive organisms such as bacteria did not fit into either category and organisms like slime moulds are amoeboid but form fruiting bodies similar to fungi.

B. Three kingdom system of classification

Ernst Haeckel (1866), a German zoologist suggested that a third kingdom, Protista be created to include those unicellular microorganisms that are

typically neither plants nor animals. He included bacteria, algae, fungi and protozoa under Protista. Three kingdoms according to Haeckel are Protista, Plantae and Animalia. This solves the problem of assigning suitable kingdom to the organisms which have similarities with both plants and animals. However, certain drawbacks of two kingdom system persist in system also. Unicellular and multicellular organisms are kept together in Protista. Bacteria and fungi have been grouped with unrelated organisms.

C. Four kingdom system of classification

Copeland (1956) suggested that all prokaryotes such as bacteria, cyano bacteria, etc. be placed under kingdom Monera. According to him, four kingdoms are Monera, Protista, Plantae and Animalia. Fungi continued to remain with plants. The main drawback of this system is that fungi are not properly placed.

D. Five Kingdom System of Classification

In which of these five kingdoms you classify yourself? Why?

In order to suggest a better system of classification of living organisms, R.H. Whittaker (1969) an American taxonomist divided all the organisms into 5 kingdoms: Monera, Protista, Fungi, Plantae and Animalia.

Activity 5.5

Discuss the following questions in a group and present to the class.

1. List down unicellular organisms and multicellular organism.
2. List down the major groups of unicellular and multicellular organs.
3. Explain their difference interms of body structure, habitat and habit .

5.2.1. Kingdom Animalia

Major characteristics of animals

Animals are eukaryote multicellular organisms. The bodies of animals are usually composed of groups of cells organized into tissues, organs and organ systems. Animals lack cell wall and chlorophyll (the green pigment), and that they do not carry out photosynthesis. Because of this, all animals including humans are heterotrophs (organisms that cannot produce their own food) and they form the consumers of an ecosystem.

Animals respond quickly and appropriately to change in their environment. Movement of animals is very important characteristics that helps some animals to find food, shelter and place for mating.

Sexual reproduction is also another characteristic of animals, although many animals reproduce sexually as well as asexually.

Project work 5.1

Perform the following project in group and present your work to the class.

Collect flat worms, flies such butter fly from your school compound and identify their body structures.

Caution: While you are working on this project, use personal protective equipments as well as do not carry out this work unless and otherwise suprevised by you general science teacher.

Major groups of animal and their habitats

Habitat is a place where living organisms live.

1. Invertebrates

Invertebrates are animals without back bone. The followings are the most common invertebrate phylas. They are; Porifera , Platyhelminthes, Nematodes, Coelenterates, Mollusca, Echinodermata, Annelida and Arthropoda.

Porifera

These are the salt-water sponges; there are approximately 8,000 separate species existing today.

Figure 5.1. Porifera (sponges)

Platyhelminthes

These are the flatworms which inhabit both marine and freshwater habitats; over 15,000 species exist today.

Figure 5.2. Platy helminthes

Nematodes

Nematodes are among the most abundant animals on the earth. This phylum consists mainly of about 80,000 known parasitic worms. Nematodes are also called round worms. They are bilaterally symmetrical, elongated, and usually tapered at both ends. Examples of round worms are ascarias, hook worm, tape worm, and etc.

Figure 5.3. Nematodes (worms)

Coelenterates (Cnidarians)

The coelenterates include some exceptionally beautiful creatures and also very poisonous ones. Sea anemones, hydra, jelly fish and coral are examples of this phylum.

Figure 5.4. Coelenterate (hydra)

Mollusca

This major group consists of snails, clams, squid, and octopus; there are over 110,000 known species. Many of these groups have shells.

Figure 5.5. Mollusca (snail)

Echinodermata

The sea urchins, starfish and brittle stars make up this phylum invertebrates. The skin contains many spines. They appear very simple and have mouth on the lower side a gut and anus on the upper side. Example; marine steris, echinis, and etc.

Figure 5.6. Echinoderm

Annelida

The annelida are bilaterally, symmetrical, triploblastic coelomates invertebrate organisms. About 15,000 individual segmented worms comprise this phylum. The common example is an earthworm

Figure 5.7. Annelida

Arthropoda

This very large group consists of insects and it is estimated that there are over 1 million species of insects existing today. They characterized by having jointed legs.

Figure 5.8. Arthropoda (insects)

Do spider belongs to these group? Reason out.

2. Vertebrates (Phylum Chordata)

Vertebrates are animals with a back bone. Vertebrates are further classified into 5 common classes. These are fishes, repitiles, amphibians, birds and mammals.

Fishes

Fishes are aquatic craniate, gill-bearing vertebrate animals that lack limbs with digits, although they generally have two pairs of fins and several unpaired fins that allow them to swim (move) efficiently through water. Almost all fishes are entirely aquatic, although there are a few species that can survive out of the water for short periods of time.

Figure 5.9. Fish

What is a main reason that fish cannot survive out of water? Justify.

Amphibians

They are animals that live both in water and land habitats. Almost all amphibian species produce eggs that cannot survive outside of water, and this is the reason for their reproductive system depend on aquatic environment. Examples: frogs, toads, and salamanders etc.

Figure 5.10. Amphibians (frog)

Why frogs are described as an amphibian? Explain.

Reptiles

They are animals that crawl or move on its belly. Example: lizards, snakes, turtles, etc.

Figure 5.11. Reptiles (A-tortoise, B-snake)

Birds

Birds are tetrapods warm-blooded ((maintain constant body temperature) egg-laying vertebrate. They are characterized by the presence of feathers and wings. Almost all birds are capable of flight except ostriches and penguins.

Figure 5.12 Birds

Mammals

Mammals are warm-blooded breast feeding animals. Example: human being, bat, cow, horse etc.

What is the difference between mammals and egg laying animals? Justify.

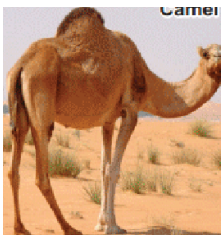


Figure 5.13 Mammals (A-cow, B-camel, C-red fox)

Exercise 5.2

Choose the correct answer

1. Which one of the following is described as chordate?

   A. Cockroaches
   B. Lizard
   C. Butterfly
   D. Tape worm

2. One of these is an amphibian:

   A. Fish
   B. Wasp
   C. Eagle
   D. Frog

3. Which one of the following is not a mammal?

   A. Hen
   B. Bat
   C. Cat
   D. Rat

4. Which one of the following is parasitic invertebrate animal?

   A. House flies
   B. Hook worm
   C. Mosquito
   D. Butterfly

5. In which of these phylum we humans are categorized?

   A. Anthophila
   B. Arthropoda
   C. Chordata
   D. Mammalia

5.2.2. Kingdom Plantea

Activity 5.6

Discuss the following questions in a group and present to the class.

Collect different types of plants from your surrounding.

1. Identify your collection based on similarites or difference.
2. Classify your collections under four divisions of a plants.

Major characteristics of all plants

All plants have eukaryotic cells and they all are multicellular organisms. They contain a green pigment called chlorophyll and carry out photosynthesis.

Almost all are living on terrestrial (land) habitat and few of them are found in aquatic (water) habitat. Some others are epiphytes (living on the body of other plants). Most of them have a waxy cuticle that helps to prevent from drying out.

Major groups of plants and their habitats

Based on presence or absence of vascular tissues, plants are classified into two major groups. These are;

A. Bryophytes (non-vascular)

Bryophytes are the simplest group of land plants. They are also relatively poorly adapted to life on land, so they are mainly confined to damp shady places.

These are terrestrial non-vascular plants (no vascular tissue namely xylem and phloem) which still require moist environment to complete their life-cycle. Hence, these are called amphibians of plant kingdom. Examples: liverworts, hornworts and mosses.

Figure 5.14. Bryophyte (mosses)

B. Tracheophytes (Vascular plants)

These are plants having vascular tissues.They are further divided into two. These are:

i. Pteridophytes (seedless plants):

Pteridophytes are the spores bearing vascular plants. They grow in a variety habitat. Most are terrestrial and few are aquatic while still others are epiphytes. They are the simplest plants among the tracheophytes. Example: the ferns.

Figure 5.15 pteridophytes (Ferns)

ii. Spermatophytes (Seed bearing plants)

a) ***Gemnospermae***

Gymnosperms represent a primitive group of seed bearing non-flowering plants (Spermatophytes) in which the seeds are naked i.e. they are not covered by the fruit wall as in angiosperms (The word 'Gymnos', means naked and 'spermos' means seed). Example: conifers.

Figure 5.16: Gymnospermae

Is a Juniper (tid) plant is belongs to gymnosperm? Why?

b) *Angiospermae*

Angiosperms are seed bearing flowering plants. A seed is covered by ovary wall. The flowering organ of angiosperm is called flower. Angiosperms live in all sorts of habitats, from fresh water to desert and from the frigid north to the torrid tropics. They range in size from the tiny, almost microscopic, duckweed to eucalyptus that are over 100 meters tall.

Angiosperms are divided into two groups: dicotyledons and mono cotyledons. The dicotyledons have two cotyledons or seed leaves. Example: apples, avocado, bean, peas, and etc. Mono cotyledons have one cotyledon. Example: wheat, rice, corn (maize), and etc.

Can you give other examples of dicots and monocots?

Figure 5.17. Angiospermae

Flowers

Flowers are the reproductive organs of flowering plants.

Activity 5.7

Discuss the following questions in group and present to the class.

1. What is the purpose of a flower?
2. What are the male and female parts of a flower?
3. How do monocot flowers differ from dicot flowers?

Flowers are made of many intricate and important parts. Most flowers contain male and female parts (see figure 5.13).

a. Male Flower Parts

The male part of the flower is called the ***stamen***. It is made of the stalk-like filament that holds up the sack-like ***anther***. The anther contains pollen, the grain released by flowers, which contains the sperm. Flowers that have male parts and no female parts are called ***staminate***.

b. Female Flower Parts

The female part of the flower is called the pistil. The carpel is the basic unit of the female reproductive organ, and a pistil may consist of one or more carpels. The carpel is composed of a stigma, style, and ovary. The stigma is a sticky tissue at the end of the pistil that is receptive to pollen. A rod-shaped middle part that located below the stigma is called the style and a swollen base (called the ovary) that contains eggs. Once the pollen reaches the stigma, it forms a pollen tube down through the style to the ovary where sperm is deposited. Flowers that have female parts and no male parts are called pistillate.

c. Other Parts

Flowers have parts that are not classified as male or female. The petals, usually colorful leaf-like structures, attract animals and insects. Sometimes the petals are fused together and form a structure called a corolla. Beneath the petals are green leaf-like structures called sepals. The sepals support the petals and protect the flower before it opens; the sepals may be fused together to form a calyx. Together, the petals and the sepals are called the perianth.

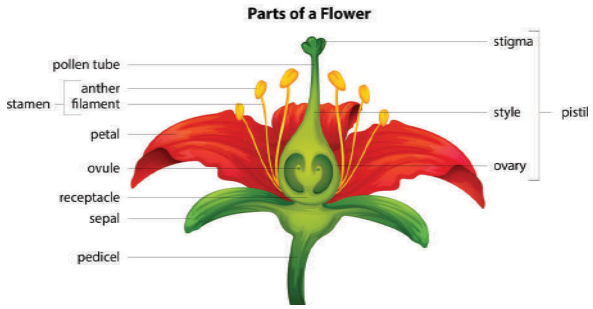


Figure 5.18. Parts of flower

Project work 5.2

Perform the following project in group and present your work to the class.

Take a round through a garden or in your sourrundings and list the plants that you see.

1. Draw their pictures and identify the differences on their body stuctures such as difference on their root, stem, leaves, and flowers as well as seeds that you observe.
2. Write the differences that you observe and in which group the plant that you observed is catagorized?
3. Find their local and scientific name of the plant in internet and summarize your work in table.

Excerise 5.3

Choose the correct answer

1. In which of these plant division a maize plant belongs?

   A. Gemnospermae
   B. Angiospermae
   C. Bryophyta
   D. Pteridophyta

2. Epiphytes are a plant that grow on _____.

   A. terrestrial habitat
   B. aquatic habitat
   C. other plant
   D. mosit area

3. Which one of the following is the common characterstics of all plants?

   A. Having chlorophylls
   B. Having vascular tissues
   C. Having flowers
   D. Having spores

4. From the followings, one is not the character of angiospermae.

   A. Double fertilization
   B. Secondary body
   C. Seed is covered by ovary
   D. Nacked seed

5.2.3. Kingdom protista

Activity 5.8

Discuss the following questions in group and present to the class.

1. List the organism that cause diseases like malaria and Ameobic dysentery.
2. Identify the group of organism you list. In which group of protista, the organism you listed is catagorized?
3. What are the organisms that have plant like characteristics?

Major characteristics of Protista

Kingdom protistas include microscopic single celled eukaryotic organisms and multicellular algae that have a membrane bounded nucleus. Protista can be quite complex in their shapes. Some of them bear cilia or flagella for locomotion. Most of them are photosynthetic and thus, they are autotrophs. They form the chief producers of food in oceans and in fresh water. They lack cell wall and

show holozoic mode of nutrition as in amoeba. Some Protistas are parasitic. Some are symbiotic while others are decomposers.

Major group of protista their habitats

A. Algae

Algae are mainly aquatic photosynthetic organisms with simple body structure. They have no tissues and organs like root, stem and leaves, but they have root like structure called ***thallus*.**

They are considered as plant-like because they contain the green pigment chlorophyll and carry out photosynthesis and have rigid cell walls. They are unicellular to multi-cellular and either motile or non-motile. The study of algae is known as ***Phycology*.** There are different classes of algae such as rhodophyta (red algae), phaeophyta (brown algae), chlorophyta (green algae), and etc. Chlorella and spirogyra are examples of green algae.

i. Chlorella

Chlorella is a unicellular and microscopic spherical shaped green alga. It is found usually in moist areas. It has a cup-shaped chloroplast containing chlorophyll.

ii. Spirogyra

Spirogyra is a filamentous green algae found in fresh water. It has a series of cells joined end to end to form a filament. Each cell has a spiral shaped chloroplast. Small protein bodies called ***pyrenoids*** are present in chloroplast.

B. Protozoa

Protozoa are animal-like microscopic organisms those are move around and have body structure for movement (locomotion) from place to place such as pseudopoda , cilia and flagella. Most of them are parasitic organisms that causes serious disease for animals and plants while few of them are free living. Examples of harmful protozoa are plasmodium which causes malaria,

Entamoeba histolyca, which cuses *Amoebic dysentery*, and Trypanosoma, the blood parasite that causes sleeping sickness. Paramecium and euglena are examples of free living protozoa. There are four major groups of protozoa. These are;

i. Amoeba (Sarcodina)

Amoeba posses pseudopodia (false foot) for their locomotion and feeding. They are simplest protozoans because they have few organelles. Feeding habit is phagocytosis, feed on other organisms by engulfing food by pseudopodia. Some of them are free living and still others are parasites. They can be reproduced by binary fission, sometimes they reproduce by multiple-fission.

ii. Sporozoa (Plasmodium)

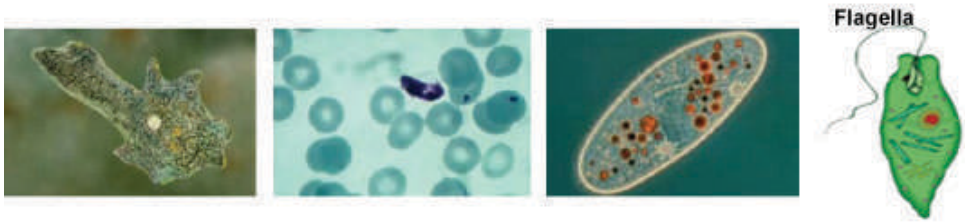
Sporozoa have no locomotory structure and most of them are intracellular parasite that causes disease. Have alternating sexual and asexual cycles and this is unique feature of the class. Example: Plasmodium.

iii. Flagellated protozoa (Mastigophores)

Flagellated protozoa have one or more whip-like structure called flagella which are for locomotion and feeding. Example: Trypanosoma and euglena. Euglena, a protozoan has two modes of nutrition. In the presence of sunlight it is autotrophic and in the absence of sunlight it is heterotrophic. This mode of nutrition is known as a myxotrophic and hence, they form a border line between plants and animals.

iv. Ciliated protozoa:

These protozoa are called ciliated because they move by short, hair like cilia lining the cell membrane. Cilia are used for locomotion and feeding purposes. They also have permanent contractile vacuole to pump out excess water. They are largest group of protozoa. Most of these groups are live in freshwater, but some are in marine water. They can form protective cysts to survive unfavorable conditions. Example; paramecium



(A) Amoeba (B) Plasmodium (C) Paramecium (D) Euglena

Figure 5.19. Some example of protozoa

5.2.4. Kingdom Monera

Activity 5.9

Discuss the following questions in group and present to the class.

1. What is your idea about the cause of Thyphus disease?
2. What causes milk to be spoil?
3. Do you think that bacteria found in or on your body without causing a disease?
4. Do you expect bacteria are found in air?

Major characteristics of Monera

Kingdom monera consists of prokaryotic unicellular organisms. They have cell wall like that of kingdom of plantea and fungi but their cellwall is made up of peptidoglycan that is (protien + glucose). Some monera such as cyanobacteria are also known as blue green algae. Many others are parasites and rely on other organisms to get their food. Some of them can cause disease while others live on or in the body of other organisms without causing disease. Such bacteria are known as also normal flora.

Major group of Monera and their habitats

Kingdom monera have three major groups such as Eubacteria (ordinary), Cyanobacteria (blue green alge) and Archae bacteria.They are ubiquitous (found almost everywhere), that is, in soil, in water, inside and outside other organisms.

Body structures of bacteria

Cytoplasm matrix is one unit (no compartment), cell membrane closed circular DNA (naked), ribosome with simpler phagocytosis. Cell wall composed of peptidoglycan which is not found in other organisms enclosed by an outer slime capsule layer (in some). The capsule which protects bacterial cells from phagocytosis. The cell membrane, cytoplasm and nucleoid are their components of prokaryotic cells.

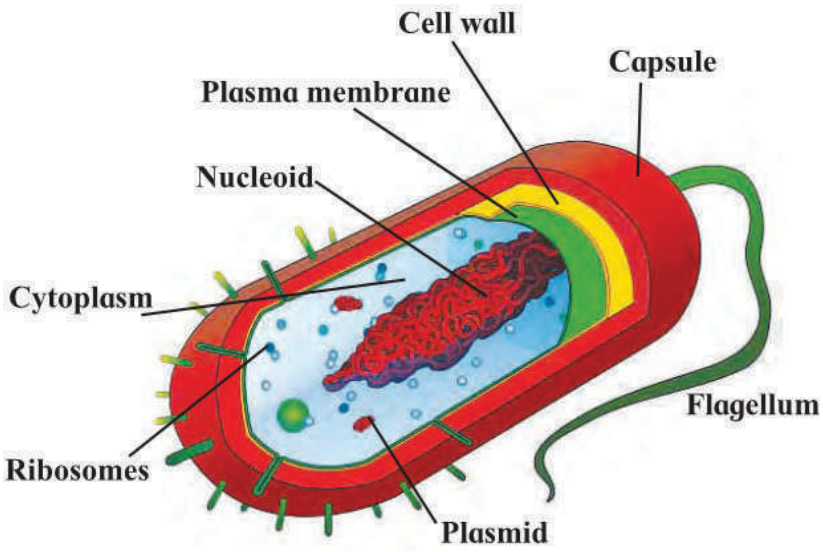


Figure 5.20. Structures of bacterial cell

5.2.5. Kingdom Fungi

Activty 5.9

Discuss the following questions in group and present to the class.

1. What is the white substance that grow on food like enjera, fruits & breads? What conditions favor the growth of this white substance on food?
2. Do you think that such white substance grow on the food?
3. In which of the five kingdoms, can you classify this white substace?

Major characteristics of Kingdom Fungi

Fungi are large and very sucsseful groups of eukaryotic organisms that vary in size from unicellular yeast to the larger puff balls and most of them are multicellular. Like kingdom plantea and monera, they have a cell wall that made up of chitin. Fungi undergo different modes of nutrition (feeding system). Many fungi are saprophytic that feed on dead organic substance, also called decomposers. Saprophytic fungi usually produce huge number of spores which float in air and are tansported by wind, then lay on dead substance and germinated, forming new fungi. Most fungi especially decomposers play key role in ecosystem by returning nutrients into the soil. The fungi such as rhizopus (bread mould) and many others play this role.

Many fungi are parasitic live in or on the other organism and they cause various diseases. Example; ring worm and athlete foot. Some others are symbiotic.

Symbiosis is any relationship or interaction between two dissimilar organisms to benefit each other. For eaxmple, the relation between algae and fungi live together to form lichens.

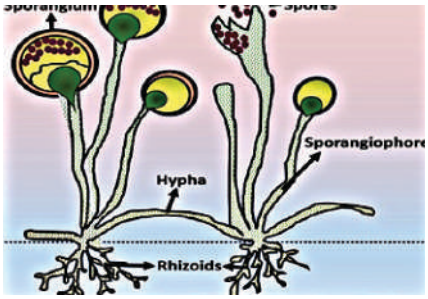
Major groups of Fungi and their habitats

Based on asexual or sexual spores true fungi are subdivided into 5. These are:

a) Mastigomycotina (flagellated fungi)

Mastigomycotina produce flagellated zoospores in their life cycle. Hence, the subdivision Mastigomycotina is com¬monly known as zoosporic fungi. One large group of the mastigomycotina is aquatic and primarily terrestrial. They live either as saprophytes or parasites. Example: Pythium, Phytophthora, Albugo, and etc.

b) Zygomycotina (conjugation fungi)



Most of the Zygomycotina are present in soil and dung, although they can live in both fresh and marine water environments. They can be asexually reproduced by conidia or sporangia that contians asexual spores. They have non-separeted hyphae. Example: rhizopus, mucor.

Figure 5.21. Structures of rhizopus

c) Ascomycotina (sac fungi)

Ascomycotina possess well-developed, profusely branched mycelium except the unicellular yeasts. Ascomycotina are heterotrophs and obtain nutrients from dead or living organisms. As saprotrophs they can consume almost any carbonaceous substrate such as cellulose lignin (found in wood) and recycled dead plant material. As parasites, ascomycetes account for most of plant pathogens including powdery mildews that attack fruits and chestnut blight. They asexually reproduced by conidia; they have not sporangia, but have separeted hyphae. Example: Yeast, candida, morels, truffles, and penicillium.

Figure 5.22. Penicillium fungus

d) Basidiomycotina (Club fungi)

Basidiomycotina produce basidiospores. They are mostly terrestrial and saprophytic or parasitic. Like all fungi, basidiomycotina can undergo both asexual and sexual reproductions. They reproduce asexually by either budding or asexual spore formation. Example: mushrooms, toadstools, stinkhorns, puffballs, and shelf fungi.

a)Toadstool

b) Mushroom

Figure 5.23. Some examples of basidiomycotina

e) Deuteromycotina (Imperfect fungi)

The deuteromycotina are characterized by a well-developed septate mycelium, and some of them are siphonaceous (thallus is not divided up by septa). They can be reproduced asexually by means of conidia, but their sexual reproduction is not known; thus deuteromycotina are known as "imperfect fungi". Many forms of deuteromycotina are pathogenic, affecting man, animals, or plants. Example: alternaria, colletotrichum, trichoderma, and etc.

Project work 5.3

Do the following project work in group and present your group work to the class.

Collect fungi such as bread mold, mushuroom, todstool and agaricus.

1. Identify the body structures of each of these fungi.
2. List similarites and differences that you observed.
3. List the place (habitat) you collected the specimen.

UNIT SUMMARY

- Living things share the common characteristics such as reproduction, respiration, nutrition, growth, and etc.
- Grouping of similar living things is known as classification. The science of classification is called taxonomy and a system we use grouping living things in to categories is called taxa.
- Living organisms are grouped in to five kingdom systems such as kingdom Animalia, Plantea, Protista, Monera and Fungi.
- Kingdom Animalia consist of all multicellular invertebrate such as profera, platyhelminthes, nematodes, cnidarians, echinodermates, annelida and arthropods and vertebrates animals such as fish, amphibians, birds, reptiles and mammals.
- Kingdom Plantea are eukaryotic multicellular organisms which consist of 4 major divisions such as bryophytes, pteridophytes, gymnosperms and angiosperms.
- Kingddom Protista are all microscopic single celled eukaryotic organisms that have a membrane bounded nucleus. There are two major groups of this kingdom such as algae and protozoa.
- Kingdom Monera are all the single celled microscopic organisms tha they do not have membrane bounded nucleus.
- Kingdom Fungi are a large and very successful group of eukaryotic organisms that vary in size from unicellular yeast to the larger puffballs and most of them are multicellular. There are 4 major groups of fungi such as zygomycotoina, ascomycotina, basidiomycotina and deutromycotina.

Key Terms

- Aquatic
- Binary fission
- Binomial nomenclature
- Classification
- hierarchy
- Invertebrate
- Kingdom
- Living things
- Normal flora
- Phylum
- Scientific name
- Sexual
- Symbiotic
- Taxa
- Taxonomy
- Terrestrrial
- Vertebrate

REVIEW EXECRISES

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

1. Taxa is grouping living things in to categories.
2. Scientists do not need crateria inorder to classify living things.
3. The science of classification is called taxonomy.
4. Phylum chordate contains all organisms that have backbone.
5. Phylum are the division of plants and animals.

Part II: Choose the correct answer

1. All are the reasons that biologists classify living things **except;**
   - **A.** to simplify their study
   - **B.** to bring order out of chaos or confusion.
   - **C.** to try understanding how living things reproduce.
   - **D.** to understands how life is originated.

2. Which one is correct about scientific name of human?
   - **A.** *homo sapiens*
   - **B.** *Homo sapiens*
   - **C.** Homo Sapiens.
   - **D.** Homo Sapiens
3. Cyanobacteria are found in the kingdom of:
   - **A.** Plantae
   - **B.** Protista
   - **C.** Monera
   - **D.** Fungi
4. In the hierarchy of classification which one is the smallest?
   - **A.** Order
   - **B.** Kingdom
   - **C.** Species
   - **D.** Class
5. In the hierarchy of classification cows are found in the class of:
   - **A.** mammalian
   - **B.** amphibians
   - **C.** repitiles
   - **D.** arthropod
6. The cell wall of fungi is made from:
   - **A.** cellulose
   - **B.** chitin
   - **C.** peptidoglycan
   - **D.** lipoprotein
7. Which one is an animal like eukaryotic organism?
   - **A.** Protozoa
   - **B.** Algae
   - **C.** Bacteria
   - **D.** Fungi

Part III: Fill in the blank spaces

1. _____ are group of individual organisms that interbreed and produce fertile offspring.
2. _____is a naming organisms by two names.
3. Kingdom Animalia is divided into _____and _____major groups.

Part IV: Write a short answer

1. List common examples of five kingdom systems.
2. List down the major groups of each five kingdom and describe their characteristics and habitats.

Part V: Label each floral part.

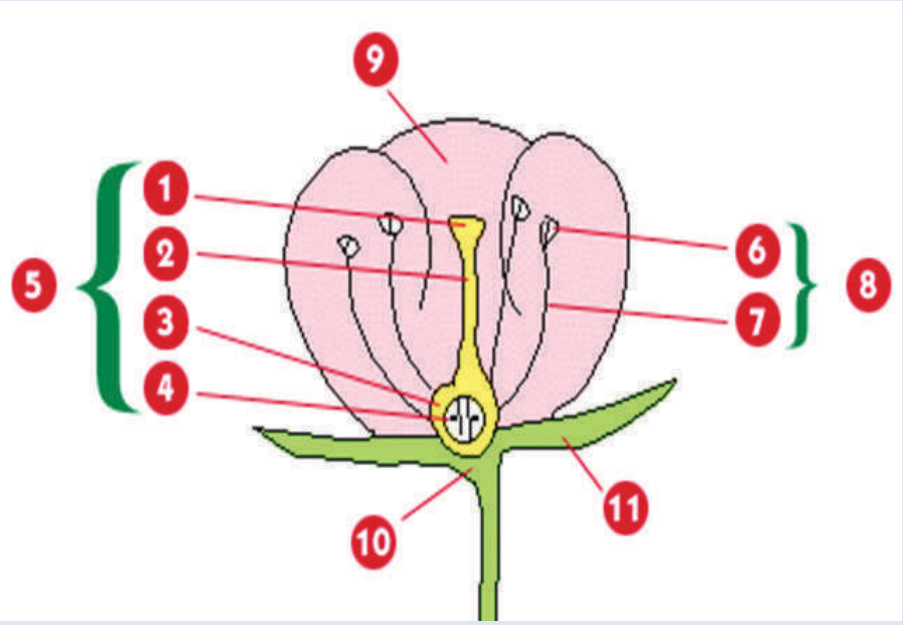


Figure 5.24. Parts of flower

UNIT SIX

EARTH IN SPACE

Learning Outcomes

At the end of this unit, students will be 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 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 and demonstrate it.*
- *construct the model of earth and explain phenomena related to its motion;*
- *identify atmospheric and lithosphere systems;*
- *explain their cycle effects of the earth; and*
- *describe the measuring techniques for too big (earth) and to small (continental drift) quantities measurement and estimation.*

Main Contents

6.1. Shape and dimensions of earth
6.2. Parts of the earth
6.3. Movements of the earth
6.4. Atmospheric and lithosphere systems and cycles

Start-up Activity

Be a group and discuss on the following questions and present to your class.

1. Discuss about the shape, body parts, movement and dimensions of the earth.
2. What will happen when the earth moves on itself and about the sun?

Introduction

Earth is our home planet. Scientists believe Earth and its moon formed around the same time as the rest of the solar system. They think that it was formed about 4.5 billion years ago. Earth is the fifth largest planet in the solar system. And Earth is the third closest planet to the sun. Its average distance from the sun is about $1.5x10^8$km. Earth is the only planet known to have large amounts of liquid water. Earth is the only planet where life is known to exist.

Under this unit, you will learn about the earth which is the only planet that we live. The unit has four sections such as shape and dimensions of earth, parts of the earth, movements of the earth and atmospheric and lithosphere systems and cycles.

For successful completion of the unit, you are expected to read the contents provided in the unit carefully, perform all questions, activities, project works and exercises incorporated in the unit.

6.1. Shape and Dimensions of Earth

At the end of this section, you will be 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; and*
- *name dimensions (circumferences, diameters, and angular distances) of the earth*

6.1.1. Local and global ideas about the shape of the earth

Activity 6.1

Be in group of six and then discuss with in your group member

1. Discuss about the shape of the earth.
2. List local and global ideas about the shape of the earth.

There were different answers at different times for the question of the shape of the earth. Some people have maintained that the earth is flat or even disc-shaped which was advocated by a Greek author Homer (750 BC). Despite centuries of evidence proving the contrary, some people still believe the Earth is flat. A number of ancient cultures believed that the Earth was flat because, simply, they didn't know any better. For example your parents told you that, the earth is flat and if you travel further you will fallen from the ground. Additionally, when you look around in all directions, it seems like the earth and sky meet.

The notion that the Earth is spherical in shape was developed by the ancient Greeks. Pythagoras (six century BC) and Aristotle (384-322) are known to have decided that the earth was round or spherical. Aristotle observed lunar eclipses and noticed that only a round sphere could imply a circular shadow.

An idea of spherical earth continued until 16th century. However, Isaac Newton

has found that the earth is not perfect sphere. Newton computed that the Earth's shape should be an oblate spheroid, a solid formed when an ellipse is rotated about its axis. Due to earth's rotation, the equatorial area is bulged and polar area was flattened. This means, the equatorial diameter is greater than polar diameter. This is called polar flattening.

The shape of the earth in very general way is **spherical**, but when this shape is critically examined it is not perfect spherical. Because the equatorial circumference and meridonial circumference are not equal in length, the best model of the Earth is a Geoids or Spheroid.

*A **geoid** is the irregular-shaped "ball" that scientists use to more accurately calculate depths of earthquakes, or any other deep object beneath the earth's surface. A **spheroid** is an ellipsoid having two axes of equal length, making it a surface of revolution.*

6.1.2. Evidence to the Round shape of the Earth

1. **Sun rise and sunset**: The sun rise and sets at different times in different parts of the world. It would rise and set at the same time everywhere if the earth were flat.

2. **The moon's eclipse:** The shadow cast by the earth on the moon's surface in eclipse is always circular and the only geometrical shape which at all times and under all circumstances casts a circular shadow in a sphere.

3. **Planets and heavenly bodies:** The other planets and heavenly bodies have all been observed to be spherical thus, by analogy, it may be concluded that the earth is also a sphere.

4. **Circumnavigation of the earth:** It is possible to travel round the world in various directions and return to one's starting point. This is possible only on spherical surface.

5. **Aerial photographs:** Photographs taken by high flying space craft portray the curve nature of the earth's surface quite unmistakably.

6. **A Ship's visibility:** The figure 6.2 below shows two ships but the observer is able to see only one of them. If the earth were flat, the observer would see both.

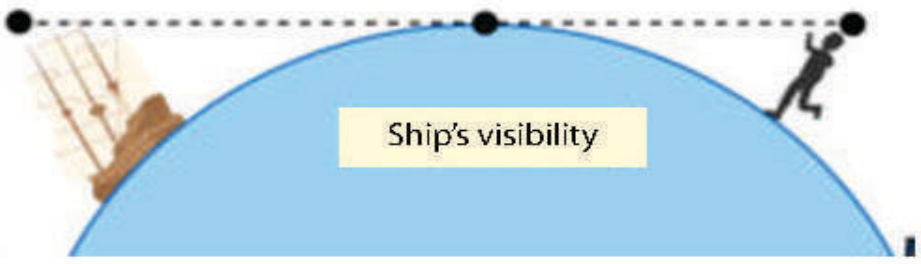


Figure 6.2. Visibility of a ship

Assignment 6.1.

Find evidences supporting the shape of the earth from Internet and other references and present your findings to your class.

6.1.3. Dimensions of the earth

Activity 6.2

Be in group of 4 students and then discuss on the following questions:

1. Define the words like circumference, diameter, and radius of circle.
2. What is the difference between polar and equatorial circumferences?

As you have learned in section 6.1, the shapes of earth is not a perfect sphere because the equator diameter of the Earth is not equal to polar diameter of the earth. The equator diameter of the Earth is 12,756 km and the a polar diameter of the earth is 12,713km. The diameter of the Earth at the equator is about 43 km larger than the pole-to-pole diameter.

The average diameter of the earth is the sum of its polar and equatorial diameter which is then divided by two. From this, we get a mean diameter of 12,742 km.

$$D_{average} = \frac{\text{Polar diameter} + \text{Equatorial diameter}}{2}$$
$$= \frac{12,713\text{km} + 12,756\text{km}}{2}$$
$$= 12,742\text{km}$$

You know that the radius of circle is half of diameter of a circle. That is:

$$R = \frac{D}{2} \text{ or } D = 2R$$

Where D is diameter of circle and R is the radius of circle

The equatorial diameter for Earth is 12,756 km and from this you can calculate the equatorial radius of the earth. From the above formulae

$$R = \frac{D}{2} = \frac{12,756\text{ km}}{2} = 6,378\text{km}$$

Therefore, The equatorial radius of the earth is 6378 km

Can you calculate the polar radius of earth?

The radius of Earth at the equator is 6,378 km. The earth's rotation causes it to bulge at the equator. Earth's polar radius is 6,356 km. The difference between equatorial radius to polar radius is (6,378 km - 6,356 km = 22 km).

Can you calculate the average radius of the earth?

You know that the circumference of the circle is

$C = 2\pi R$

Where, C is circumference of the circle and

$\pi = 3.142$ and R is the radius of circle.

Earth's circumference is the distance around Earth. The polar circumferences of Earth is calculated by using circumference formula is given above;

$C = 2\pi R$

You know that the polar radius of earth is 6356km and $\pi = 3.142$

C=2x3.142x6,356km=39,941km

Therefore, the meridional circumference of the Earth is 39,941km.

Can you calculate the the equatorial circumference of Earth?

The equatorial circumference of Earth is about 40,079 km. However, from north pole to south pole or the polar circumferences (the meridional circumference) of the Earth is about 39941 km around. This shape caused by the flattening at the poles, is called an oblate spheroid.

Average diameter of an earth is 12740 km and average radius is 6370 km. The difference between length of equatorial axis to length of poles (polar axis) is 43 km. Equatorial section is also slightly elliptical and called ellipsoid. Southern hemisphere little larger than northern is called ovaloid (polar section are oval). Resultant surface are considered as spheroid. The earth's new shape name is geoid.

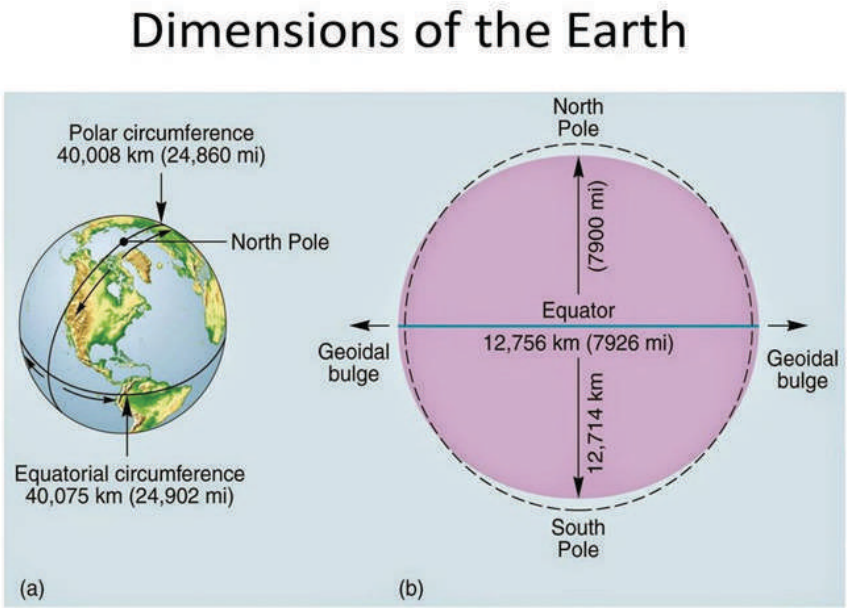


Figure 6.3. . Dimensions of earth

Exercise 6.1

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

1. The earth's shape is likened to perfectly circular object.
2. The best model of the earth is a spheroid.
3. The shape of earth is flat.

Part II: Choose the correct answer from the given alternatives.

1. Which one of the following is spheroid in shape?
   - **A.** Sun
   - **B.** The earth's orbit
   - **C.** Earth
   - **D.** None

2. The best model of the earth is known as:
   - **A.** map
   - **B.** geoid
   - **C.** sketch map
   - **D.** earth's satellite photo

3. The equatorial circumference greater than the polar circumference by approximately:
   - **A.** 22 km
   - **B.** 68 km
   - **C.** 125 km
   - **D.** 625 km

4. The distance of the equator from either of the poles is:
   - **A.** 500 km
   - **B.** 5001 km
   - **C.** 10,002 km
   - **D.** 36,005 km

Part III: Write the short answer for the following questions

1. Why the earth's shape is not perfect spherical?
2. Write at least three evidences which support shape of the Earth?
3. Write the dimensions of the earth.

6.2. Parts of the Earth (Body and Atmosphere)

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; and*
- *explain different observations about the earth in terms of the nature and behaviors of the different parts of the earth.*

Activity 6.2

Make a group and discuss on the questions below and present to the class.

1. Name all parts of the earth and its organization and contents.
2. Explain different observations about the earth in terms of the nature and behaviors of the different parts of the earth.

Is the Earth a solid planet? Liquid? Gas?

Human lives on the surface of a globe that has a radius of nearly 6500 km, yet no one has ever penetrated more than a few kilometers below the solid earth. Geophysicists have inferred that the earth is composed of a great central ***core*** and a series of surrounding layers, known collectively as the ***mantle***, and the ***crust*** (see figure 6.4).

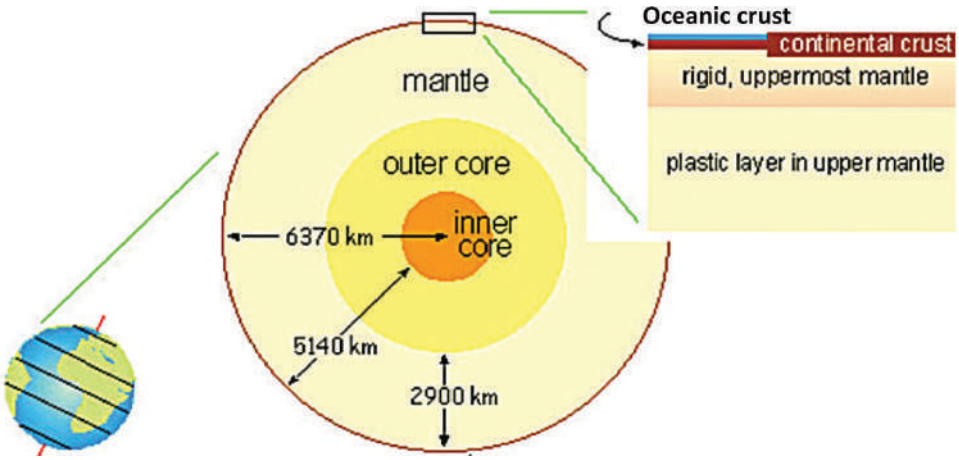


Figure 6.4. Different layers of earth

1. The earth's crust

The crust is the outermost and thinnest layer. Because it is relatively cool, the crust consists of hard, strong rock. Crust beneath the oceans differs from that of continents. Oceanic crust is between 4 and 7 kilometers thick and is composed mostly of dark, dense basalt. In contrast, the average thickness of continental crust is about 20 to 40 kilometers, although under mountain ranges it can be as much as 70 kilometers thick. Continents are composed primarily of light-colored, less dense granite. Relative to its size, earth's crust is about as thin as an apple skin about 0.01 percent in volume.

2. The mantle

The mantle lies directly below the crust. It is almost 2900 kilometers thick and makes up 80 - 84 percent of the earth's volume. Although the chemical composition is similar throughout the mantle, the earth's temperature and pressure increase with depth. These changes cause the strength of mantle rock to vary with depth, and thus they create layering within the mantle.

3. The core

The core is the innermost layer of the earth. It is a sphere with a radius of about 3470 kilometers, and is composed largely of iron and nickel. The outer core is molten because of the high temperature at the center of the core. The core's temperature is about 6000ºC, which is as hot as the sun's surface. The pressure is more than 1 million times that of the earth's atmosphere at sea level. The extreme pressure compresses the inner core into a solid, despite the fact that it is even hotter than the molten outer core. About 15 percent of earth's volume is an iron - nickel core the size of Mars.

Exercise 6.2

Part I: Match the parts of earth under column B with their description under column A.

Column A	Column B
1. It is about 20 to 40 kilometers.	A. Crust
2. It is almost 2900 kilometers thick.	B. Mantle
3. Composed largely iron and nickel.	C. Oceanic crust
4. It is the thinnest layer.	D. Core
5. It composed mostly of dark, dense basalt.	E. Granite
	F. Continental crust

Part II: Answer the following questions

1. In which part of the earth are you living?
2. Which layer constitutes about 80 percent of the volume of the earth?
3. Which layer of the earth account about 15% of the earth's volume?
4. What makes the mantle develop different layers?
5. How many degrees Celsius the core temperature measured?

6.3. Movements of the Earth

At the end of this section, you will be able to:

- *demonstrate movements of the earth (revolution and rotation)*
- *explain the effects of motions of the earth; and*
- *construct the model of earth and use it to explain phenomena related to its motion.*

Activity 6.3

Make a group of 5-6 and then discuss the following question and present to the class.

1. Discuss types of movements of the earth.
2. Explain the effects of motions of the earth.

In ancient times, people believed that the earth was stationary and heavenly bodies moved around it. Nicolaus Copernicus, a Polish astronomer, first said that the earth spins on its own axis and moves around the sun. Thus, the earth has two types of movements: rotation and revolution.

a) *Rotation*

Rotation is the movement of the earth on its axis. The earth rotates about its axis at a speed of $7.27x10^{-5} rad/s^2$ and revolves around the sun at speed of 29.78km/s. The Earth is constantly in motion, revolving around the Sun and rotating on its axis.

These motion account for many of the phenomenon we see as normal occurrences: night and day, changing of the seasons, and different climates in different regions. The earth takes about 24 hours to complete one rotation around its axis. The period of rotation is known as the earth day. This is the daily motion of the earth.

What would happen if the earth did not rotate?

The portion of the earth facing the sun would always experience day, thus bringing continuous warmth to the region. The other half would remain in darkness and be freezing cold all the time. Life would not have been possible in such extreme conditions.

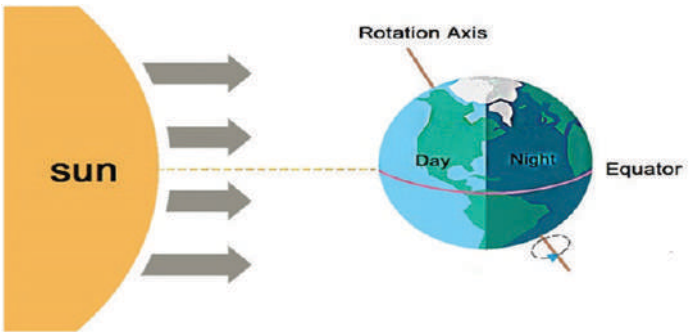


Figure 6.5. The portion of the earth facing the sun

b) *Revolution*

The movement of the earth around the sun in a fixed path or orbit is called *revolution*. It takes 365 days (one year) to revolve around the sun. Six hours saved every year are added to make one day (24 hours) over a span of four years. This surplus day is added to the month of February. Thus, every fourth year, February is of 29 days instead of 28 days. Such a year with 366 days is called a leap year. Due to this a year is usually divided into summer, winter, spring and autumn seasons. Seasons change due to the change in the position of the earth around the sun (fig 6.7).

Projects 6.1.

Construct the model of earth or use glob to explain phenomena related to motion as shown figure 6.4

Materials: balloon, globe model, world map and torch (battery)

Procedures:

- Cover globe or balloon by world map.
- Torch (battery) light "on" the globe or balloon.
- See which part get light.

Figure 6.6. model of earth

based on the above observation answer the following question

Which part of earth is dark? Or which part receives light? Which continent is get light or dark?

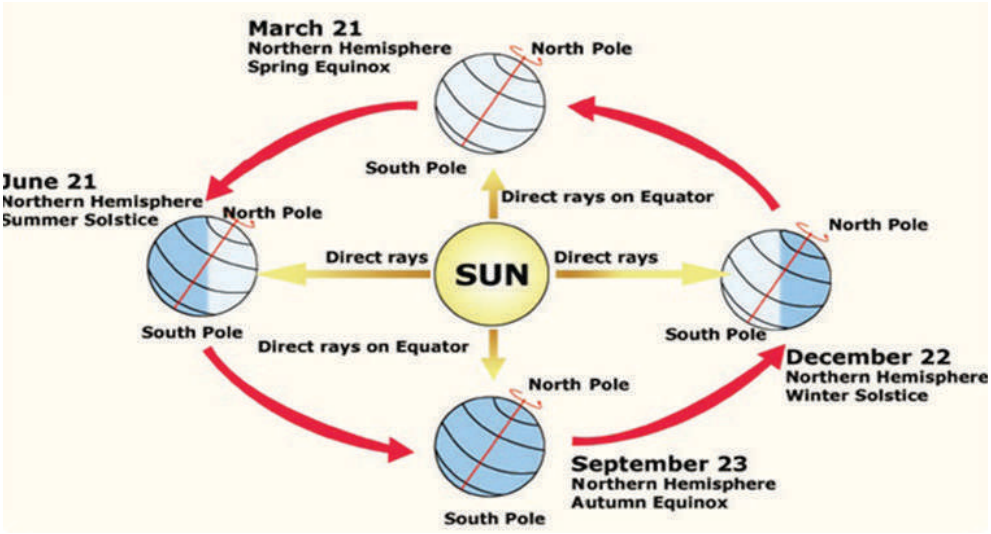


Figure 6.7. Seasonal change due revolution

On June 21 or 22:

- The north pole is tilted most directly towards the sun and north arctic circle has 24 hours day light and south antarctic circle has 24 hours dark hours.
- It is known as the summer solstice. After summer solstice the north pole begins tilting away from the sum.
- Day light hours begin to decrease in the northern latitudes.

September 22 or 23:

- Day light and darkness hours are the same in both hemispheres.
- Day light hours continue to decrease in the northern hemisphere and increases in the southern hemisphere until december 21 or 22.
- Day light fall begins in the north and spring begins in the south.

December 21 or 22:

- South of the antarctic have 24 hours of day light.
- It is known as winter solstice .On the northern hemisphere experiences its longest night and winter begins.
- Across the southern latitudes they have the most day light hours of any time of the year and summer begins.

March 20 or 21:

- Earth is beginning side by side to the sun .This day is called the spring or vernal equinox.
- Day light and night hours again are equal for both hemispheres.
- March 21 is the first day of spring in northern hemisphere and the first day of all in the southern hemisphere day light hours continue to increase in the northern hemisphere until june 21 or 22. Cycle of the seasons repeat.

Equinox: is the event when the Sun can be observed to be the Earth's equator, occurring around March 20 and September 23 each year. the equinoxes are the two days each year when the center of the Sun spends an equal amount of time above and below the horizon at every location on Earth.

Solstice: A solstice occurs twice a year, whenever Earth's axis tilts the most toward or away from the Sun, causing the Sun to be farthest north or south at noon. At the solstice, the Sun reaches a maximum or a minimum.

Exercise 6.3

Part I. Write true if the statement is correct and false if the statement is wrong.

1. The earth moves around the sun.
2. Rotation of the earth causes seasons.

Part II: Choose the correct answers from the given alternatives.

3. The movement of the earth around the sun is known as:

   A. rotation
   B. revolution
   C. inclination
   D. D. all

4. Direct rays of the sun fall on the equator on:

   A. 21 March
   B. 21 June
   C. 22 December
   D. 23 September

5. Cycle of the seasons is caused due to:

   A. rotation
   B. revolution
   C. gravitation
   D. none

Part III: Fill in the blanks with appropriate terms.

1. The daily motion of the earth is _____.
2. The earth travels around the sun in _____ orbit.

6.4. Systems and Cycles of earth

At the end of this section, you will be able to

- *identify atmospheric and lithospheres systems;*
- *explain their cycle effects of the earth; and*
- *describe the measuring techniques for too big (Earth) and too small (continental drift) quantities measurement and estimation.*

Activity 6.4

Make a group then discuss about the followings and present to the class

1. The atmospheric and lithospheres systems of the earth.
2. What are compositions and systems of earth?

6.4.1. Earth's systems and its components

Everything in the parts of earth's system can be placed into one of four major subsystems: the water portion of the planet, (the hydrosphere), earth's gaseous envelope, (the atmosphere), and the solid Earth, (the lithosphere). But it should be noted that our physical environment is highly integrated and not dominated by rocks, water, or air alone (see figure 6.8). Rather, it is characterized by continuous interactions as air comes in contact with rocks, rocks with water, and water with air. These components are also systems by themselves and they are tightly interconnected. These components of the earth system are interconnected by flows of energy and materials. The most important flows in the earth system are those concerned with the transfer of energy and the cycling of key materials

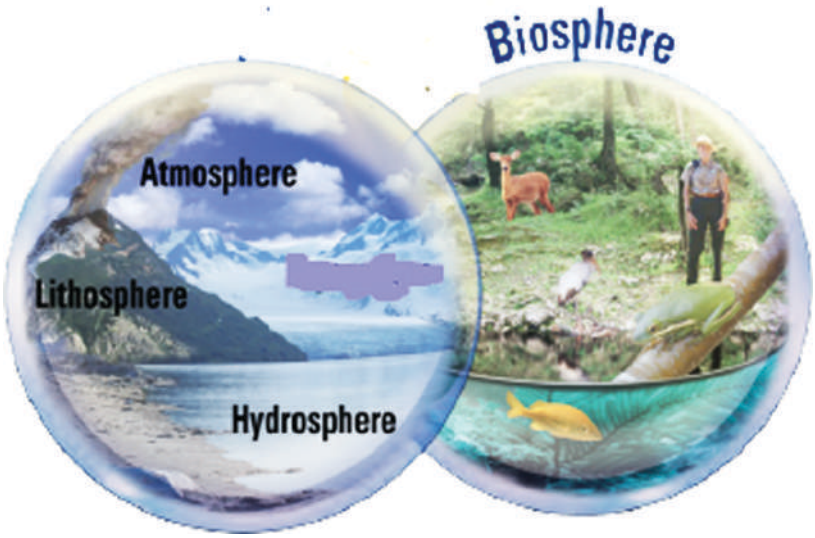


Figure 6.8. Subsystems of the earth

1. Atmosphere

What do you know about the atmosphere?

The atmosphere is a blanket of colorless, odorless, and tasteless gases, water, and fine dust wrapped around earth. It is about 700 km deep. It has no upper boundary and simply fades into space as it gets thinner.

All living beings on this earth depend on the atmosphere for their survival. It provides us the air we breathe and protects us from the harmful effects of the sun's rays. Without this blanket of protection, we would be baked alive by the heat of the sun during day and get frozen during night.

What are the layers of earth's atmosphere?

The atmosphere is divided into layers according to the way its temperature changes with height such as troposphere, stratosphere, mesosphere, thermosphere and exosphere (see figure 6.9).

- *Troposphere:* is the lowest layer, extends only 12 km above the ground but contains more than 75 % of the atmosphere's gas, and vast quantities of water and dust. The air we breathe exists here. Almost all the weather phenomena like rainfall, fog and hailstorm occur in this layer.
- *Stratosphere*: It lies above the troposphere. It extends up to a height of 50 km. This layer is almost free from clouds and associated weather phenomenon, making conditions most ideal for flying airplanes. It contains a layer of ozone gas which protects us from the harmful effect of the sun rays.
- *Mesosphere*: This is the coldest layer of the atmosphere. It lies above the stratosphere. It extends up to the height of 80 km. Meteorites burn up in this layer on entering from the space.
- *Thermosphere:* It is the hottest layer of the atmosphere. It extends between 80km- 400 km. This layer helps in radio transmission. In fact, radio waves transmitted from the earth are reflected back to the earth by this layer.
- *Exosphere:* the outermost layer that fades into space. This layer has very thin air. Light gases like helium and hydrogen float into the space from here.

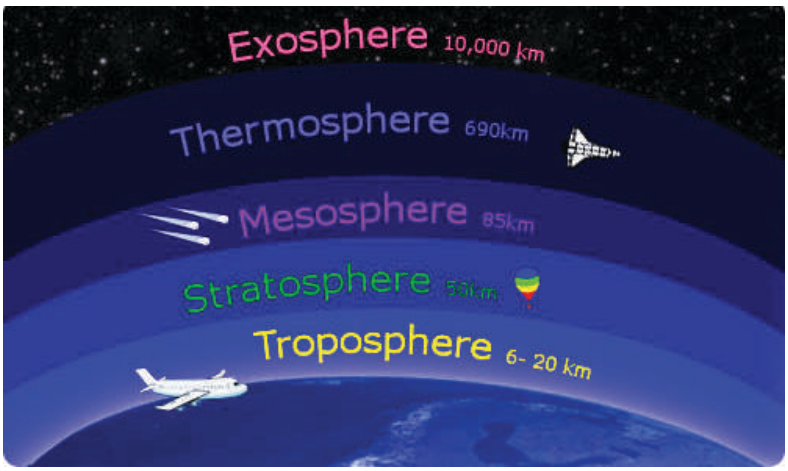


Figure 6.9. The layers of atmosphere

2. Lithosphere

What makes the top of the lithosphere?

Lying beneath the atmosphere and the oceans is the solid earth, referred to as the lithosphere. The lithosphere consists of three major layers: the crust, mantle and core (see figure 6.10). The outermost layer is a thin layer called the crust. Below a layer of soil and beneath the ocean water, the crust is composed almost entirely of solid rock.

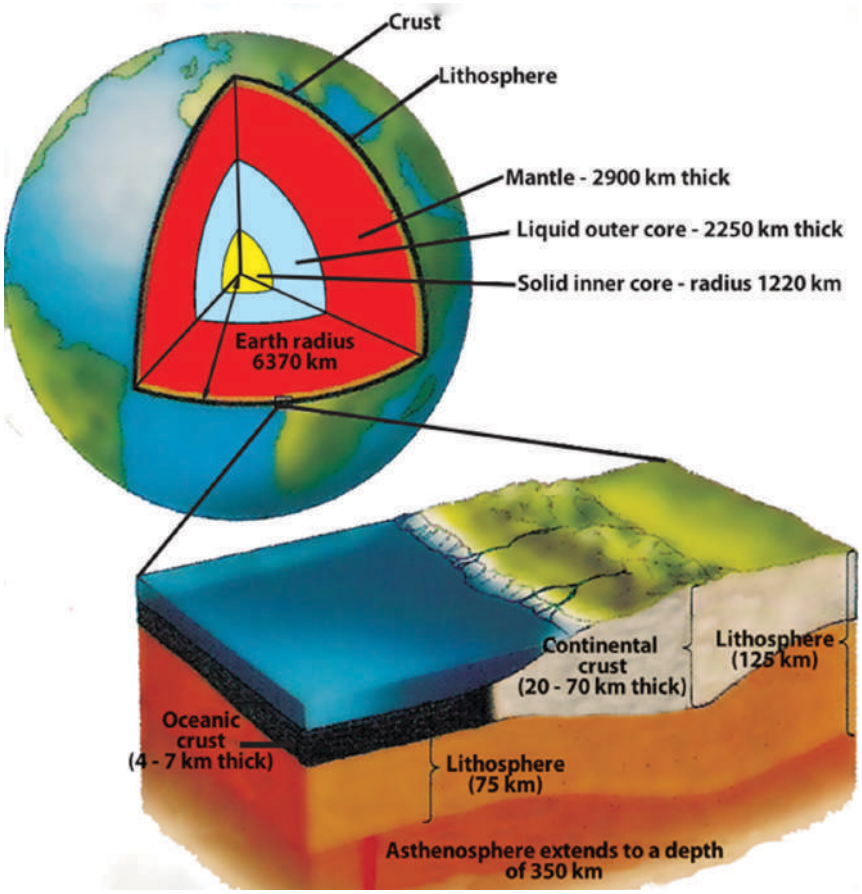


Figure 6.10. The layers of the lithosphere

3. Biosphere

What are the life forms that exist in the biosphere?

The biosphere includes all life on earth, including animals and plants on land and those in the sea and air (such as tree roots, flying insects, and birds). The biosphere interacts with and exchanges matter and energy with the other spheres, helping to drive the global recycling of carbon, nitrogen, phosphorus, sulfur, and other elements.

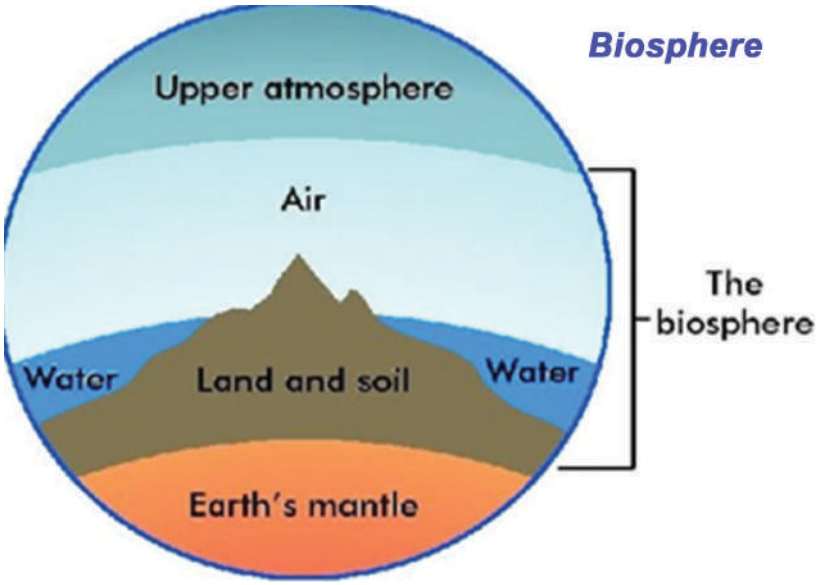


Figure 6.11. Components of biosphere

4. Hydrosphere

What percentage of the hydrosphere forms streams and lakes?

The hydrosphere refers to the total mass of water on or near earth's surface. Water bodies cover 71% of the earth's surface. The total area of the earth is about 5.1x108 sq km. Out of this, 29% is covered by land area and 71%is covered by oceans and sea. A small portion of the water in the earth's hydrosphere is fresh (non-salty) and 97% of earth's water is salty.

Figure 6.12. The hydrosphere

The key materials flows and cycles of the earth

What are the materials that cycle through earth system?

The earth system contains several 'great cycles' in which key materials are transported through the environment. The key materials that cycle through the earth system are water, rock, oxygen, carbon dioxide, nitrogen, carbon, phosphorous and sulphur. All of which are essential for life. These cycles operate at the global scale and involve all of the main components of the earth system; thus, materials are transferred continually between the lithosphere, atmosphere, hydrosphere and biosphere. From these earth's cycles, let us see some of them below:

The water cycle

The water cycle is a continuous cycle during which water evaporates, travels into the air and becomes part of a cloud, falls down to Earth as precipitation, and then evaporates again. This process is a never-ending cycle. It shows the continuous movement of water within the Earth and atmosphere.

The rock cycle

A rock is a solid, cohesive aggregate of grains of one or more minerals, and a mineral is naturally occurring solid inorganic element or compound with a definite composition possessing a regular internal crystalline structure. One type of rock changes to another type under certain conditions in a cyclic manner. This process of transformation is known as the rock cycle.

Project 6.2.

Ask your social Studies subject teacher and prepare a detailed report on;

1. key processes of water cycle
2. rock types and its cycle
3. continental drift theory

Present your report to the class.

Carbon dioxide and oxygen cycle

As stated above, atmosphere is composed of gases, dust and ice droplets. From gaseous parts, let us explain the cycle of carbon dioxide and oxygen as they have high impacts on the living things.

In the process of photosynthesis, plants convert atmospheric carbon dioxide and water from the soil through chemical rearrangements in the presence of sunlight energy into organic matter of food, which is the source of the chemical bond energy for the life activities for not only green plants but also all other organisms. When the sun rises and photosynthesis begins in the morning, the CO_2 concentration in the air gradually decreases as leaves convert CO_2 into organic compounds. They contain roughly 0.03% of the amount CO_2 in the atmosphere. For more information see picture below.

How oxygen can be circulated on this earth?

The atmosphere under which life arose on the Earth was almost certainly devoid of free oxygen. From that time onwards, oxygen became one of the most important elements that play a fundamental role in aerobic respiration and that allowed organisms to extract more energy from organic matter they consumed.

During respiration, organisms remove oxygen from the air and allow it to react with the chemicals in the food at inside the cells and release CO_2. So, while photosynthesis adds electrons to carbon dioxide, respiration removes the electron. It must, at last, be noted that while oxygen is abundant in the atmosphere, it does not readily dissolve in water. Hence, many aquatic environments are starved for oxygen.

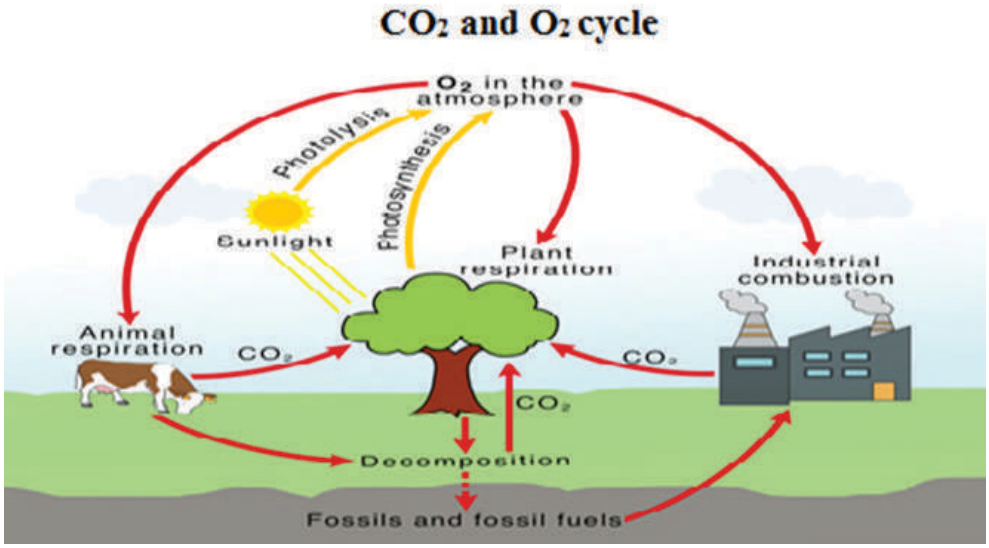


Figure 6.12. CO_2 and O_2 cycle

6.4.2. Effects of earth's system cycles on each other

Water influences the intensity of climate variability and change. It is the key part of extreme events such as drought and floods. Humans use water for drinking, industrial applications, irrigating agriculture, hydropower, waste disposal, and recreation. It is important that water sources are protected both for human uses and ecosystem health. These stresses have been made worse by climate variations and changes that affect the water cycle.

Living things especially plant can affect water cycle, rock cycle and material cycle. Transpiration is a loss of water from plants leaves which can be a source of rain. When plant are died, they will be changed into soil and finally into rock. Soil is important of plant growth.

Over many thousands of years, energy from the Sun moves the wind and water at the Earth's surface with enough force to break rocks apart into sand and other types of sediment. When sediment is buried and cemented together, it becomes a sedimentary rock such as sandstone or shale.

6.4.3. Measuring techniques for too big (earth) and too small (continental drift) quantities, measurement and estimation

What is continental drift?

Before the earth drift or split the large land mass was called Pangaea. This too big earth body drifted many continents by plate tectonic force. Plate tectonics is the unifying theory of geology and revolutionized geology. Corner stone of earth system approach explains connections between seemingly unrelated geologic phenomena.

The plates slowly moves crashing into each other to form mountain ranges, volcanoes and earth quakes. The plates like raft, floating on water, this called

continental drift. It describes one of the earliest ways geologists thought continents moved over time.

Volcanoes are the molten rock or magma in the inner the part of the earth. This magma penetrating the weak parts of the earth to arrive the out parts of the earth was called volcanoes. Earth quakes are the movement of the earth during the volcanic eruption period.

The evidences and measuring techniques of the land drifts or splits:

i. similarities of mountain ranges and sequences.
ii. gracial features. that means the ice covering south poles of southern american and southern africa.
iii. distribution of fossils land animals and plants.
iv. the earth magnetic fields.
v. climatic conditions.
vi. soil properties.
vii. volcanic material similarities.

Exercise 6.4

PART I: Choose the correct answers from the given alternatives.

1. 1. Animals breath in _____ from the air.
   - A. oxygen
   - B. carbon dioxide
   - C. carbon monoxide
   - D. Nitrogen
2. 2. Plants take _____ from the atmosphere.
   - A. carbon dioxide
   - B. oxygen
   - C. nitrogen
   - D. carbon monoxide

Part II: Match the parts of earth under column B with their descriptions under column A.

A column	B column
1. Blanket of air which surrounds the earth.	A. Biosphere
2. Domain of water.	B. Atmosphere
3. The rocky outer shell of the earth.	C. Lithosphere
4. All living things on the planet.	D. Hydrosphere

PART III. Write Short answer for the following questions.

1. Write the evidences and measuring techniques of the land drifts.
2. Explain the effects of earth cycles on each other.

UNIT SUMMARY

- The shape of the earth in very general way is spherical, but when this shape is critically examined it is not perfect spherical.
- There three major parts of earth such as crust, mantle and core.
- Everything in the parts of Earth's system can be placed into four major sub-systems: atmosphere, hydrosphere, biosphere or lithosphere.
- The earth has two types of movements: rotation and revolution.
- In a year there are four season's; summer, winter, spring and autumn. Seasons change due to the change in the position of the earth around the sun.
- Our atmosphere is divided into five layers:-troposphere, stratosphere, mesosphere, thermosphere and exosphere.
- The water cycle is a continuous cycle during which water evaporates, travels into the air and becomes part of a cloud, falls down to Earth as precipitation, and then evaporates again.
- Lithospheres systems are the structure of the solid earth based on the chemical and physical properties.
- A rock is a solid, cohesive aggregate of grains of one or more minerals.
- Rocks in the earth's crust are constantly being recycled through weathering, erosion, transportation, deposition, and subsequent physical and chemical changes.

Key Terms

- Atmosphere
- Biosphere
- Carbon cycle
- Core
- Crust
- Earth
- Geoids
- Hydrosphere
- Lithosphere
- Mantle
- Oxygen cycle
- Revolution
- Rock cycle
- Rotation
- Spheroid
- Water cycle

REVIEW QUESTIONS

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

1. The best model of the shape of the earth is flat.
2. The biosphere is a thin gaseous envelope surrounding the Earth.
3. Evaporation is the process by which water vapor changes to a liquid.
4. Chemical weathering is largely caused by oxidation and the hydrolysis of groundwater.

Part II: Fill in the blank spaces with the appropriate word

1. _____is the linear distance of the earth around the equator.
2. _____ lies directly below the crust.
3. The coldest layer of the atmosphere is known as_____.
4. _____is an ellipsoid having two axes of equal length, making it a surface of revolution.

Part III: Choose the correct answer from the given alternatives.

1. Which of following is not evidences that supporting the shape of the earth?
   - **A.** Sun rise and sunset
   - **B.** The Moon's eclipse,
   - **C.** Gravitational attraction of earth
   - **D.** Circumnavigation of the earth
2. Everything in the parts of Earth's system can be placed:
   - **A.** land
   - **B.** B. water
   - **C.** living things and air
   - **D.** all
3. The astronomer who explains the rotation and revolution of earth is:
   - **A.** Nicolaus Copernicus
   - **B.** Isaac Newton
   - **C.** James Watt
   - **D.** Michael Faraday

4. Which one of the following are not the occurrences of motion of earth?
   - **A.** Variation of climate in different regions of the earth.
   - **B.** Changing of the seasons.
   - **C.** Night and day.
   - **D.** The movement of tree in the spheres.

5. The highest element of atmosphere is;
   - **A.** Nitrogen
   - **B.** Oxygen
   - **C.** Carbon dioxide
   - **D.** Argon

6. A gas that increases the green house effect is _____.
   - **A.** hydrogen
   - **B.** carbon dioxide
   - **C.** oxygen
   - **D.** none of the above

Part IV: Give short answer to the following questions

1. List local and global ideas about the shape of the earth.
2. Write all parts of the earth.
3. Explain the effects of motions of the earth.
4. Explain the cycle effects of earth's systems.

UNIT SEVEN

MOTION, FORCE, ENERGY AND ENERGY RESOURCES

Learning Outcomes

At the end of this unit, students will be able to:

- *describe the term motion;*
- *identify types of motion and show those types of motion in the class;*
- *explain the term force and demonstrate the pulling/pushing activity of force;*
- *explain gravitational force;*
- *list all effects of force and demonstrate some effects of force;*
- *relate effects of force with their daily life experience;*
- *identify different measuring scales on measuring device of force;*
- *explain parts of measuring device of force;*
- *define energy and list all forms of energy;*
- *explain which energy converted to other forms of energy;.*
- *list sources of energy and distinguish b/n renewable and nonrenewable;*
- *describe how energy is used wisely;*
- *list the strategies of conservation of energy; and*
- *explain resource depletion and environmental degradation.*

Main Content

7.1. Motion
7.2. Force
7.3. Energy
7.4. Resource depletion and environmental degradation

Start-up activity

Be in group of six and then discuss with in your group member one the following questions.

1. Assume you are observing a car and the car is moving at a certain speed. Justify a motion of that car based on its initial position and final position.
2. Describe the force and give some examples of forces from your daily activities.

Introduction

Motion, force and energy are the key topics in science. Everything in the universe is not static rather it moves. The term force is used in different situations however force is a technical term in science. It is a very important physical quantity. It is used to describe interactions between two bodies in nature. Hence, in science the term 'force' is used to describe a 'push' or a 'pull' exerted on a body.

In this unit, you will learn about motion and types of motion, force and gravitational force, effects of force and measuring force, energy and conversion of energy, sources of energy, wise use of energy and resource depletion and environmental degradation.

7.1. Definition and types of motion

At the end of this session, you will be able to

- *describe the term motion;*
- *identify types of motion (motion on straight line, circular motion; rotary motion and curvilinear motion); and*
- *show those types of motion in the class.*

7.1.1. Definition of motion

Activity 7.1

Discuss on the following questions with your friends and present to the class.

1. What is motion?
2. When would you say an object is at rest?
3. What do you know about initial point and motion?

Consider your daily travel from your home to your school. When you go to the school, your journey begins from your home. Your home is your original position. After, sometimes you will reach your school. Your school is your final position. In this process, you are continuously changing your position. 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 initial position. Hence, motion is a continuous change in position of an object relative to the initial position. The concepts of at rest and motion are relative; that means

- *A body is said to be at rest if its initial position does not change with time.*
- *A body is said to be in motion if its position changes with time.*

7.1.2. Types of Motion

Activity 7.2

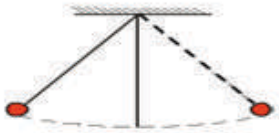
Observe the figure given below

1. Do you see any difference between the motion in figure 7.1(a-d)? and write the name of motion for each figure.
2. Demonstrate these types of motion in the class.

A. a car moving on a straight line

B. a car around a circular path

C. minute hand of a wrist watch



D. the motion of a pendulum

Figure 7.1 Types of motion

Based on the path, a motion is classified into four types. The followings are types of motion of a body.

1. **Rectilinear motion** is the motion of a body along a straight line (see figure7.1 A). Examples:-Motion of a car along a straight level road, and etc.

Give another example for rectilinear motion.

2. **Curvilinear Motion** is the motion of a body along a curved path (figure7.1 B). Examples:-Motion of a car around a circular path, the motion of the moon around the earth, and etc.

Note that circular motion is a special case of curvilinear motion, in which the body moves along a circular path.

Give another example for curvilinear motion.

3. **Rotary motion** is the motion of a body about an axis (figure7.3 C). Examples: -the motion of the second or minute hand of a wrist watch, the motion of a wheel of a car, and etc.

Give another example for rotary motion.

4. **Vibratory motion** is a 'to and fro' or back and forth or up and down motion of a body (figure7.1 D). Examples:-the motion of a pendulum, the motion of objects suspended on a spring, and etc.

Note that both rotary and vibration motions are ***periodic*** motions (repeat themselves).

Give another example for vibratory motion.

Exercise 7.1

1. What is motion?
2. Write down some examples of motion from your daily experiences in the following table.

Types of motion	Practical examples	
A. Rectilinear		
B. Curvilinear		
C. Circular motion		
D. Vibration motion		

7.2. Force

At the end of this section, you will be able to

- *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; and*
- *explain parts of measuring device of force.*

7.2.1. Definition of force

Activity 7.3

Be in a group and answer the following questions

1. Looking the figures below, explain the force.

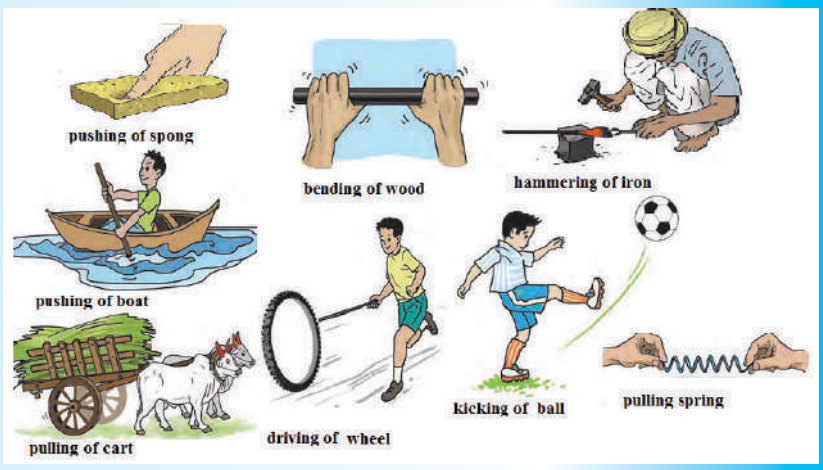


Figure 7.2. Effect of force.

2. Do you think that the force that are used to perform in the above figures are the applied force? Justify .

When we kick the football coming in our direction, towards the goal, we apply force. In day-to-day life, we do many actions such as lifting, pulling, riding a bicycle and stopping it at times, pushing a load, bending something and driving vehicles. It is necessary to apply force for doing all these actions. Force is applied to an object to pull it or push it in any manner.

No object changes its initial position on without applying force. Force is required to move an object. It is used to change the direction of an object in motion, or to stop it.

Give an example of force which you use in your day to day life?

Force is a very important physical quantity. It is used to describe interactions between two bodies in nature.

A force is a push or a pull exerted on a body by another body

7.2.2. Types of forces

Activity 7.4

1. Throw a ball vertically upward and observe its motion. What will happen to the ball? Will it continue to move upward forever? Why?

You know that a force is a push or a pull an object. ***Do all bodies push or pull other bodies by making a physical contact only?*** From your Activity 7.4, you might have noticed that bodies could be in contact to each other or they could be without contact or at a distance from each other. Therefore, forces are classified into two broad categories such as contact forces and non-contact forces.

1. **Contact forces** is direct contact with an object such as muscular, friction, spring force, etc

2. Non-contact force is a field force or act at a distance such as magnetic force, electromagnetic force and gravitational force.

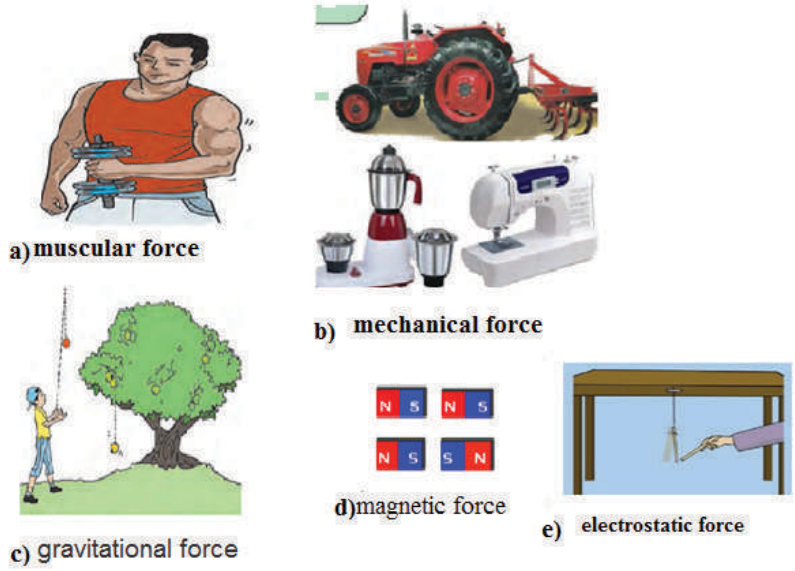


Figure 7.3. Some contact forces and non-contact force.

Gravitational force is the force applied by the earth to pull objects towards it.

The earth pulls all the objects towards itself or objects or things fall towards the earth because it pulls them. This force is called the force of gravity. It is an attractive force. The force of gravity acts on all objects.

Mass is the amount of matter present in the object. The earth attracts every object with a certain force and this force depends on the mass of the object and the acceleration due to the gravity.

The weight of the object is the product of mass of an object and gravity.

$$Fg = mg$$

Where Fg= gravitational force of a body m=mass of a body g =gravity of the earth and its value is constant which is 9.8m/s²

Exercise 7.2

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

1. Motion is a push or a pull that applied on an object.
2. The force exerted by electrically charged materials is contact force.

Part II: Write the short answer for the following questions.

1. Explain the term force.
2. What is a gravitational force?
3. Write examples of contact and non contact forces.

7.2.3. Effects of force

It is not simple to describe an effect of force as you can describe some material objects such as a chalk, pen, orange etc. You can only say what a force can do. For example, when a body at rest is acted and it will begin to move. If a body is already moving, a force may change its velocity. That is, a force produces motion or changes motion of a body.

Acitivty 7.5

Be in a group and discuss on the following activity and present to the class.

1. Observe the activities shown in fig 7.4.

   a) *Explain the effects of forces in each activity.*
   b) *Can you summarize the effects of force?*

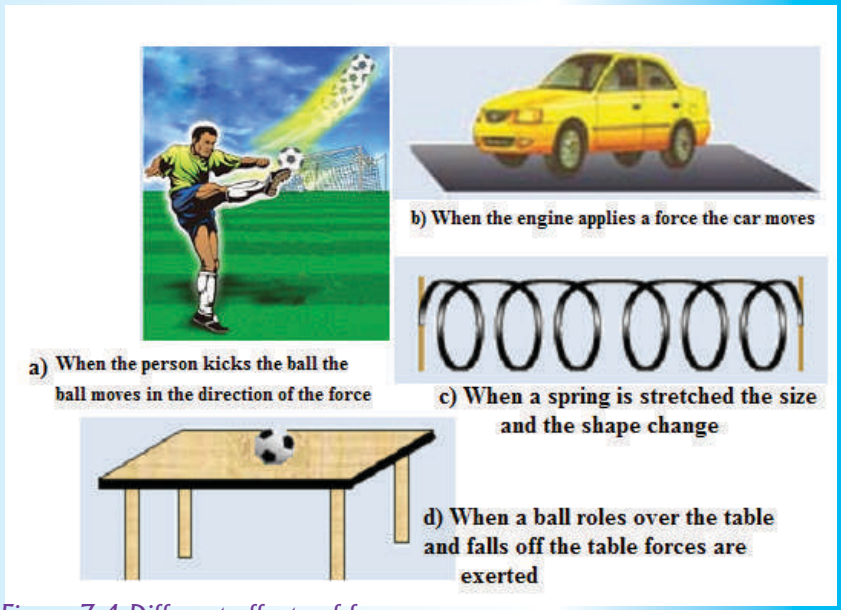


Figure 7. 4 Different effects of forces

2. Can you demonstrate some effects of force infront of the students which represent the above figures? Please show to your friends.

Some effects of forces are :

1. **Force can change the state of motion**: An object can be in two states.

   a) *Rest state:* When an object is not moving. This means, a stationary object

is said to be in the state of rest. For example in the above activity figure "d" a ball on the table is not moving but at rest.

b) *Motion state:* A moving object is said to be in the state of motion. For example in the above activity figure. "a" When the person kicks the ball, the ball is in the motion.

2. Force can change the shape and size of an object is called deformation.

Generally, a force has the following main effects, when it is exerted on an object:

1. It changes the shape and size of the objects (deformation).
2. It changes the state of motion of the objects and its direction. i.e. when a force is exerted on a body:

a) *a stationary body starts to move*
b) *a moving body increases its motion,*
c) *a moving body decreases its motion and gradually stops moving*
d) *a moving body changes it direction.*

Exercise 7.3

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

1. Force can change the shape and size of an object.
2. A stationary object is said to be in the state of motion.
3. A moving object is said to be in the state of rest.

Part II: Write the short answer for the following questions

1. List all effects of force
2. State the effects of force in your daily life experience

7.2.4. Measuring force

Activity 7.6

Do the following tasks with your friends.

1. Name measuring device of force.
2. Explain parts of measuring device of force.
3. Explain the scientific instrument used to measure a force and its unit

A force is measured using an instrument called a spring balance. As you can observe from Fig 7.5 there is a stretch (increase in length) of the spring when it is pulled. We can use this, increase in length of a spring to measure the magnitude of the force stretching the spring.

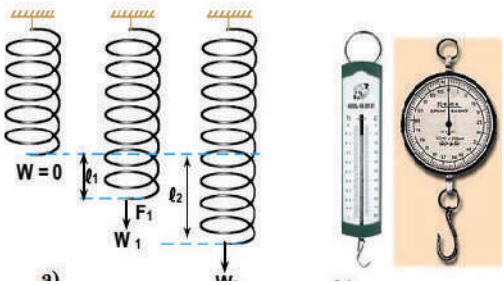


Figure 7.5. Spring balance

Each time an extra weight is added you find that there is the same extension because each object is identical. They are attracted to the earth with the same force, so what we have found is that equal force produced equal extensions of the spring.

Newton meter is the scientific instrument used to measure a force. The SI unit of force is Newton and symbolized by N. The unit Newton is named, after the great scientist Sir Isaac Newton. Newton meter has different parts such as hook, spring scale (Newton) and supporter or holder.

Fig 7.6 (a) illustrate the structure of a Newton meter. It is made up of a spring attached to a hook and a scale leveled in Newton. Fig 7.6 (b) illustrates the

weight of stone in kilogram. When the spring balance is held by the hand it shows a certain weight for the piece of stone. Here, the weight is 0.5kg. To know the weight of the stone in Newton, you have to multiply by 9.8 m/s^2. For example, to describe the magnitude of force (the weight), stone which Newton meter read and we use formula;

F=mg this means 0.5kg x 9.81m/s^2=4.91N

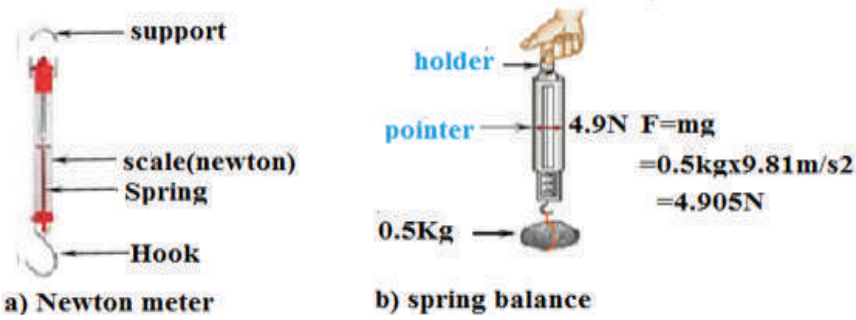


Figure 7.6. Weight measuring instrument

Exercise 7.4

Part I: From the following figure below find the magnitude of force (take g=10m/s^2.)

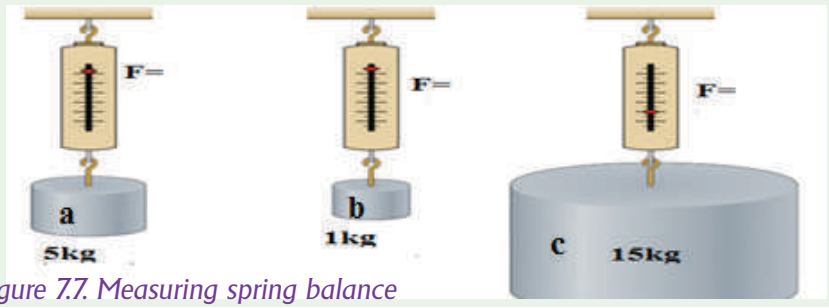


Figure 7.7. Measuring spring balance

Part II: Fill in the blank space

1. _____ is the scientific instrument used to measure a force.
2. _____ is used to measure the weight of a body

7.3. Energy

At the end of this section, you will be able to;

- *define energy.*
- *list all forms of energy;*
- *explain which energy converted to other 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; and*
- *list the strategies how energy is used wisely.*

7.3.1. Definition of energy

Activity 7.6

Discuss on the following question with your friends

What is energy?

Energy is something that objects possess. Energy is also defined as a property of a matter that can be converted. A body is said to possess energy when it is capable of doing work. Thus, the energy of a body is measured by the quantity of work that the body do.

Energy is the capacity to do work. The SI unit of energy is Joule, named in honor of James Priscatt Joule. Another unit of energy is calorie (1calorie is equals to 4.2 Joules).

Energy is involved in all life cycles, for example:

- crops need energy from solar radiation to grow;
- harvesting needs energy from the human body to do work;
- cooking needs energy from biomass as a fire and the food, in turn, provides the human body with energy.

Explain the uses of energy for human in our daily activity.

7.3.2. Forms of energy and Energy conversion

Activity 7.7

Discuss on the following questions in a group.

1. List all forms of energy.
2. Which forms of energy do you think is mostly used in our country?

Forms of energy

The world we live in provides us with different forms of energy. There are many forms of the energy in the nature such as mechanical energy, electrical energy, chemical energy, nuclear energy, solar energy, sound energy, heat energy, wind energy ,water energy, and etc.

Mention the other forms of energy? Give at least two examples for each.

In this section, you will learn about some forms of energy such as mechanical energy, chemical energy, heat energy and electrical energy.

i. Mechanical energy

What is mechanical energy?

Mechanical energy is the energy possessed by an object due to its motion and position related to the earth's surface. There are two types of mechanical energy:

A. Kinetic energy is the energy of a body due to its motion. For example: running cars, thrown stones, rotating wheels, etc have kinetic energy due to their motion.

B. Potential energy is the energy associated with the position of a body relative to the earth's surface. For example, lifted masses above the earth's surface.

Generally, mechanical energy is the sum of kinetic and potential energy.

ii. Chemical energy: (coal, oil, natural gas)

What is chemical energy?

Chemical energy is the energy that bonds the material atoms together, and when atomic bonds broken, this energy is released. For example the dry wood is a store of chemical energy. As it burns in the fire place, chemical energy is released and converted into thermal energy (heat) and light energy.

iii. Heat energy: Heat energy is caused by the internal motion of the atoms, because moving particles has friction producing heat. Heat energy is the total kinetic energy of moving particles of matter.

iv. Electrical energy: Electrical energy is resulting from the motion of electrical charge between two positions.

Energy conversion

Activity 7.8

Discuss in a group on the following questions and present to the class.

List the energy conversion that takes place in each of the following cases.

a) *Hydroelectric power stations (Koka Dam, Gilgel Gibe dam etc) supply electric energy to our cities.*
b) *Using fuel energy in our home to cook foods and boil water.*
c) *Using dry cells (chemical energy) for lighting a torch, and listening to radio, etc.*

Energy conversion means converting energy from one form into another through a transducer. The device used to convert energy from one form to another is called transducer.

The law of conservation energy state that:

> Energy neither destroyed nor created but it is can be converted from one form to another and the total amount remains constant.

Some examples of conversion of energy, such as:

- generator is device used to convert mechanical energy to electrical energy,
- microphone is device used to convert electrical energy to sound energy.
- solar cells are device used to convert sunlight to electricity and heat.

See the following diagram below and write the devices that used to convert one form of energy to another form.

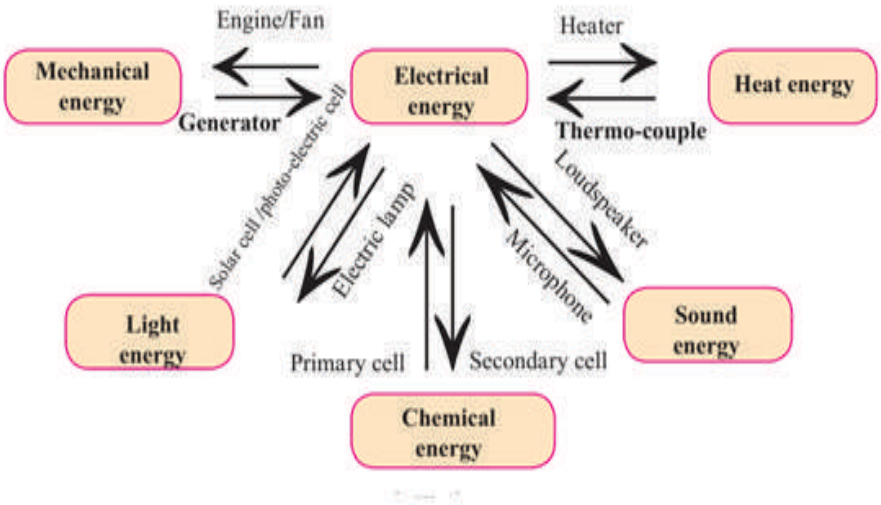


Figure 7.8. Types of energy

Exercise 7.5

Write short answer for the following questions

1. Write at least three forms of energy.
2. Write at least four energy converter devices.
3. State the law of conservation of energy.
4. Explain the use of energy.

7.3.3. Energy Sources

Activity 7.9

Discuss on the following questions with your friends.

1. List sources of energy.
2. Differentiate renewable and non-renewable forms of energy,

People have always used energy to do work. This energy get from different sources such as sun, fuel, hydroelectric, wind and nuclear reaction. Humans burned wood to provide light and heat their living spaces, and cook their food. People used the wind to move their boats from place to place and using falling water to make electricity. The figure below (fig.7.9) shows some forms of energy such as solar, wind, hydroelectric dam and nuclear reaction.

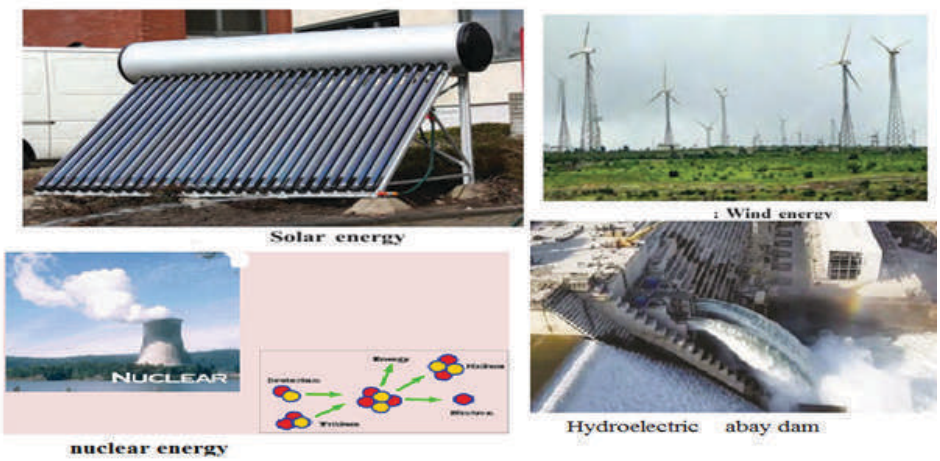


Figure 7.9. Some sources of energy

a. Solar energy

What is solar energy?

The energy obtained from the sun. Sun is the root of all energy available on the earth. A variety of devices have been developed for making use of solar energy. For example, the solar cooker, solar water heater, solar cell, etc.

b. Wind energy

What is wind energy?

Electricity is generated by means of windmills using strong winds. A windmill is also used for drawing water from a well.

List the uses of energy for your daily life?

c. Hydroelectric or hydro power:

The water stored in a dam at a height is brought down through a tunnel and the turbines of the generator are rotated. The place where electricity is generated in this way is called a 'hydroelectric or hydro power' plant. For instance, the Grand Ethiopian Reneissance Dam (GERD).

Mention some hydroelectric power dams in Ethiopia.

d. Nuclear energy

What is nuclear energy?

Nuclear power is the energy associated with changes in the nucleus of an atom and produced in two ways: When two or more nuclei join together and when the nucleus of an atom split apart.

Based on their renewability, the sources of energy are classified into two broad groups such as non-renewable and renewable.

1. Non-renewable energy

Non-renewable energy sources cannot be replaced in a short period of time and it cannot be made quickly. Some non-renewable energy sources include coal, petroleum, natural gas, propane, uranium, and etc.

Explain the uses of non-renewable energy sources?

2. Renewable energy

Renewable energy sources are replaced in a short time. Some renewable energy sources include biomass, geothermal, hydropower, solar, wind, and etc.

Explain the uses of non-renewable energy sources?

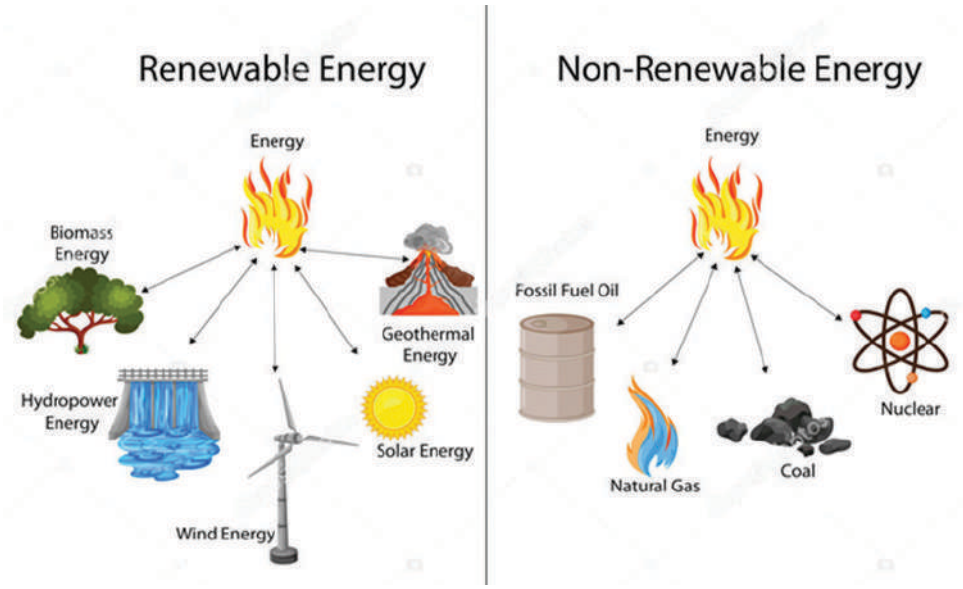


Figure 7.10. Renewable and Nonrenewable energy sources

Renewable energy sources	Non-renewable energy sources
Can be replaced by natural process in a short period of time or recycled.	These are natural resources that either cannot be replaced or may take a millions of years to replace by natural process like coal and oil.
Can be reused or recycled and used many times.	Cannot be reused or recycled.
No harm done to the environment because of its use	Huge harm done to the environment because of the harmful emissions
Examples: wind, solar, hydroelectricity, geothermal, etc.	Example: Coal, petrolumNatural gas, nuclear energy, fossil fuels, etc.

Exercise 7.6

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

1. Electricity is the root of all energy available on the earth.
2. Renewable energy sources are replaced in a short time.
3. Electricity can be generated by means of winds.

Part II: Write the short answer for the following questions.

1. List sources of energy.
2. Write examples of renewable and non-renewable sources of energy.

7.3.4. Wise use of energy

Activity 7.10

Discuss on following questions in group and present to the class.

1. How energy is used wisely? Explain by giving examples.
2. Explain the strategies how energy is used wisely.

Wise use of energy means that less energy is needed and reduces its costs. It is the decision and practice of using less energy. Turning off the light when you leave the room, unplugging appliances when they are not in use, and etc are some examples of how energy is used wisely.

Energy conservation is the practice of using less energy in order to lower costs and reduce environmental impact. This can mean using less electricity, gas, or any other form of energy that you get from your utility and pay for. With finite energy resources available on our planet, actively conserving energy when possible is beneficial individually and to our larger energy systems. We must conserve energy because of a number of reasons such as:

1. demand exceeds supply: - is an increasing demand for energy due to increasing population, industrialization, traffic on roads and automation in home, office and farms.
2. energy saved is energy generated.
3. some common sources of energy are limited. The deposits of coal, gas and oil are limited.

Conservation of energy has to be the order of the day. Each and every one of us has to unite and collectively take action to preserve and conserve energy.

How energy can be saved at home, work place or on the road?

1. Energy Conservation at Home

a. Save Power

1. Switch off lights and fan while leaving a room.
2. Change over to energy efficient tube lights from power consuming bulbs *Remember! A 40 watt tube light gives twice as much light as a 100 watt Incandescent bulb. This means a savings of 60% power in addition to more light!*
3. Replace traditional lamp of tube lights with Light Emitting Diode (LED). They consume one third energy.
4. Use light colors for walls. This helps reduce lighting requirements by up to 40%.

Switch off a little ..... save a lot!

b. Fuel

The prices of fuel or kerosene are not far behind. So what can we do to reduce our fuel bills? Here are some tips.

1. Replace traditional wood stoves with the 'smokeless stove.
   These are 20-25 % more heat efficient.
2. Use solar cookers as far as possible.
   Solar energy is free and abundantly available.
3. Avoid cooking in open pans
4. Switch on the gas after putting the pan on and switch off before removing the pan.
5. Switch off the regulator switch of the gas cylinder at night.

The above are just some tips to avoid excessive power and fuel use at home.

2. At the work place

Just like as we conserve energy in our home, we have to conserve energy at work place. Here are some of the suggestions:

1. Ask the cleaning staff not to switch on all lights and fans before people come to the office.
2. Switch off fans and lights when you leave the room.
3. Minimize the use of air-conditioners.
4. Switch off computers when not in use.
5. Avoid unnecessary photocopying of documents.
6. Encourage people to use the stairs instead of the lift, especially in places like hospitals.

3. On the road

Vehicles are used to go to the office as well as for family outings. This has resulted in a tremendous increase in the use of petrol, diesel and compressed natural gas.

What do you suggest to control the use of petrol, diesel and compressed natural gas?

We could consider the following:

1. Use a car pool instead of individual cars to travel to work
2. Adopt petrol saving measures such as
3. Encourage installation of light sensitive switches and solar panels for lights
4. Discourage the use of neon lights for advertising. These can easily be replaced by using solar panels which convert solar energy to electrical energy which lights up neon signs at night.

Exercise 7.7

Short answer for the following questions

1. What does wise use of energy mean?
2. Write the strategies how energy is used wisely at home and the work place.

7.4. Resource depletion & environmental degradation

At the end of this section, you will be able to;

- *explain resource depletion and environmental degradation.*

Activity 7.11

Make a group and discuss on the following question with your friends.

What do you mean by resource depletion and environmental degradation?

The depletion of natural resources occurs when resources are consumed at a faster rate than that of replacement. Natural resources are those resources that are in existence without human actions and they can either be renewable or non-renewable. It is the wise uses of water, farming, and fossil fuel consumption, fishing and mining.

Some causes of depletion of natural resources are;

- over population growth
- poor farming practice
- logging
- overconsumption of natural resources
- pollution
- industrial and technological development

Some effects of depletion of natural resources are;

- water shortages
- oil depletion
- loss of forest covers

- depletion of minerals

Some solutions of depletion of natural resources are;

- controlling deforestation
- reducing oil, mineral and material consumption
- more exploration and use of renewable sources of energy
- protecting wetlands and coastal ecosystems

Environmental degradation

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.

Environmental changes may be driven by many factors including economic growth, population growth, urbanization, intensification of agriculture, rising energy use and transportation.

Some examples of environmental degradation are;

- deforestation
- water pollution
- soil erosion
- throwing waste in river.
- falling levels of ground water
- use of chemical fertilizers and pesticides.
- depletion of the ozone layer
- burning of coal and mineral oil

Some solutions for environmental degradation are;

- stop deforestation
- refrain from plastic packaging and disposable cups.
- reduce waste production
- reduce consumption levels
- education
- stricter government regulations

Exercise 7.8

Write the short answer for the following questions.

1. What is the environmental degradation?
2. Explain effects of depletion of natural resources.
3. What are solutions of depletion of natural resources?
4. Give some examples of environmental degradation.

UNIT SUMMARY

- Motion is a continuous change in position of an object relative to the initial position.
- There are four types of motion: - rectilinear motion, Curvilinear Motion, Rotary motion and Vibratory motion.
- A force is a push or a pull exerted on a body by another body.
- Force is used to change the direction of an object in motion, or to stop it.
- There are two types of forces namely; contact forces and non-contact force.
- The gravitational force is a force applied by the earth to pull objects towards it.
- A force is measured using an instrument called a spring balance.
- Newton meter is the scientific instrument used to measure a force.
- Energy is the ability to do work.
- Some forms of energy are electrical energy, chemical energy, nuclear energy, solar energy, sound energy, heat energy, mechanical energy, and etc.
- Energy conversion means converting energy from one form into another.
- Energy Conservation law state that: energy can't be destroyed or created from nothing, but it is converting from one form to another.
- Energy gets from different sources such as sun, fuel, hydroelectric and nuclear.
- Non-renewable energy sources include coal, petroleum and natural gas.
- Renewable energy sources include biomass, geothermal, hydropower and solar.

- Conserving energy means that less energy is needed and reduces its costs.
- The depletion of natural resources is the wise uses of water, farming, and fossil fuel consumption, fishing and mining etc.
- Environmental degradation is the deterioration of the environment through depletion of resources such as quality of air, water and soil.

Key Terms

- Conservation
- Conversion
- Depletion of resources
- Energy
- Environmental degradation
- Force
- Gravitational force
- Motion
- Non-renewable energy
- Renewable energy
- Wise use

REVIEW EXERCISES

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

1. Motion is continuous change of position of an object.
2. A ball fall from a certain height is example of curvilinear motion.
3. An object changes its position by its own.
4. Forces can change the state of motion.
5. Wise use of energy means that high energy is needed and increases its costs.
6. Potential energy is energy in motion.

Part II: Choose the correct answer from the given alternatives

1. Which one of the following is contact force?
   - **A.** Magnetic
   - **B.** Electromagnetic
   - **C.** Friction
   - **D.** Gravitational
2. A push or a pull exerted on a body by another body is:
   - **A.** time
   - **B.** force
   - **C.** energy
   - **D.** mass
3. An instrument used to measuring force of an object is;
   - **A.** newton
   - **B.** spring balance
   - **C.** triple balance
   - **D.** beam balance
4. The energy that comes from the nucleus of an atom is;
   - **A.** chemical energy
   - **B.** nuclear energy
   - **C.** sound energy
   - **D.** electrical energy

5. According to which law states, energy is neither created nor destroyed?
   - A. First law of motion
   - B. The law of force
   - C. Laws of Energy
   - D. Law of conservation of energy

6. What is energy conversion? It is the;
   - A. way of one type of energy changing to another type of energy
   - B. way of energy in one object going into another object
   - C. way of energy units changing
   - D. way of energy units staying the same

7. Which energy-conversion process occurs whenever coal is burned?
   - A. Chemical to thermal
   - B. Mechanical to thermal
   - C. Mechanical to electrical
   - D. Electrical to thermal

8. A device that convert electrical energy to light energy is;
   - A. blender
   - B. light Bulb
   - C. bicycle
   - D. balloon

9. Energy stored because of gravity is called:
   - A. chemical Energy
   - B. potential Energy
   - C. kinetic Energy
   - D. D. mechanical Advantage

10. The capacity to do work is;
   - A. force
   - B. energy
   - C. speed
   - D. Gravity

11. Which one of the following is non-renewable source of energy?
   - A. Biomass
   - B. Geothermal
   - C. Natural gas
   - D. Hydropower

12. All are non-renewable energy sources except one.
   - A. coal
   - B. petroleum
   - C. propane
   - D. solar

13. Which one of the following is not the form of energy?
   - A. Chemical Energy
   - B. Heat Energy
   - C. Electrical Energy
   - D. Force Energy

14. The form of energy which is stored in the nucleus of an atom is;

A. electrical Energy
C. solar Energy
B. mechanical Energy
D. nuclear Energy

15. A device used to convert chemical energy to electricity (electrical energy) is;

A. solar cells
C. primary cells
B. B. secondary cells
D. electric generator

Part III: Write the Short answer the following questions

1. Write the types of motion.
2. List all effects of force.
3. List all forms of energy.
4. List the sources of energy.
5. Write causes of depletion of natural resources.
6. What are solutions for environmental degradation.