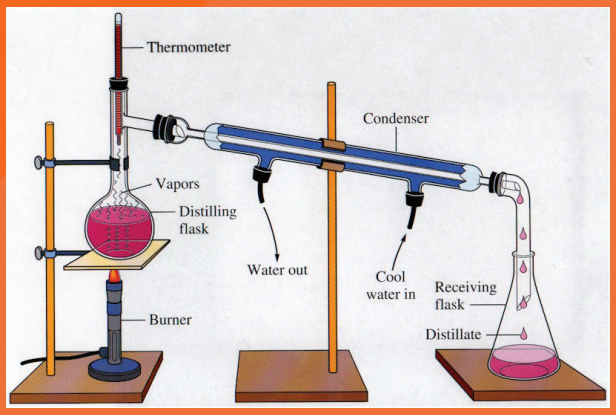
General Science

Student Textbook



Grade 7

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General Science

Student Textbook Grade 7

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Unit 1 BASIC CONCEPTS OF SCIENCE

Learning Outcomes

At the end of this unit, you 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 and technology;
- identify different laboratory tools;
- demonstrate safe ways of using apparatus in the laboratory;
- practice precautionary measures in the laboratory;
- exhibit knowledge of laboratory safety rules and procedures;
- identify potential hazards and implement appropriate safety procedures when working in the laboratory.

Main Contents

1.1 The Nature of Science and its Branches

By the end of this section you should be able to:

- Define science;
- Distinguish between the Indigenous Science and Conventional 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;
- Solve the issue of environmental problems in their school compound and its surroundings.

Introduction

In the lower grades, you have learnt about science in general. For example, environmental science. In this and next grade you will learn about general science which deals with things related to your day to day life.

Activity 1.1

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

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

The word science comes from the Latin word ***'Scientia'***, which means ***'Knowledge'.*** But science is not just about having knowledge: Science is a systematic method of gaining knowledge about the physical and natural world and the social aspect of human society. It provides an ordered way of learning about the nature of things, based on observation and evidence. Science can be indigenous or conventional.

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

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

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

Activity 1.2
Perform the following activities.
Find some practical indigenous knowledge in your community that solves community problems and present your finding to your class

Why Do You Learn Indigenous Knowledge In Science?

There are two main reasons to include Indigenous Knowledge in the science: firstly, to increase awareness of original culture and identity and secondly, to integrate indigenous knowledge with western science. Ethiopia is one of the countries where a wide variety indigenous knowledge practiced for a long time to solve practical problem that exist in different areas like:

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

1.1.2. Branches of Science

Activity 1.3
Form a group and discuss the following questions. Then share your ideas to the class
1.What are the major branches of science?
2. Give short descriptions of physics, Chemistry and Biology.

Science has two major categories, which are natural science and social science.

Natural science is the study of nature and natural laws. It includes fields such as Chemistry, Biology and Physics.

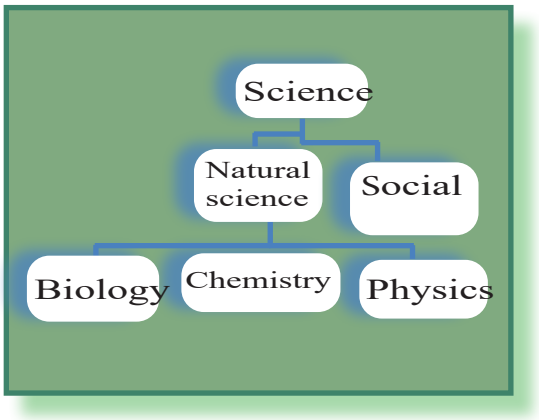


Figure 1.1. Branches of science

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

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

◊ **Biopysics:** a combination of Biology and Physics. It is the study of physical phenomena and physical processes in living things, on scales spanning molecules, cells, tissues and organisms.

◊ **Biochemistry:** combination of biology and Chemistry. It is the branch of science that explores the chemical processes within and related to living organisms. It involves the study of chemical reaction in living things.

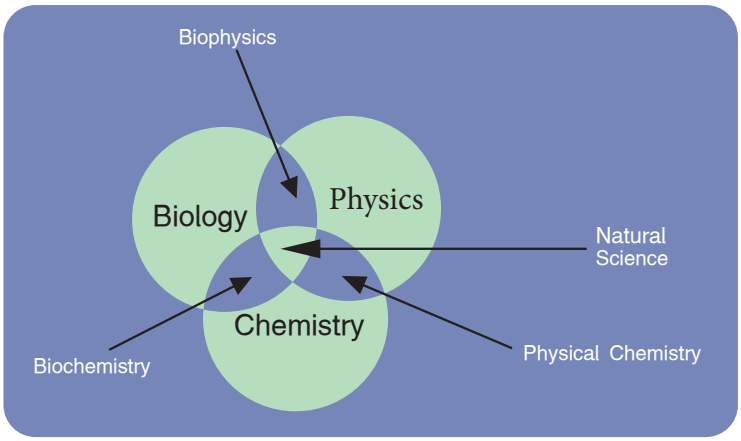


Figure1.2.The relationships between some fields of Natural Science

Exercise 1.1

I. Give short answer for the followings questions

1. What is science?
2. List the three branches of natural science
3. Which field of science studies about matter and energy?
4. What is the difference betwen biophysics and biochemistry?

1.1.3. Science and Technology

You have already discussed what science is. Now, you will see what a technology is.

Technology is the use of scientific knowledge to help human beings work easier and live better as well as enjoy their environment more. It includes the use of materials, tools, techniques, and sources of power to make life easier, more pleasant and work more productive.

Things such as automobiles, TV sets, radio, bulb, microchip, computer, airplane and home tools (appliances) are the products of technology.

Key words

Science is a systematic method of gaining knowledge about the physical and natural world.

Technology is the use of scientific knowledge to help human bings work easier and live better or putting scientific knowledge intopractice.

A person who studies technology is called a technologist.

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

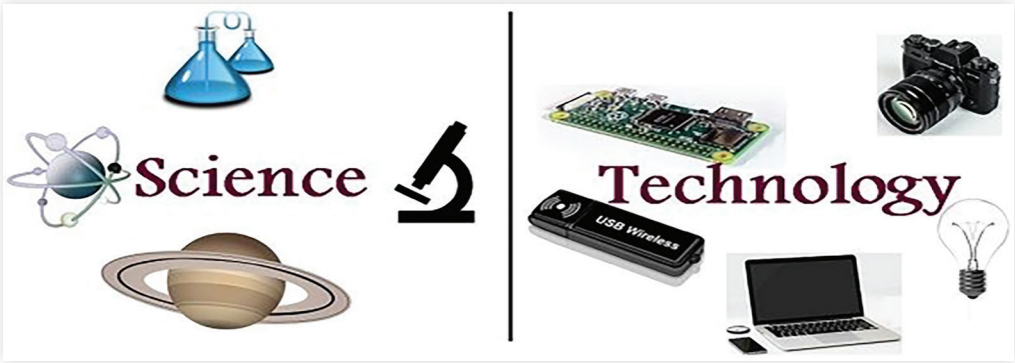


Figure 1.3 Relationship of science and technology

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

Uses of Science and Technology for the Society

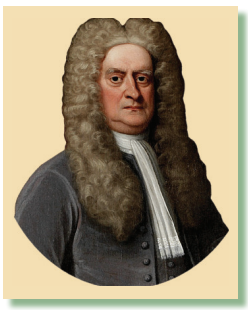
Science and technology plays an important role in our daily life. They mainly concerned with the production of new materials of desirable properties and qualities to satisfy social needs.They play an important role in agriculture, in production of medicines and drugs, in environment and population control,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

1.1.4. Scientists and Ethical Discipline

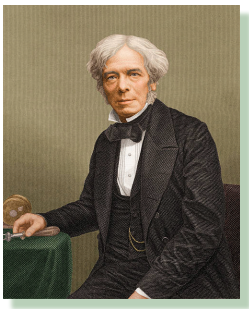
Famous Scientists in the World and Ethiopia

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

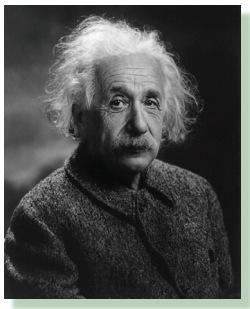
Marie Curie (1867-1934), won the Nobel Prize for the discovery of the elements polonium and radium



Isaac Newton (1643-1727) discovered the laws of motion and law of gravity.



Michael Faraday (1791-1867),discovered the generation of electricity from magnetism. He built the 1st dynamo.



Albert Einstein (1879-1955) Developed special relativity theory

Fig1.4 Some World known scientist and their works

Activities 1.4

Form a group and do the following activity

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

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

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

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

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

Fig1.5 Some Ethiopian known scientist and their works

Ethical Principle in Science

Activity 1.5
Form a group and discuss on the following questions then present your opinion to the class
i. Do you think ethical discipline is important for science?
ii. List down some ethical disciplines in science

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

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

Exercise 1.2

Choose the best answers for the following questions.

1. The natural science disciplines are
   A. interacting C. interrelated
   B. overlapping D. all of the above
2. The branches of natural science studying the composition of compounds and the processes taking place in organisms, respectively, are:
   A. Chemistry and Biology C. Biology and Physics
   B. Physics and Geology D. Biology and Geology
3. Which one of the following is true about Science?
   A. It is the study of physical and natural world.
   B. It comes from Latin word "Scientia meaning 'knowledge'
   C. It is the system of acquiring knowledge based on scientific method.
   D. All are correct
4. Which one of the following is true about Indigenous knowledge?
   A. It is based on scientific method.
   B. The knowledge derived from western countries.
   C. It incorporates local people's knowledge.
   D. It has universal perspective and commonly recognized as western science.
5. Which one of the following is the World famous scientists who discover law of motion and gravity?
   A. Michael Faraday B. Marie Curie
   C. Isaac Newton D. Albert Einstein

1.2 Common laboratory Equipment, Uses, Safety Rules and Procedures in Science laboratories

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

- Identify different laboratory tools (such as Balance, Beaker; Tongs, Bunsen burner, Test tubes, Petri dishes, etc.), and describe 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;
- Demonstrate the appropriate use of personal protective equipment for a given laboratory activity.

1.2.1. Common Laboratory Apparatus

Activities 1.6

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

Laboratory equipment comprises different sets of apparatus, which are designed to perform various tasks in the laboratory by students, teachers and scientists. The students can conduct laboratory work smoothly and more efficiently only when they are familiar with the apparatus commonly used in the laboratory. Some laboratory apparatus are shown in table 1 below.

Table 1 Different laboratory tools and their use

Name	Picture	Uses
Triple-beam balance		Obtaining the mass of an object
Beaker		Holding water (also used to heat liquid
Tongs		Transporting a hot beaker; and removing lid from crucible
Thermometer		Used to measure temperature
Test tubes		Holds small amounts of liquids for mixing or heating.
Petri dish		To grow and count bacteria
Graduated cylinder		Marked with milliliter (ml) scale and is used to measure volume
Bunsen burner		Heating (flame-safe) contents in the lab

Key words

Laboratory equipment refers to the various tools and equipment used by students, teachers and scientists working in a laboratory.

Laboratory report explains what you did in experiment, what you learnt and what the result mean

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

1.2.2 Laboratory Safety Rules

Activities 1.7
i. List down some laboratory safety rules
ii. Discuss hazard symbols on chemical bottles, electrical gadgets and other materials found in the laboratory

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

- Dress appropriately (goggles, gloves, shoes and laboratory coats).
- Tie back loose hair.
- Know the locations of safety equipment like fire extinguisher.
- Know what to do in case of an accident.
- Do not taste or smell chemicals.
- Do not eat or drink in laboratory.
- Never add water to concentrated acid solutions. Always add acid into water. Follow the Amharic AW! Not WA! (A-acid, W-water)
- Carry out only the experiments assigned by your teacher.
- Dispose of all chemical wastes properly.

1.2.3 Science Laboratory Safety Symbols and Hazard Signs, Meanings

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

Figure: 1. 6 A) hazard signs **B) Laboratory safety symbols**

1.2.4 Writig a Laboratory Report

Laboratory is a place where experiments in science is performed; therefore, it helps students learn and develop their power of observation, skill in handling apparatus varies kinds and independent thinking.

A laboratory report is a written composition of the results of an experiment. It should be written precisely and clearly, using good grammar and punctuation. Each report must include: *date*, *title, objective, theory, materials or equipment, chemical used, procedure, observation, result, discussion, and conclusion.*

Exercise 1.3

Choose the best answers for the following questions

1. Which one of the following is NOT allowed in science laboratory?
   A. Knowing the hazards of the materials being used
   B. Reading the labels on the reagent bottle carefully
   C. Wearing any type of cloth and shoes
   D. Not using laboratory glassware for eating or drinking purposes.
2. Which of the following laboratory tool is used for the approximate measurements of volume of liquids
   A. Test tube
   B. Thermometer
   C. Measuring Cylinder
   D. Dropper
3. The type of laboratory equipment categorized under measuring equipment is
   A. Bunsen burner B. Triple-beam balance
   C. Tongs D. Stand and clamp

Key terms

Conventional Science
Ethics
Hazard Signs
Indigenous Science
Laboratory
Laboratory Equipment
Natural Science
Safety Rules
Science
Scientist
Technologist
Technology

Unit Summary

- Science is a systematic method of gaining knowledge about the physical and natural world and the social aspect of human society.
- Indigenous science is process by which Indigenous people build their empirical knowledge of their natural environment
- Conventional science is the system of knowledge which relies on certain laws that have been established through the application of the scientific method to phenomena in the world around us.
- Science has two major categories, which are natural science and social science.
- Natural science has three branches which are Biology, chemistry and physics.
- Technology is the use of scientific knowledge to help human beings work easier and live better as well as enjoy their environment more.
- A person who studies technology is called a technologist.
- Science and technology plays an important role in our daily life
- Some famous scientists in Ethiopia are Dr. Aklilu Lemma, Engineer Kitew Ejigu,Dr.Gebisa Ejeta, and Prof.Yalemtsehay Mekonnen
- Famous scientists from the world are Albert Einstein, Michael Faraday. Marie Curie and Isaac Newton etc.
- Laboratory equipment comprises different sets of apparatus, which are designed to perform various tasks in the laboratory.
- Knowing Laboratory safety rule is very important to reduce risks faced during laboratory investigation.

Review Exercise

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

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

Part II: Choose the best answers for the following questions

1. The study of living things is the concern of
   A. Chemistry C. Biology
   B. Physics D. Geology
2. _____ is a branch of natural science which studies the nature of matter, energy and their interaction.
   A. Chemistry C. Biology
   B. Physics D. Geology
3. The famous Ethiopian scientist who discovered a natural treatment to Schistosomiasis or bilharzia disease.
   A. Eng. Kitew Ejigu C. Dr. Gebisa Ejeta
   B. Dr. Aklilu Lemma D. Prof. Yalemtsehay Mekonen
4. Which of the following is NOT a laboratory safety rule?
   A. You should tie back loose hair.
   B. You should add water to Acid.
   C. Do not suck solution in the pipette by mouth.
   D. When lighting a Bunsen burner, you should light the match stick before turning on the gas.

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

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

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

A	B
1. Biochemistry	A. Combination of Biology and Physics
2. Physical Chemistry	B. Combination of Geology and Physics
3. Biophysics	C. Combination of Biology and Chemistry
4. Geo-physics	D. Combination of Chemistry and Physics

Part IV; Fill in the blanks with appropriate terms.

1._____is the place where experiments in science is performed.

2. A person who study about technology is called _____.

3.Who is the famous Ethiopian scientist involved in development of African commercial hybrid strains of sorghum_____.

Part V: Give short answer to the following questions.

1. Define technology
2. What is the difference between science and technology?
3. Mention the steps to write laboratory report.
4. Why ethics in science is important?

Unit 2 MATTER IN OUR SURROUNDING

Learning Outcome

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

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

Main Contents

Introduction

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

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

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

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

2.1. Characteristics and Nature of Matter

After completing 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;
- apply particle nature of matter in explaining diffusion and every day effect of diffusion;

- describe and/or make a representation of the arrangement, relative spacing, and relative motion of the particles in each of the three states of matter;
- describe and explain compression in terms of distance between particles;
- use the terms melting, evaporating, condensing, and freezing/ solidification to describe changes of state;
- use the particulate nature of matter to explain: melting, freezing/ Solidification, Evaporation, Condensation.

Activity 2.1

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

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

2.1.1. Meaning and Properties of Matter

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

Therefore, various forms of energy such as heat, light, and sound are not considered to be matter.

Exercise 2.1

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

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

2.1.2 Particulate Nature of Matter.

Activity 2.2

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

1. Inflate a balloon and observe its shape in the class room
2. Make observations while wind blowing leaves, or dust in your surroundings. Based on the above activity, work on the given question below
   - **a**. What do you think that matter is made of?
   - **b**. How do the particles move around in space

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

Activity 2.3

Perform the following activities

Fill in the blank by using the following words

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

1. Everything is made of _____.
2. Particles are always_____.
3. An increase in _____makes particles move _____.

4. An increase in_____ is the same thing as an _____ in energy.
5. The particles in hot water have _____energy than _____water.
6. The particles in ice move _____ than particles in _____.

2.1.3 Particle Theory of Matter (Particle Model of Matter)

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

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

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

Exercise 2.2

I. Give short answers

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

2.1.4. Diffusion

Experiment: 2.1

Title: simple experiment on diffusion
Objective: To discover what is meant by diffusion
Materials and Chemicals: Perfume, ink, beaker, pipette, Water (H_2O)
Procedure

1. Take a bottle of perfume and open it in one corner of the room and record how long it takes to reach to different students at different distances to smell it.
2. Add 2 or 3 drop ink into a beaker of water using a pipette and watch the ink diffuse to color the water.
3. Record your observation for the above to experment

Observation and analysis
Write your result/conclusion for the above experiments

The mixing and spreading out of a substance with another substance due to the movement or motion of its particles is called **diffusion.** It is also defined as the net movement of particles from an area of high concentration to an area of low concentration.

Diffusion in gases is very fast. This is because the particles move very quickly in all direction. Example: The smell of hot sizzling food reaches us even when we are at considerable distance.

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

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

Diffusion in Daily Life

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

Tea: A tea bag placed in a cup of hot water will diffuse into the water.
Perfume: When perfume is produced in one part of a room, it spreads to the rest through diffusion. There are fewer of the scent-producing chemicals in the further parts of the room, so the molecules naturally spread out.
Food Coloring: A drop of food coloring in a glass of water colors the water through diffusion. The dye molecules slowly spread evenly through the liquid, creating one particular shade.
Soda: Leave a soda bottle open and the carbon dioxide bubble will diffuse and leave it flat. Air has a lower concentration of that bubbly carbon dioxide than the drink does, so the CO_2 molecules depart the beverage and spread into the air.

Exercise 2.3

1. Complete the blank space from the word box

Diffusion	low	scent	high

You can smell deodorant like axe in the classroom after someone sprays it in the hallway because the _____moves from_____ concentration in the hallway to___ concentration in the classroom. This is an example of_____

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

2.1.5 Properties of Solids, Liquids and Gases

Activity 2.4

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

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

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

Solids

In solids, the particles are arranged in fixed pattern. The particles held together strongly and are tightly packed. Particles in solid can vibrate, but, they stay in the same place. Solids have definite shape and definite volume. Examples of Solids are Stones, wood, metals etc.

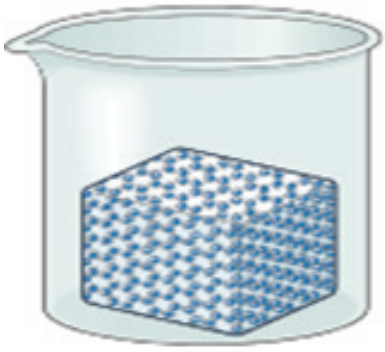


Figure 2.1: pattern of Solids

Liquids

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

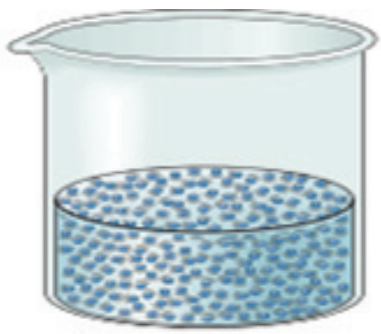


Figure 2.2: pattern of liquids

Gases

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

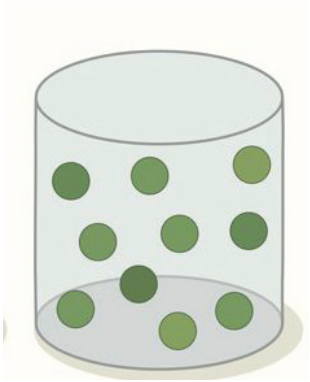
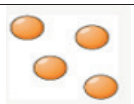
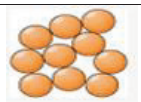
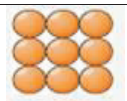


Figure 2.3: pattern of gas

Table 2.1 Properties of solids, liquids and gases

Properties	Physical states		
	Gases	Liquids	Solids
Arrangement of particles	-disorderly arranged -particles are very far apart -almost no attractive force between particles	•Less orderly arranged particles are relatively close to each other -Have relative attractive force between particles	•Orderly arranged(regular pattern) •Particles are very close to each other
Motion of particles	-flow(move) freely -flow together in random motion -are known as fluids	flow together in random motion -are known as fluids	-Do not flow or move -Vibrate in a fixed position
compressibility	Highly and easily compressible	Compressible to a very small extent	Not compressible
Volume and shape	-Have no definite Shape and volume -Assume the shape of the container and entirely fill it.	-Have no definite Shape -Assume the shape of the container - have definite volume	-Have definite Shape and volume
Density	Have very low density than liquids and solids	-Have low density than solids -Condensed state compared to gases	-Denser than all -Condensed state than all
Pressure	Exert pressure equally in all direction	Exert pressure towards depth.	Exert pressure towards gravity
Diffusion	Diffuse spontaneously in all directions with random motion	Diffuse very slowly in random motion	Difficult to diffuse
Diagram			

Exercise 2.4

I. Give short answers

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

II. Choose the correct answer for the following questions.

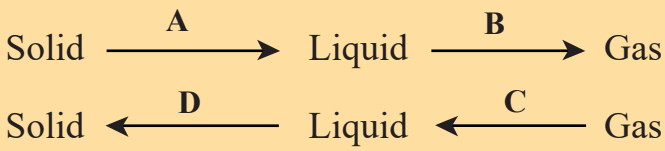
1. Which state of matter is fluid?
   A. solid B. Liquid C. Gas D. B and C
2. In which state of matter are particles close together?
   A. solid B. Liquid C. Gas D.all

2.1.6. Changes in State

Activity 2.5

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

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



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

How do solids and liquids change state?

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

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

How do liquids and gases change state?

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

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

How do solids and gases change state?

Some solids and gases can change state without ever becoming a liquid. The change from a solid state directly into a gas is called **sublimation.**

Some common substance undergo sublimation are: Iodine, ammonium chloride and solid carbon dioxide (dry ice).

Deposition is the change in state from a gas directly to a solid.

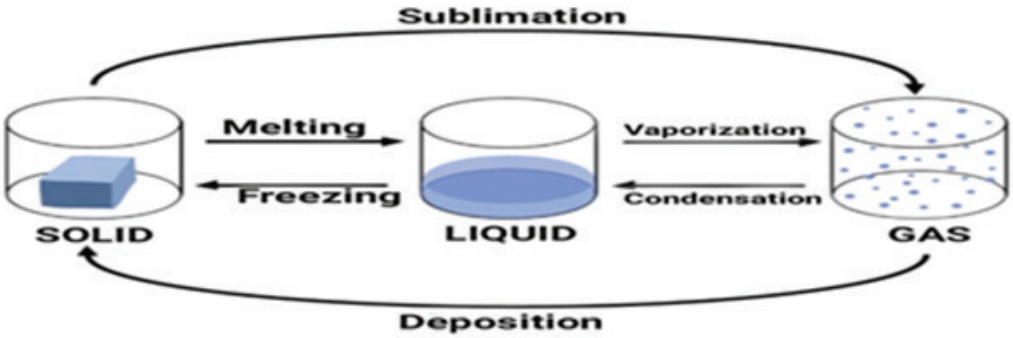


Figure 2.4: Interconversion process of the three state

2.2. Physical and Chemical Properties of Matter

After completing this section, you will be able to

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

2.1.4 Physical properties of matter

Activity 2.6

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

1 Which of these physical properties have constant values under specific condition, such as temperature?
2 Which physical properties can be recognized directly by our sense organs?

3 Which of these properties are measured using instruments?
4 What will happen to ice kept in a cup in the classroom?
5. Which sense organs help us to detect color, odor and taste?
6. How do you describe the taste of lemon?

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

There are two kinds of physical properties, namely, extensive and intensive physical properties.

Extensive physical properties are the properties, which depend on the amount or quantity of sample and they vary from sample to sample. Examples: length, diameter, mass, and volume

Intensive physical properties are properties which do not depend on the amount of a substance present. Examples: density, color, melting point, and hardness.

Intensive properties are useful in distinguishing between different substances because they do not vary from sample to sample.

Some Physical Properties of Substances are Listed Below

1. Physical Properties Detected by Sense Organs

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

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

Caution!

Care has to be taken in smelling substance as they may be harmful

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

Caution!

Tasting can be used to identify substances only if the substance to be tasted is not harmful.

Activity 2.7

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

Discuss your finding in group and present to the class.

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

3. Measurable Physical Properties

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

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

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

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

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

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

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

2.1.5 Chemical Properties of Matter

A chemical property is a characteristic of a substance that describes the way the substance undergoes or resists change to form a new substance. Chemical properties cannot be determined just by viewing or touching the substance; therefore, the substance's internal structure must be affected for its chemical properties to be investigated.

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

Table 2.2: Comparison between Physical and chemical properties.

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

Exercise 2.5

1. Classify each of the following properties as a physical property or a chemical property.
   a. Iron metal rusts in an atmosphere of moist air.
   b. Mercury metal is a liquid at room temperature.
   c. Nickel metal dissolves in acid to produce a light green solution.
   d. Potassium metal has a melting point of 63°C.
   e. Copper metal possesses a reddish brown color.
   f. Titanium metal can be drawn into thin wires.
   g. Beryllium metal, when inhaled in a finely divided form, can produce serious lung disease.
   h. Silver metal shows no sign of reaction when placed in hydrochloric acid.
   i. Lead is denser than aluminum.
   j. Flammability of plastics.
2. Classify each of the following properties as an intensive property or extensive property.
   a. boiling point b. length c. mass d. Color e. density
   f. volume g. melting point

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

a. Density b. odor c. taste d. melting point
e. color f. conductivity

2.3 Classification of Substances

After completing 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 non-metals and compile a list of general properties;
- investigate the properties of non-metals and compile a list of general properties;
- describe and classify mixtures as homogeneous and heterogeneous.
- use models/ particles diagrams to show differences between homogenous and heterogeneous;
- describe the relationship among elements, compounds, mixtures, homogenous mixture and heterogeneous mixtures.

Activity 2.8

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

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

Classify each of them under pure substance or mixture.
Among pure substances, state whether it is an element or a compound

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

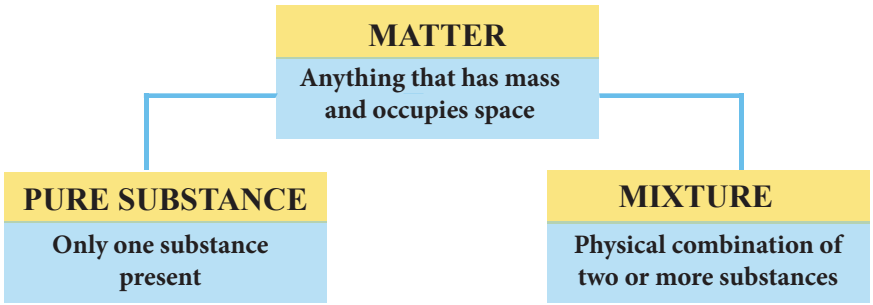


Figure 2.5 Matter falls into two basic classes: pure substances and mixtures.

2.3.1. A Pure Substance

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

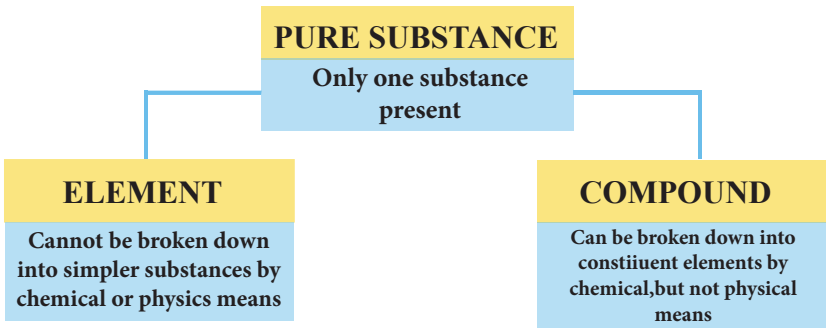


Figure 2.6 a pure substance can be either an element or a compound.

2.3.2 Elements and compounds

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

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

Metals are characterized by the following physical properties

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

Figure 2.7: Image of copper, silver & gold

Non-metals: non-metal is a chemical element that does not have metallic properties and they are few in number as compared to metals. Carbon, oxygen, sulfur, fluorine and phosphorous are some common examples of nonmetals.

Activity 2.9

Perform the following activity in groups.

Which non-metal is essential for our life?

Non metals are characterized by the following physical properties:

- they exist in two of the three states of matter at room temperature except bromine which exists as a liquid state.
- they are not shiny (dull appearance), and are non-conductors of heat and electricity
- they have relatively, low melting points and boiling points.

Figure 2.8: Images of carbon and sulfur

Table 2.3 Comparison between metals and non-metals.

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

Compounds

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

What distinguishes an element from a compound?

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

Experiment 2.2

Title: Distinguishing compounds and mixtures.

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

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

Procedure

Part I

1. Prepare a mixture containing iron powder and sulfur powder in the ratio 7:4 by mass. Do this by weighing out 7 g of iron powder and 4 g of finely powdered sulfur onto separate pieces of filter paper (or use weighing boats).
2. Mix the two powders by pouring repeatedly from one piece of paper to the other until a homogeneous mixture (by appearance) is obtained.

Note the appearance of the pure elements and the mixture.

3. Demonstrate that iron can be separated from the mixture by physical means. Do this by bringing one end of a magnet close to the mixture as shown in figure 2.9

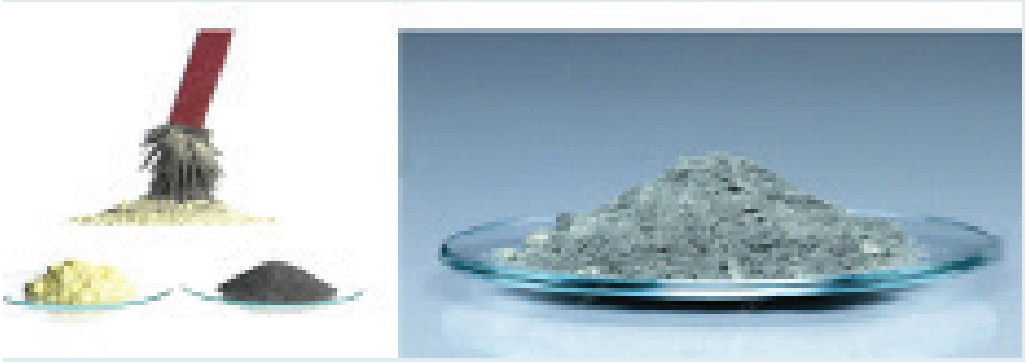


Figure 2.9 Separating iron from a mixture of iron and sulfur

Questions: i .What did you observe as you bring the magnet close to the mixture?

ii. What did you observe under the magnifying glass?

Part II 1. Place about 2 g of the mixture into a soda glass tube

2. Insert a plug of mineral wool (mineral fiber) into the mouth of the test tube. Clamp the test tube as shown in the diagram

3.Heat the powder mixture at the base of the test tube gently at first and then more strongly (use a blue flame throughout). Heat until an orange glow is seen inside the test tube. Immediately stop heating. Let the students see that the glow continues and moves steadily through the mixture.

4. Allow the test tube to cool down.

5. Once cool, it is possible to break open the test tube to show the appearance of the product, iron (II) sulfide. The test tube can be broken open using a pestle and mortar. It is advisable to wear protective gloves.
6. Take the product formed and powder it. Examine the product under a magnifying glass. Bring a magnet over it.

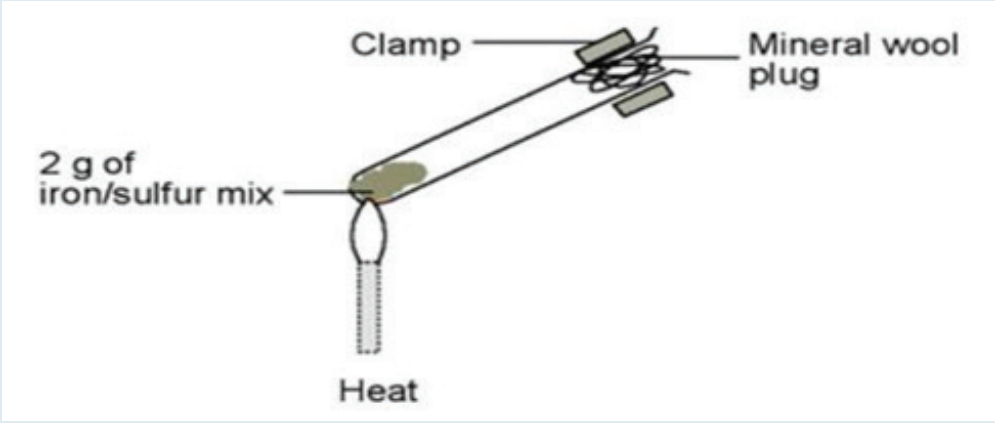


figure 2.10 The reaction between iron and sulfur

2.3.3. Mixtures

Activities 2.10

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

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

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

Activity 2.11

Perform the following tasks in groups and present your findings to the rest of the class.
The following substances are given: air, milk, soil, salt solution, brass, chalk, water, cooking oil, gold, silver, sugar solution, Pepsi. Identify which of them are homogeneous mixtures.

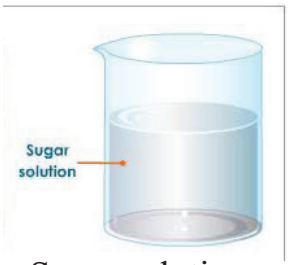
Homogenous mixtures are a combination of two or more substances that has the same composition throughout and has no visible boundary. A homogeneous mixture also called solution. For example, a mixture of table salt and water (salt solution) is a homogeneous mixture because all the parts of the solution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

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

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

Vinegar

Steel



Sugar solution

Figure 2.11 Some common examples of homogeneous mixture

Heterogeneous Mixtures

Activity 2.12

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

Consider the following substances: ethanol alcohol, bronze, sugar solution, iron, water, milk, oxygen, copper, gold, sugar, table salt, cooking oil, sulfur, air, silver, charcoal, ink, chlorine and soil.

Then identify among the list of substances which are heterogeneous mixture

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

Soup

Soil

Blood

Figure 2.12 Some common examples of heterogeneous mixtures

Table 2.5: Differences between homogenous and heterogeneous mixtures.

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

Exercise 2.6

I Answer the following questions correctly

1. Classify each of the following as a mixture or a pure substance.
   a.Water b. uranium c. blood d .alcohol e. the oceans
   f. iron g. table salt h. brass i. hydrogen j. gold
   k. sugar. l. milk m. honey n. benzene

Of the pure substances, which are elements and which are compounds?

2. Define and give four examples illustrating each of the following terms.
   a. element b. compound c. homogeneous mixture
   d. heterogeneous mixture

II. Choose the best answers for the following questions

1. Which of the following is metallic liquid element at room temperature?
   A. bromine B. mercury C. sodium D. iron
2. Substance 'Y' is hard, lustrous solid which readily conduct heat and electricity. 'Y' is likely to be:
   A. Salt. B. Metalloid C. Metal D. Non-metal
3. Which of the following substance make a homogeneous mixture with water?
   A. benzene B. oil C. sugar D. sulfur
4. Which of the following substances is not a mixture?
   A. air B. Sea water C. Pure water D. Brass

2.4. Change around Us: Physical and Chemical Changes

After completing this section, you will be able to

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

Activity 2.13

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

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

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

2.4.1. Physical Change

A physical change is a process in which a substance changes its physical appearance but not its chemical composition. A new substance is never formed as a result of a physical change.

Figure 2.13 melting of ice

Melting of ice, Grinding salt, tearing paper into small pieces, Making an iron bar magnetic, evaporation of water, dissolving sugar in water and breaking a stick are common examples of physical changes.

2.4.2. Chemical Change

A chemical change is a process in which a substance undergoes a change in chemical composition. Some examples of chemical changes are: Iron nail going rusty, heating magnesium ribbon, burning candle. photosynthesis,fermentation,etc

Figure 2.14 burning of candle

Experiment 2.3

Title: Rusting of iron.

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

Materials and Chemicals: test tube rack, iron nail, test

Procedure:

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

Figure: 2.15 rusting of iron

Observation and analysis

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

2.4.3 Characterstics of physical and chemical changes

Activity 2.14

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

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

Characteristics of Physical Change

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

Characteristics of Chemical change

- New substances with new properties are formed
- The composition of substance altered
- It is accompanied by Energy changes
- The change is not easily reversed
- It is a change in chemical property

2.4.4 Useful and Harmful physical and Chemical Changes

Activity 2.15

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

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

a. Important physical changes
b. Important chemical changes
c. Harmful physical changes
d. Harmful chemical changes

Useful effect of Physical changes

Physical changes are useful in the following ways:

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

Harmful effect of Physical changes

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

Useful effect of chemical changes

Chemical Changes are useful in the following ways:

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

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

Food and medicine production, food digestion, fermentation, food cooking, etc. are also some important chemical change in our life to produce new substance.

Harmful effect of Chemical changes

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

Exercise2.7

I Answer the following questions correctly

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

a. the cutting of wood
b. interaction of food with saliva and digestive enzymes
c. The vigorous reaction of potassium metal with water to produce hydrogen gas and potassium hydroxide.
d. Straightening a bent piece of iron with a hammer.
e. The ignition and burning of a match.
f. photosynthesis
g. boiling of an egg.
h. boiling of water
i. dissolution of salt

II. Choose the best answers for the following questions

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

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

2. Which of the following statements is correct?

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

3. Among the following which one is a physical change?

A. Burning of candle B. Fermentation
C. making an iron bar magnetic D. all

2.5. Separation of Mixtures and its Application

After completing this section, you will be able to

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

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

Activity 2.16

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

1. Write the common separation methods you know for the following common mixtures from your daily life experiences
   A. A mixture of Teff and peas
   B. A mixture of iron filings and sulfur powder
   C. A mixture of chalk particles in water
   D. A mixture of cooking oil and water
   E. Salt solution
   F. A mixture of alcohol and water
   G. A mixture of salt and sand
   H. A mixture of orange, banana and mango

2.5.1. Separation Techniques of Mixture

Most of the substances around us exist in the form of mixtures. However, these mixtures can be separated into pure substances using various separation techniques. The process of separating the constituent substances of a mixture by physical methods, taking advantage of the differences in their physical properties is called **separation process.** Some of the methods used to separate mixtures are Separation by hand, sieving filtration, evaporation, magnetic separation, decantation and distillation.

Note that the methods for the separation of mixtures into their components depend on the differences in the size, magnetic property, melting point, boiling point, solubility, etc. of the components. We will discuss some of the methods that are used to separate the components of mixtures.

I. Magnetic Separation

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

a b

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

Experiment 2.4

Title: Separation of mixture using bar magnet

Objective: To separate a mixture of iron fillings and sand

Apparatus and chemicals

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

Experimental Procedure

1. Mix the sand with the iron filings in the plastic plate.
2. Wrap the plastic bag around the bar magnet

3. Suspend the bar magnet over the plate
4. The iron would be collected / attracted to the surface of themagnetic bar
5. Carefully remove the plastic bag around the magnetic bar and scrape off the iron filings

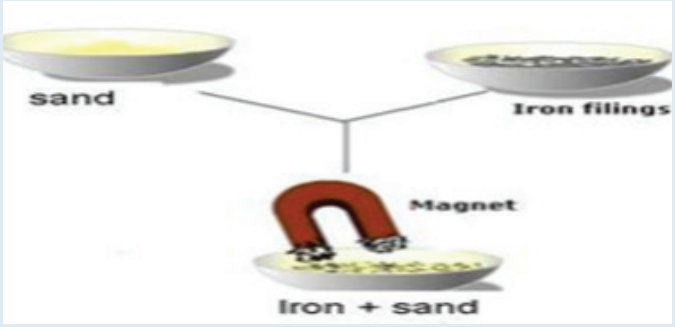


Figure 2.17 mixture of sand and iron fillings

Observation and analysis

1. Why was the sand not attracted by the magnet? What can you conclude from this experiment?

II.Decantation

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

Figure 2.18: Separation by decantation

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

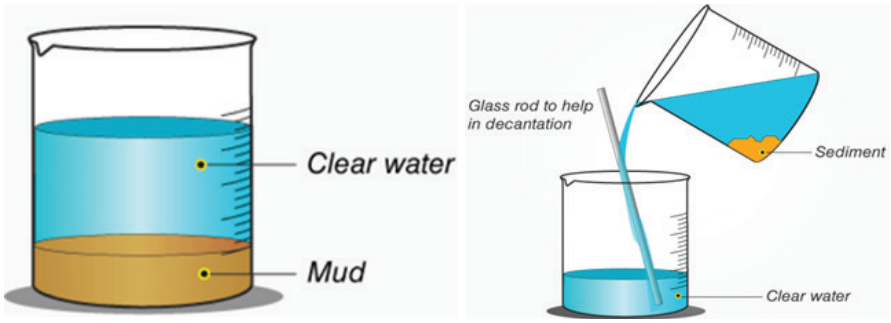


Figure 2.19: Decanation of solid from a solid-liquid mixture

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

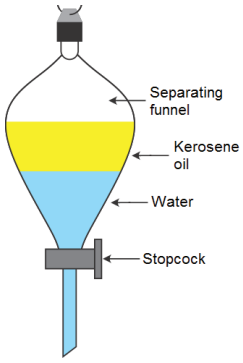


Figure 2.20: Separation of immiscible liquids using separating funnel

another beaker. Examples: Kerosene and water mixture is separated by using separating funnel method. This method is also used to separate oil and water.

III. Filtration:

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

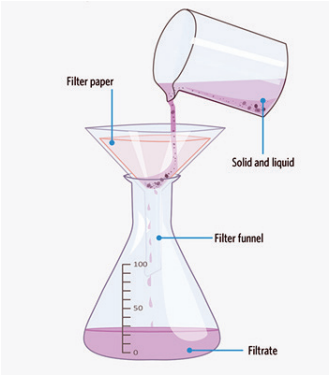


Figure 2.21: Filtration

Iv. Evaporation

Activity 2.17

Perform the following activity. Dissolve sodium chloride (or any other soluble salt) and water to form a homogeneous mixture (solution). How can you recover the salt again?

Figure 2.22: Evaporation of a solution

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

.

V. Distillation:

This method is used for the separation of a mixture containing two miscible liquids that boil without decomposing and have a large difference between their boiling points. It is also used in obtaining pure water from salt solution. Process of conversion of a liquid into vapor by boiling, and then re-condensing the vapor into liquid is called distillation. In simple distillation, a mixture is heated and the most volatile component vaporizes at the lowest temperature. The vapor passes through a cooled tube (a condenser), where it condenses back into its liquid state. The condensate that is collected is called distillate. Figure 2.23 show the simple distillation set up

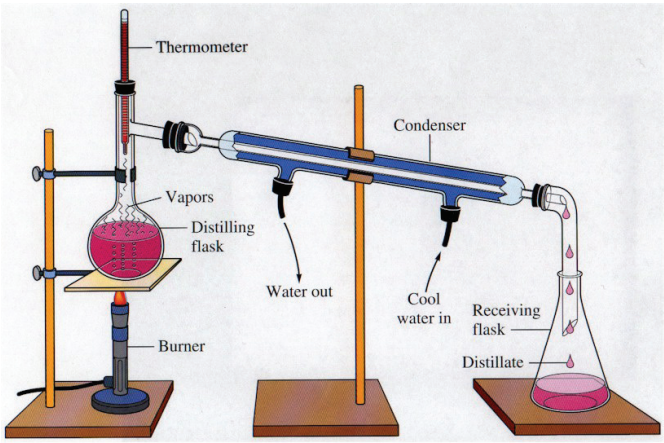


Figure 2.23: simple distillation set up

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

Activity 2.18

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

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

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

Activity 2.19

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

2.5.2. Application of Separation Techniques.

Table 2.5 application of various separation techniques

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

Project Work

Separation of mixtures using local materials

There is a mixture of table salt, sulfur powder and iron filing inside a beaker.

By using any local materials that are found around you, you should try to separate this mixture into their components.

Hint: Both sulfur powder and iron filing are insoluble in water whereas sodium chloride (table salt) is soluble in water.

Write a group report: In your report indicate the separation techniques and the materials used during the separation processes.

Exercise 2.8

I. Give short answers for the following questions.

1. How would you separate the following?
   a. salt solution
   b. Common salt and sand
   c. iron and charcoal
   d. Oil, water and sand
   e. nitrogen and oxygen
2. Name the separation technique shown in the following diagram

A

B

C

D

E

F

Key Terms

Matter	Magnetic Separation	Physical Changes
Particle Theory	Decantation	Compounds
Diffusion	Pure Substance	Elements
Physical Property	Mixture	Distillation
Chemical Property	Non Metal	Evaporation
Homogeneous Mixture	Heterogeneous Mixture	Filtration
Sublimation	Density	Freezing
Boiling Point	Freezing Point	

Unit Summary

- Matter is anything that has mass and occupies space. It can exist in three states: solid, liquid, and gas.
- The idea that matter is made up of tiny particles is called the Particulate nature of matter.
- Particle theory of matter tell us the particles of matter are always moving.
- Diffusion is the mixing and spreading out of a substance with another substance due to the movement or motion of its particles.
- The three states of matter (solids, liquids and gases) can be interconverted without changing the composition of the substance. to change a substance from one state to another, energy must be added or removed. Melting, freezing, evaporation, and condensation are all changes of state.
- A physical property can be measured and observed without changing the composition or identity of a substance.
- A chemical property is a characteristic of a substance that describes the way the substance undergoes or resists change to form a new substance.
- Matter can be classified in terms of its chemical composition into two broad categories: pure substances and mixtures pure substances.

- A pure substance is a single kind of matter that cannot be separated into other kinds of matter by any physical means.
- Pure substances are classified as elements and compounds.
- An element is a pure substance that cannot be broken down into simpler substances by ordinary chemical means.
- A compound is a pure substance composed of two or more elements that are combined chemically in a definite proportion by mass.
- A mixture is a physical combination of two or more pure substances in which each substance retains its own properties.
- A homogeneous mixture (also known as solution) has a uniform composition and properties throughout.
- Heterogeneous mixture is a mixture that does not have a uniform composition throughout.
- Changes are classified as either physical or chemical changes.
- A physical change is a process in which a substance changes its physical appearance but not its chemical composition.
- A chemical change is a process in which a substance undergoes a change in chemical composition.
- Mixtures can be separated using a variety of techniques. The process of separating the constituent substances of a mixture by physical methods, taking advantage of the differences in their physical properties is called separation process.
- Some of the methods used to separate mixtures are Separation by hand, Sieving Filtration, evaporation, magnetic separation, decantation and distillation

Review Exercise

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

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

Part II: Choose the corect answers for the following questions

1. All of the followings are matter except
   A. plant B. stone C. air D. sound
2. Which of the following decrease during the phase (state) changes of
   Solids ⟶ liquids ⟶ gases
   A. Degree of order among particles
   B. Energies of particles
   C. Speed of particles
   D. Distance among particles
3. Which of the following is not the property of solids
   A. Solids have little tendency to diffuse
   B. Solids are extremely difficult to compress
   C. Solids are fluids
   D. Solids have definite volume and definite shapes
4. The particular physical state of substance depends on _
   A. temperature B. pressure
   C. strength of intermolecular force D. all
5. Which of the following has no definite shape and volume?
   A. Water B. carbon dioxide C. iron D. gold

6. The interaction of substance with light results
   A. taste B. odor C. color D. texture
7. Which of the following is not a physical change?
   A. sublimation of iodine C. tearing a piece of cloth
   B. burning of wax in a candle D. dissolving sugar in a tea
8. All of the following are heterogeneous mixtures except
   A soil C. salt solution
   B. mixture of water and oil D. blood
9. Which of the following is not a metal
   A. iron B. sulfur C. copper D. sodium
10. Which of the following has variable composition?
   A. Water B. salt C. milk D. silver
11. A mixture of sand and sugar can be separated by
   A. evaporation followed by distillation
   B. filtration followed by evaporation
   C. dissolution followed by filtration and evaporation
   D. dissolution followed by evaporation and filtration.
12. the conversion of a vapor directly to solid without passing through a liquid state is called_____
   A. fusion B. evaporation C. sublimation D. deposition
13. Distillation is used in the process of preparation of
   A. coffee B. areki C.tella D. honey
14. Identify the heterogeneous mixture among the following
   A. sea water B. blood C. bronze D. air
15. Grade 7 students in a certain school were given the task of separating, iron fillings, sand and salt. Which of the following process is the most appropriate order?
   A.Evaporation-dissolution - filtration- magnetic separation
   B. Dissolution –magnetic separation - filtration_ evaporation
   C. Magnetic separation -dissolution - filtration –evaporation
   D. Magnetic separation - dissolution – evaporation- filtration
16. I. Physical changes are easily reversible.
   II. Physical change do not produce new substance
   III. Physical change do not involve change in mass.

Which of the above statement are correct?

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

17. Which two state of matter are fluids?

A. Solid and liquid C. Liquid and gas

B. Solid and gas D. Plasma and solid

18. All of the following are same process. EXCEPT

A. Condensation C. Crystallization

B. Freezing D. Solidification

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

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

Part IV; Fill in the blanks with appropriate terms.

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

Part V: Give short answer to the following questions

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

Unit 3 ELEMENTS,COMPOUND AND CHEMICAL REACTION

Learning Outcome

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

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

Main Contents

Introduction

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

3.1. Elements and Their Representation

After completing this section, you will be able to:

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

Activity 3.1

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

1. From your previous knowledge, what is an element?
2. List some common elements you are familiar with. Try to classify them as

   a. metal b. non -metal

3.1.1. Common Elements

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

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

3.1.2 Chemical Symbols

Activity 3.2

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

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

Scientists use symbols as abbreviation of names of an elements. An atomic symbol is defined as shorthand way of representing elements or atoms of an element. Every element has its own symbol. No two elements can have the same symbol.

How to write symbols of elements?

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

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

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

The names of some elements such as carbon and calcium begin with the same letter “C”. Therefore we cannot use the letter “C” as a symbol for both elements. Hence two letters are used for other elements except one. The first letter “C” is assigned as a symbol for carbon. The other element calcium is represented by two letter symbols Ca The same thing is true for hydrogen and helium. The first letter “H” is assigned as a symbol for hydrogen while “He” symbol stands for element helium.

Table 3.1: Name and symbols of some elements

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

Table 3.2: Symbols of element derived from Latin names

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

Exercise 3.1

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

1.Ca is the symbol of sodium.

2.Water is not an element.

3.Elements are pure substances.

Choose the correct answer from the given alternatives.

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

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

5."C" stands for_____

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

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

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

3.2. Compounds and their Representation

After completing this section, you will be able to

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

- Name compounds containing polyatomic ions.
- Identify the elements and number of atoms, and give a chemical formula.

3.2.1. Compounds

Activity 3.3

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

1. From your previous knowledge, what is a compound?
2. Copy the table on your exercise book and classify the substance as an element or, a compound.

Substance	Element	Compound
Sodium chloride (table salt)		
Water		
Gold		

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

3.2.2. Chemical Formulas

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

Formulas of Elements

The formula of an element consists of one kind of symbol.
A **molecule** is the smallest particle of an element or a compound that has a stable,independent existence.

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

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

Table 3.3 symbols and formulas of diatomic elements.

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

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

Formulas of Compounds

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

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

Exercise 3.2

I.Choose the correct answer from the given alternatives.

1. Elements exists as a diatomic and polyatomic molecular form except_____.

A. phosphorus B Nitrogen C Oxygen D Neon

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

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

3.2.3. Valence Number

Activity 3.4

Discuss in groups and share your ideas to the class

What is a valence number?

Elements combine in accordance with the laws of nature at atomic levels. Each element in a formula of a compound has a combining power. The combining power of an element is called **valence.** If we know the combining power (valence number) of the elements, it is easy to write the formula of a compound. Most common elements have valence 1, 2, or 3. Some elements have more than one valence number, which is different combining powers under different conditions. Common examples of these elements that have variable valence are iron, copper, lead and tin.Ions are atoms that have positive or negative charge. The number of negative or positive charge an ions carries is equal to the valence number of the ion.Thus, the valences of Cl^-, O^{2-} and Al^{3+} are 1, 2 and 3 respectively. The following table shows the combining power of some common elements.

Table 3.4: valences of some common elements.

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

3.2.4. Formulas of Binary Compounds

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

i. Write the symbol of the elements.

ii. Write the valence number above the symbol.

iii. Criss-cross the valence numbers to conserve charge or to become the compound electrically neutral and write below the symbols. If the valence number is one, omit the subscript.

Examples

a. Write the chemical formula for Potassium iodide

Solution Step 1: K I

Step 2:
$$\overset{1}{K}\quad\overset{1}{I}$$

Step 3:
$$\overset{1}{K}\quad\overset{1}{I} \;=\; K_1I_1$$

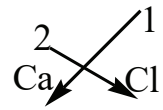
Since the subscript is 1 we omit and the chemical formula for Potassium iodide is KI.

b. Write the chemical formula for calcium chloride

Solution

Step 1 Ca Cl

Step 2: $Ca^{2}\ Cl^{1}$

Step 3  = $CaCl_2$

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

Exercise 3.3

I. Give short answers

1. Write the chemical formula for
   - A .Copper (II) oxide
   - B. Magnesium nitride
   - C. sodium chloride
   - D. Aluminum Oxide
   - E. Iron (III) Oxide
   - F. Iron (II) bromide
   - G. Silver Oxide
   - H. Calcium fluoride
2. Write the chemical name for
   A. MgO B. FeS C. AgCl

II. Choose the correct answer from the given alternatives.

3. Which of the following is the chemical formula of aluminum nitride?
   A. Al_5N_3 B. Al_3N_2 C. AlN_3 D. AlN
4. How many valence numbers does an Aluminium have?
   A. 1 B. 2 C. 3 D.5

3.2.5. Naming Binary Compounds

Activity:3.5

Perform the following activities.

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

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

Rules for naming simple binary compounds.

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

Table 3.5 Names of nonmetallic elements in binary compounds

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

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

3.2.6. Polyatomic Ions

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

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

Table 3.6 some common valence of polyatomic ions

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

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

Examples

1. Write the formula for ammonium chloride

Step 1 NH_4^+ Cl^-

Step 2 NH_4^+ Cl^-

Step 3 NH_4^+ Cl^-

So the molecular formula for ammonium chloride is $=NH_4Cl$

2. write the formula ammonium sulfate

Step 1 NH_4^+ SO_4^{2-}

Step 2 NH_4^+ SO_4^{2-}

Step 3 NH_4^+ SO_4^{2-}

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

In naming compounds containing polyatomic ions, the name of metals and ammonium ion are written first followed by the name of the polyatomic ions.

Examples: NH_4Cl (ammonium chloride), $Al_2(SO_4)_3$ (aluminum sulfate) and $FeCl_3$ Iron (III)chloride,

Exercise 3.4

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

Ions	Nitrate	Sulfate	Carbonate	Phosphate
Na^+	_____	_____	_____	_____
Ca^{2+}	_____	_____	_____	_____
Al^{3+}	_____	_____	_____	_____
NH_4^+	_____	_____	_____	_____
Fe^{3+}	_____	_____	_____	_____

2. Name the following compounds.

A. NH_4Cl C. $NaHCO_3$

B. $Cu(NO_3)_2$ D. $FePO_4$

3. Which three elements are combine in magnesium carbonate?

4. Which four elements are combine in ammonium sulfate?

3.2.7 Interpreting Formula

Activity 3.6 Perform the following activities.
1. What information is obtained from the coefficient and subscript in a formula?

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

Qualitatively : A symbol represents the identity (kind) of the element. A formula represents the kinds or types of element involved in forming a compound. For example:

- Cl_2 qualitatively the subscript 2 shows a chlorine molecule.
- The symbol O represents an atom of oxygen. No other element can be represented by the symbol O.
- Fe stands for iron metal
- CaO is qualitatively stands for calcium oxide made from one atom of calcium and one atom of oxygen.
- $Ca(NO_3)_2$ qualitatively stands for calcium nitrate made from one atom of calcium and two nitrate groups.

Quantitatively: a symbol represents the number of atoms of the elements. A formula stands for one molecule or for formula unit of an element or a compound. In Cl_2 quantitatively 2 shows there are two atoms in chlorine molecule

- Number preceding symbols, called coefficient, indicates the number of atoms of the element in a formula.
  2Fe stands for two atoms of iron (The number 2gives a quantitative meaning while Fe itself gives a qualitative meaning.
- A subscript written after a symbol (to the right) indicates that the element is in molecular form. For example, Cl_2 a chlorine molecule and O_2 is oxygen molecule
- The coefficient of a molecule or formula unit indicates the number of molecules or formula unit of that substance.

- $3H_2O$;the coefficient three shows that there are 3 molecules of water $2CO_2$ the coefficient 2 shows that there are 2 molecules of carbon dioxide 4NaCl the coefficient 4 shows that there are 4 formula unit of sodium chloride.

CaO quantitatively it shows one formula unit of CaO
$Ca(NO_3)_2$ quantitatively it shows one formula unit of $Ca(NO_3)_2$

Exercise 3.5

1. What does $3H_2O$ represents?

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

2 write the qualitative meaning for

A. 2Fe B. CO_2 C. O_2

3. Write the quantitative meaning for the following.

A. $3H_2$ B. $4H_2O$ C. 2NaCl

Project Work

Write and interpret formulae of common compounds

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

3.3. Simple chemical Reactions and Equations

After completing this section, you 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 a group to show simple chemical reaction;
- write a chemical equation;
- balance simple chemical equation by inspection;
- create and use models of particles to demonstrate balanced equations.

3.3.1. Simple chemical Reaction

Activity 3.7

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

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

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

A chemical reaction involves the transformation of reactants into products.

Reactants ⟶ Products

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

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

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

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

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

3.3.2 Evidences that Show Chemical Reaction has Occurred

Activity 3.8
Form a group and perform the following activity.Then present your finding to the rest of the class.
Record and describe the various chemical changes that occur in your daily lives (e.g cooking food, etc.) and describe the evidence you use to determine that chemical reaction occurred.

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

1. Color changes

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

Copper oxide + sulfuric acid ⟶ copper sulfate + water
(Black) (Blue)

Figure 3.1: blue copper sulfate solution

2. Evolution of a gas (formation of bubbles)

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

Magnesium + hydrochloric acid ⟶ magnesium chloride + hydrogen

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

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

Potassium + water ⟶ potassium hydroxide + hydrogen

4. Precipitate (formation of a solid)

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

Silver nitrate + sodium chloride ⟶ silver chloride + sodium nitrat

Figure 3.2 white precipitate of AgCl

3.3.3. Law of Conservation of Mass

Activity 3.9

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

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

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

3.3.4. Investigating Chemical Reaction

Expriment 3.1

Title: burning of Magnesium ribbon

Objective: to investigate the chemical reaction

Apparatus: Burner, crucible, a pair of tongs

Chemicals: Magnesium ribbon

Procedure

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

Hazards!!!

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

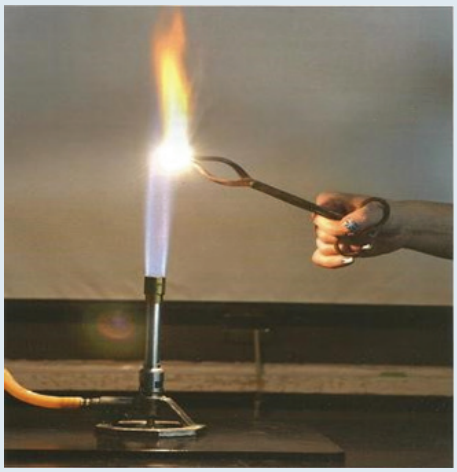


Figure 3.3: burning of magnesium

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

Observation and analysis

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

3.3.5. Writing and Balancing Simple Chemical Equation

Activity 3.10 Perform the following activity
1. What is chemical equation?

A chemical equation is a short hand expression of a chemical chanes (chemical reaction) through symbols and formulas.
In general, to write a chemical equation for a given reaction one can follow the following three steps.
Step 1: Write a word equation for the reaction.
Step 2: Change the word equation to a chemical equation i.e., write the correct symbol or formula for each reactant and product.
Step 3: Balance the equation so that it obeys the law of conservation of mass.
Example: the reaction between hydrogen and oxygen to give water.
Step1: Hydrogen + Oxygen → Water
Step 2: $H_2 + O_2 \rightarrow H_2O$
Step 3: $2H_2 + O_2 \rightarrow 2H_2O$

3.3.6. Balancing Chemical equation

Activity 3.11
Perform the following activity
Why should the chemical equation be balanced?

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

Mass reactants = mass of products

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

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

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

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

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

to give ammonia

$N_2 + H_2 \longrightarrow NH_3$

Balance nitrogen by placing 2 before ammonia

$N_2 + H_2 \longrightarrow 2NH_3$

Now you have 6 hydrogen atoms on the product side. To balance hydrogen write a coefficient 3 before H_2

$N_2 + 3\ H_2 \longrightarrow 2NH_3$

Finally check whether the equation balanced or not