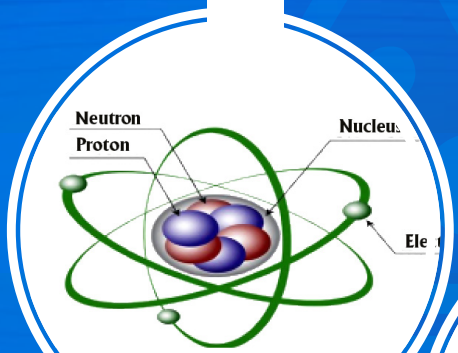
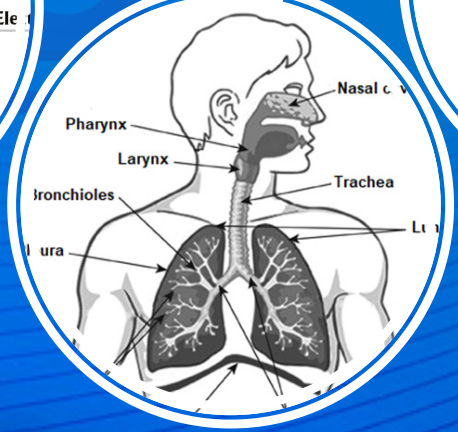
GENERAL SCIENCE

Grade 8







Student Textbook

Federal Democratic Republic of Ethiopia
Ministry of Education

Sidaama National Regional State
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GENERAL SCIENCE

Student Textbook

Grade 8

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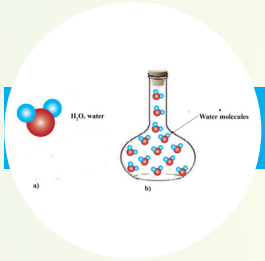
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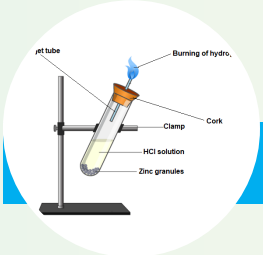
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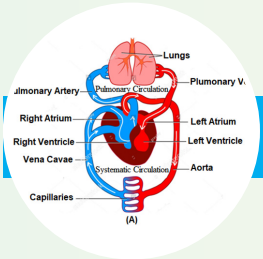


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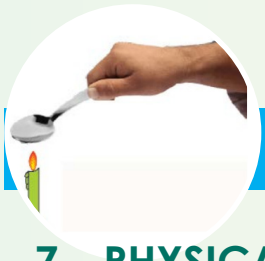
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UNIT ONE

BASICS OF SCIENTIFIC INVESTIGATION

Learning Outcomes

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

- *identify the basic and derived units of measurements;*
- *explain the concept of measuring physical quantities;*
- *describe the components of a scientific investigation; and*
- *demonstrate ability to work effectively and respectfully with others.*

Main Contents

1.1. Scientific Measurements
1.2. Doing Scientific Investigation

Introduction

Internationally, the most promoted skills in learning science are through investigation. Scientific investigation is a universal approach to learning science through practical work. Its aim is to provide students opportunities to use concepts and skills to solve problems. In grade 7 you learned about basic concepts of science, indigenous knowledge and people's perspectives, and about procedures in science laboratories where science investigation are conducted. In this, unit you will study about scientific measurements and scientific investigation.

1.1. SCIENTIFIC MEASUREMENTS

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

- *explain the concept of measuring physical quantities;*
- *describe the various indigenous methods of measurement;*
- *distinguish between the basic and derived physical quantities;*
- *identify prefixes and perform conversions among units of measurements; and*
- *distinguish between accuracy and precision in measurements.*

In this section you will learn about indigenous and modern methods of measurements, prefixes and conversion of physical quantities, accuracy and precision in measurements.

Activity 1.1.

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

1. What is science?
2. What is measurement?
3. How quantity being measured and expressed in terms of value and unit?

Science is a systematized knowledge arising from observation, study and experimentation. The determination of the size or magnitude of something "or" the comparison of unknown quantity with some standard quantity of the same rates is known as measurement. Measurements are made every day in our day to day activities in buying products, sports activities, cooking, and weather forecasting. Scientific measurements are a process of observing and recording objects or events with accuracy, clarity, without ambiguity and reported as a value.

Activity 1.2.

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

1. Measure the time taken to cover 50m distance by one of your friends.
2. Measure the height of your friend, and let your friend measure your height also. What instruments did you use?

1.1.1. Modern and Indigenous methods of measurements

Activity 1.3.

Discuss in group with your class mates and present to the class.

1. What is the difference and similarities between modern and indigenous methods of measurements?
2. What are the common terms that are used interchangeably to refer to the concept of indigenous methods of measurements?

Measurement is an integral part of human race, without it there will be no trade, no statistics. Depending on the type of instruments we can classify methods of measurements as:

1. indigenous methods of measurements, and
2. modern methods of measurements

1. Indigenous methods of measurements

Activity 1.4.

In group, list some of the indigenous methods of measurements (length, mass, volume, time) the people use in your locality and present it to the class .

Indigenous (traditional or local) methods of measurement are the methods of measurements that an indigenous community accumulates over generations of living in a particular environment. Indigenous methods of measurements are unique to a particular culture and society; and our country Ethiopia, has also its own knowledge in this field. Some of the common units of measurements are given below.

I. Mass (m): Some of indigenous methods of mass measuring instruments are:

- ***dawulla:*** A measure of mass approximately equal to 50 kg.
- ***quintal:*** a measure of mass equals to 100 kg.

🔄 ***How many kilograms are 4 dawulla?***

II. Length (l): Some of Indigenous methods of measurements of length are described below with figures.

i. Azq (in Amharic)

A measure of distance about an inch long. People in the countryside use the distance from the tip of their thumb finger to the first fold (angua in Amharic).

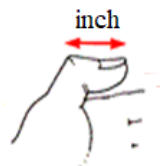


Figure 1.1 Azq

ii. "Sinzer" in Amharic ("Taakko in Sidaamu Afoo)

A measure of distance from the tip of the middle figure to the tip of the thumb while the hand is fully extended.



Figure 1.2 Sinzer

iii. "Kend" in Amharic ("Cigile" in Sidaamu Afoo): It measures a distance from the tip of one's elbow to the tip of middle finger.

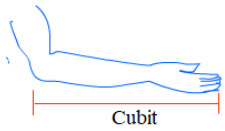


Figure 1.3 Kend

iv. "Aarb" in Amharic ("Hanqafo" in Sidaamu Afoo): A measure of length approximately about a yard.

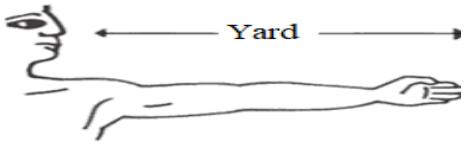


Figure 1.4 Aarb

v. "Chamma" in Amharic (Ha'ruma" in Sidaamu Afoo): A measure of a distance from the back of the heel to the tip of the big toe.

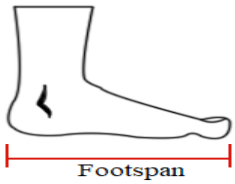


Figure 1.5. Chamma

vi. "Ermijja" in Amharic ("Qaafo" in Sidaamu Afoo): A linear distance measure of about a yard of a person's extended walk.

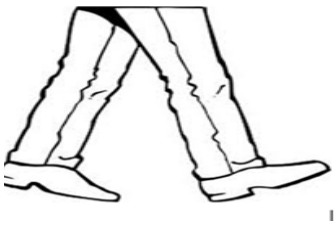


Figure 1.6. Ermijja

III. Time (t): Time describes the duration between the beginning and end of an event. Traditionally people use the sunrise and sunset as a way to measure time.

IV. Volume (v): Some of the indigenous methods of volume measuring instruments are:

i. "tassa", "ensira", "gerewoina" and "gan" (in Amharic): these are containers of liquids which are also used to measure volume.

ii. "enqib" (in Amharic): A measure of volume used to measure grains.

2. Modern methods of measurements

Can you list some of the modern measuring instruments of Length?

Physical quantity can be measured by different measuring instrument; some of the common are measuring length, mass, time and volume.

I. Measuring Length

Activity 1.5.

Perform the following activity in group and present to the class

Using any available measuring instruments in your school or locality, measure the height and width of your table and classroom door.

What types of instruments do you use to measure the distance of a place?

Length is the distance between two objects. Meter stick and different taps can measure up to 0.1mm accurate.

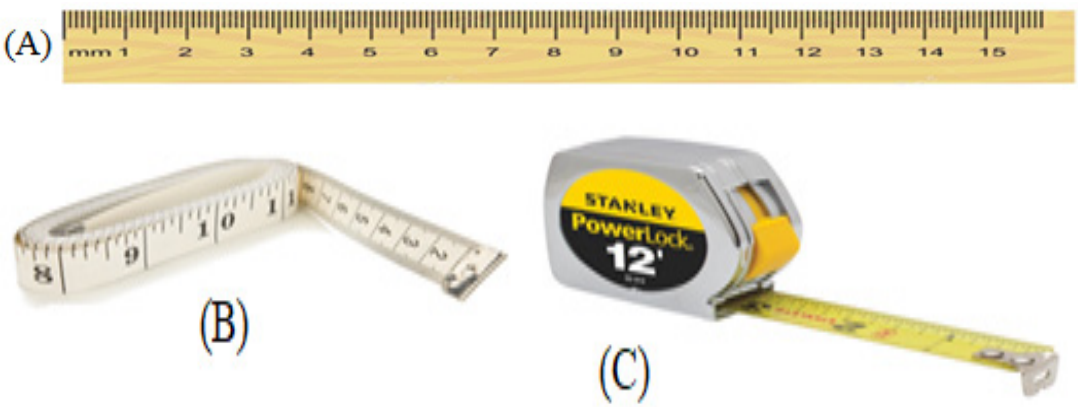


Figure 1.7. Length measuring instruments: (A) meter rule, (B) measuring taps used in sewing, (C) measuring tapes in construction

II. Measuring Mass

What types of instruments do you use to measure the mass of an object?

The followings are some of the instruments used for measuring mass:

- double beam balance, we can measure up to 1gm accurate.
- triple beam balance, we can measure up to 0.1gm accurate.
- electron beam balance, we can measure up to 0.001gm accurate.

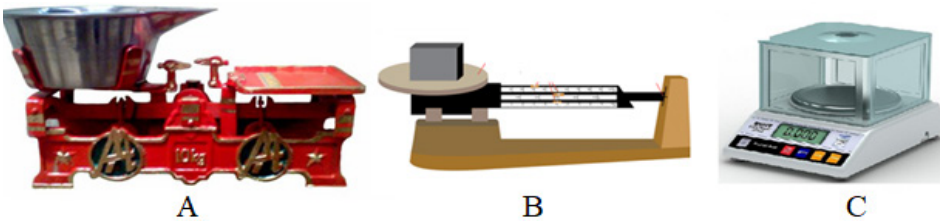


Figure 1.8. Different types of Balances: A) Double beam balance B) Triple beam balance C) Electronic balance

III. Measuring Time

What types of instruments do you use to measure the duration of an event?

The followings are some of measuring instruments of time:



Figure 1.9 Watches: A) digital stop watch B) analog stop watch C) digital watch D) analog watch

IV. Measuring Volume

What types of instruments do you use to measure the volume of a liquid?

Volume is the amount of space occupied by an object. It is expressed in cubic units. Some of the common measuring instruments of volume are measuring cup used in the kitchen, measuring cylinders burette and pipette.

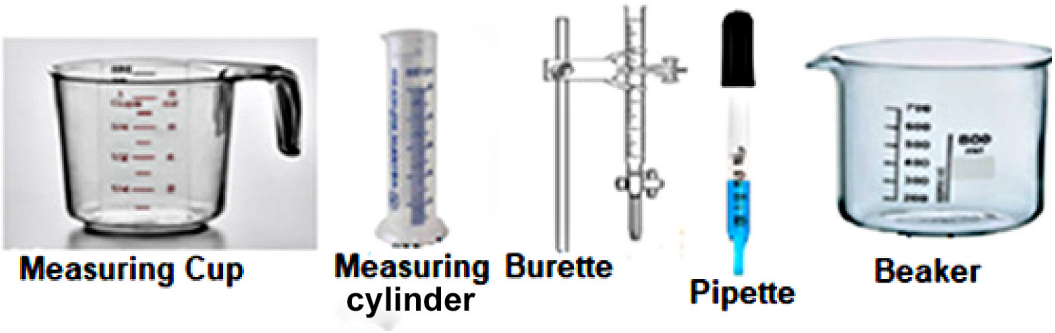


Figure 1.10. Volume measuring instruments

1.1.2. Physical quantities

Activity 1.6.

Discuss the following questions in groups and present to the class

What are physical quantities? How are they classified as basic and derived?

A physical quantity is a property of a material or system that can be quantified by measurement. A physical quantity can be expressed by a numerical value and a unit. Physical quantities are categorized into basic and derived physical quantities.

Basic and Derived physical quantities

In science, we have seven basic physical quantities. All other physical quantities (other than the seven basic quantities) can be expressed in terms of these basic quantities. These are called derived physical quantities. In 1960 an international agreement was reached specifying a particular choice of metric unit in scientific measurement. These preferred units are called SI unit (the International System of Unit).

Table 1 Physical quantities

Fundamental (basic)		Derived	
Quantity	**SI unit (Basic units)**	**Quantity**	**Units**
Length	Meter (m)	Area	m^2
Mass	Kilogram (kg)	Volume	m^3
Time	Second (s)	Density	kg/m^3
Temperature	Kelvin (K)	Force	kgm/s^2 (N)
Electric current	Ampere (A)	Speed	m/s
Amount of substance	Mole (mol)	Acceleration	m/s^2
Luminous intensity	Candela (cd)	Energy	J

The units of derived physical quantities are called derived units. They are combinations of the basic units.

1.1.3. Prefixes and Conversion of basic units

Table 2: Selected prefixes used in the basic system

Standard form	Basic numeral	Prefix	Symbol	Example
1.0×10^6	1,000,000	Mega	M	$1Ms = 1 \times 10^6 s$
1.0×10^3	1,000	Kilo	k	$1kg = 1 \times 10^3 g$
1.0×10^2	100	Hector	h	$1hm = 1 \times 10^2 m$
1.0×10	10	Deca	da	1daL = 10L
1.0×0.1	0.1	Deci	d	1dL = 0.1L
1.0×0.01	0.01	Centi	c	1cm = 0.01m
1.0×0.001	0.001	Milli	m	1ms = 0.001s
1.0×0.000001	0.000,001	Micro	μ	$1\mu s = 1 \times 10^{-6} s$

Relationship between Units of length

- 1 meter (m) = 1000 millimeters (10^3mm)
- 1 meter (m) = 100 centimeters (10^2cm)
- 1 kilometer = 1000 meters (10^3m)
- 1 centimeter (1cm) = 10 millimeter (10mm)

Relationship between units of mass

- 1000 kilogram (1000kg) = 10 quintal = 1 ton
- 100 kilogram = 1 quintal
- 1 kilogram = 1000 grams

Relationship between units of time

- 1 hour = 60 minutes; 1minute = 60 seconds
- 1 day = 24 hours
- 1 month = 30 days; 1 year = 365.25 days (365 and 1/4 days)

Relationship between units of volume

- 1 liter(l) = 1,000 milliliters(1000ml) = $1000cm^3$

Example

How many centimeters are there in 0.5m?

Given	Required	Solution
L=0.5m	L in cm	1m = 100cm 0.5m = x

$$x = \frac{0.5m \times 100cm}{1cm} = 50cm$$

Check Point 1.1

Answer the following questions.

1. What is the name given to the unit that equals
   (a) 10^3gram? (b) 10^{-6}second? (c) 10^{-3}meter?
2. a. What decimal fraction of a second is a millisecond, ms ?
   b. Express the measurement 6.0 x 10^3m using a prefix to replace the power 10.
3. Use power of ten to express 3.76 mg in grams.

1.1.4. Accuracy and Precision in measurements

What is the difference between Accuracy and Precision?

Precision is a measure of how closely individual measurements agree with one another. Accuracy refers to how closely individual measurements agree with the correct, or, "True" value.

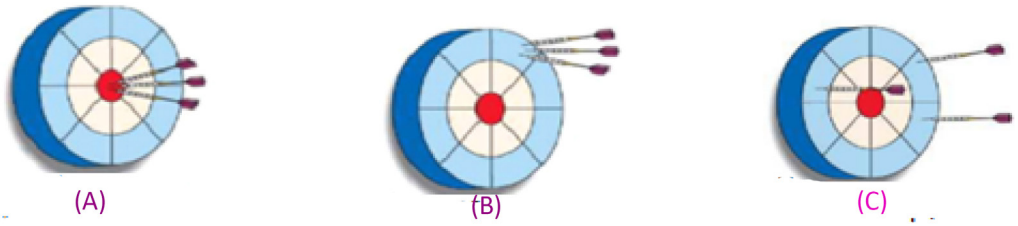


Figure 1.11 The distribution of darts on a target illustrates the difference between accuracy and precision

From the figure 1.11 (A) shows high accuracy and high precision since it is bunched in the centre of the target and figure 1.11 (B) indicates low accuracy and high precision form a tight off-centre cluster. But figure 1.11 (C) illustrates, the measurements of low accuracy and low precision are scattered and off-centre.

Exercises 1.1

Give answers to the following Questions.

1. Write examples of indigenous measurements of length and mass.
2. Give example of modern instruments of measurement of length.
3. Write two modern instruments of measurements of mass.
4. What power of ten do the following prefix symbol represents?

   i. d ii. c iii. μ iv. M v. k vi. M

5. What name of prefixes do you use to write the following measurements without use of exponents?

   a. 4.56×10^{-2} L b. 9.5×10^{-6}s c. 1.0×10^{-3}m

6. Convert the following unit from:

   a. 4.0 cm to m. b. 4.0 m to cm. c. 40 mm to m.

   d. 4.0 cm to mm. e. 10 ms to second. f. 1 μs to s.

7. What is meant by accuracy and precision?

1.2. DOING SCIENTIFIC INVESTIGATION

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

- *state the importance of scientific investigation;*
- *describe the basic procedures of a scientific investigation;*
- *explain the ethical issues that to be respected in scientific investigations;*
- *conduct, with guidance, simple investigations using inquiry approach;*
- *demonstrate the ability to work effectively and respectfully with others;and*
- *conduct simple investigations using local materials and procedure.*

1.2.1. Introduction to Scientific Investigation

Activity 1.7.

Form a group and perform the following activity; and present to the class.

How can the scientific investigation be used to answer questions about daily life? Think of a question in your life that you could answer using the scientific method. Then describe each step of the scientific method as you move toward answering your question.

Investigations are at the heart of science. Scientific investigation is a systematic way of gaining scientific knowledge. Scientific investigations produce evidence that helps to answer questions. Scientific investigation is a quest to find the answer to a question using the scientific method.

Everything you do and encounter during your daily activities involves scientific investigation. Humans can acquire knowledge and understanding of the natural world through observation, experimentation, and reflection. Making coffee, cooking eggs, and baking bread involve the different methods. The products you use like soap and shampoo, the fabrics you wear, the electronics that keep you connected to your world, the gasoline that propels a car, etc; all of these and more are a result of scientific investigation.

🔄 ***In which activities do you use scientific investigation? Can you give examples?***

Scientific investigation generally involves some or all of the following basic components: ask a question, form a hypothesis, testing hypothesis, gather and analyze evidence, support the hypothesis with evidence, draw conclusions, and communicate results.

Exercise 1.2

Answer the following questions.

1. What is scientific investigation?
2. Describe the components of a scientific investigation.

1.2.2. Scientific Method and Ethical Discipline

Scientific Method

Science is a study of the natural environment. It is a body of organized knowledge obtained about nature through observation, explanation, interpretation and rationalization of certain types of information.

Scientific method is a systematic approach to problems. It is a process that is used to find answers about the world around us. The steps in scientific method includes making careful observations, asking questions, identifying the problem, forming a hypothesis, test the hypothesis with experiment, analyze data, make conclusion, and communicate results.

Step 1: Making careful observations:

The first step of the scientific method involves making an observation about something that interests you. It is a critical look through of natural world by using our sense organs.

Step 2. Ask question (Identifying the problem):

First the problem has to be identified before proceeding to the next steps. Beginning the question with 'what,' 'how' or 'why' is a good start. State the problem as a question. An example of a good question is, "How does fertilizer affect plant growth?" This is simple, measurable and can be done in the lab.

Step 3. Form a hypothesis:

Hypothesis is an explanation for an observation. It is basically an educated guess that can be tested based upon a thorough review of the existing knowledge of the subject. It is important to note that a hypothesis is tentative and must be testable.

Step 4. Experimentation (Testing Hypothesis):

Helps us to test our hypothesis by carrying out experiments using the collected data.

Step 5. Analyze and interpret the data:

Analysis of data means studying the organized material in order to discover the essential facts. After the experiment, results are recorded carefully and systematically organized in the form of data, charts or graphs in addition to verbal explanations and the interpreted data accordingly.

Step 6. Drawing conclusion:

Conclusions or generalizations require careful and objective analysis of the data gathered. The conclusion may or may not support the hypothesis.

Step7. Communicate results (Theory, principles, facts and laws):

When a given hypothesis has been tested many times and found to be acceptable it is no longer a hypothesis, but it becomes a theory. A **theory** is *a tested explanation of hypothesis and facts*. For example, Dalton's atomic theory, modern atomic theory etc. A concise verbal statement or a mathematical equation that summarizes a broad variety of observations and experience is known as **scientific law**. A familiar example is the law of gravity.

Can you give other examples that are scientific theory and scientific law?

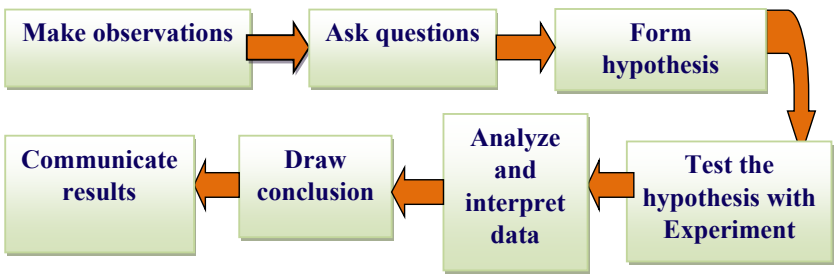


Figure 1.12 Basic steps in scientific method

Check Point 1.2

Each sentence below describes a step of the Scientific Method. Match each sentence under column "A" to the correct step of the Scientific Method under column "B".

Column "A"	*Column "B"*
1. A student said, "If I fertilize my plants, they will blossom".	A. Recognize a problem
2. Student's experiment proved that earth worms move away from light.	B. Form a hypothesis.
3. A student read about growing plants in water; and he wanted to know how plants could grow without soil.	C. Test the hypothesis with an experiment
4. A student grew bacteria from the mouth on plates. She placed drops of different mouth washes on the bacteria of each plate.	D. Draw conclusions
	E. Making observation

Ethical Discipline

Why it is necessary to follow ethical discipline in scientific investigations?

Ethics is a set of moral obligations that define right and wrong in our practices and decisions. Doing science with principles of ethics is the bedrock of scientific activity. Scientific investigations must be guided by ethical rules. The following are some of the common *ethical disciplines* across scientific investigations.

- **Duty to society:** contribute to the well-being of society.
- **Beneficence:** help others and yourself; and maximize benefits.

- **Conflict of interest**: what is the right thing to do?
- **Informed consent:** follow procedures and know the risks.
- **Integrity**: demonstrate honesty and truthfulness; moral soundness.
- **Non discrimination:** be fair and treat equally.
- **Non exploitation**: do not harm others or yourself.
- **Privacy and confidentiality**: be faithful, keep promises and agreements.
- **Professional competence**: being adequate or well qualified.
- **Professional discipline**: respect truth, do not lie, cheat or deceive.

1.2.3. Semi-guided investigations

In this section, students are asked to perform Semi-guided investigations to answer the following questions:

(a) does a coiled nail act like a magnet?
(b) is air necessary for burning?
(c) do plants store their food in their leaf?

Experiment 1.1



Objective: To investigate a coiled nail act like a magnet.

Apparatus: A big nail , an insulated copper wire about 0.25m long, one or two cell, pin or paper clips

Procedure:

1. Wind some turns of an insulated copper wire round an iron nail core.
2. Connect it to a battery (dry cell) as in the **fig.1.13 (A)**.
3. Place some pins on a paper and bring them to the nail.

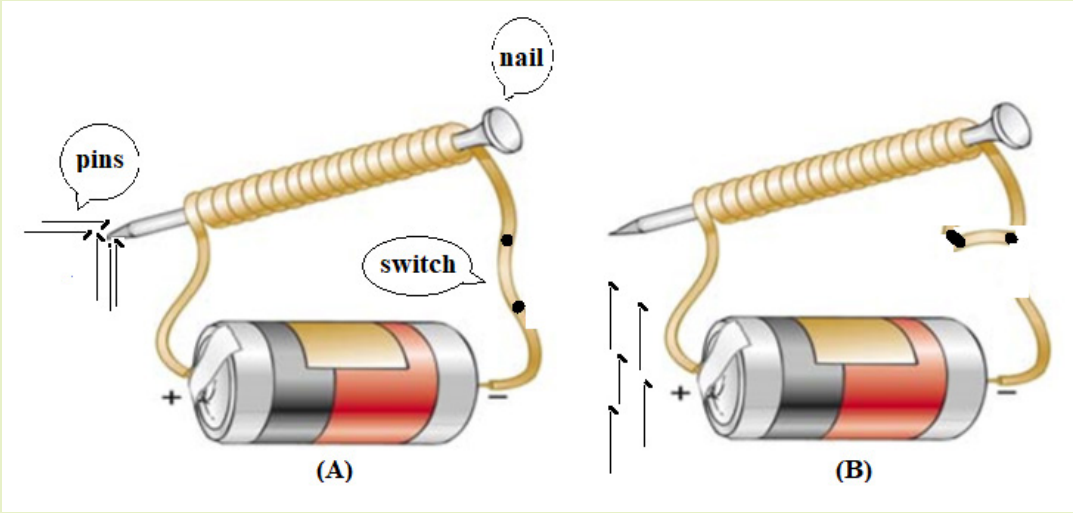


Figure 1.13 (A) Pins are attracted when switch is closed (B) Pins fall when switch is open

Observations and Analysis:

1. What do you observe when the switch is closed and bring pins to the nail?
2. What do you observe when the current is switched off? **See Fig.1.13(B)**
3. What do you conclude from this demonstration?

Write a laboratory report in groups and present your to the rest of the class.

Experiment 1.2

Objective: To investigate if air is necessary for burning.

Materials: three gas jars (glasses or beakers) of different size, three equal sized candle pieces, match and a table of smooth surface

Procedure:

1. Attach three candles on smooth surface of a table.
2. Strike a match and lit fire to each candle.
3. Simultaneously invert the gas jars on each candle.
4. Observe what happens and record all your observations/data in writing.

Caution: *This experiment requires supervision and safety considerations!!*

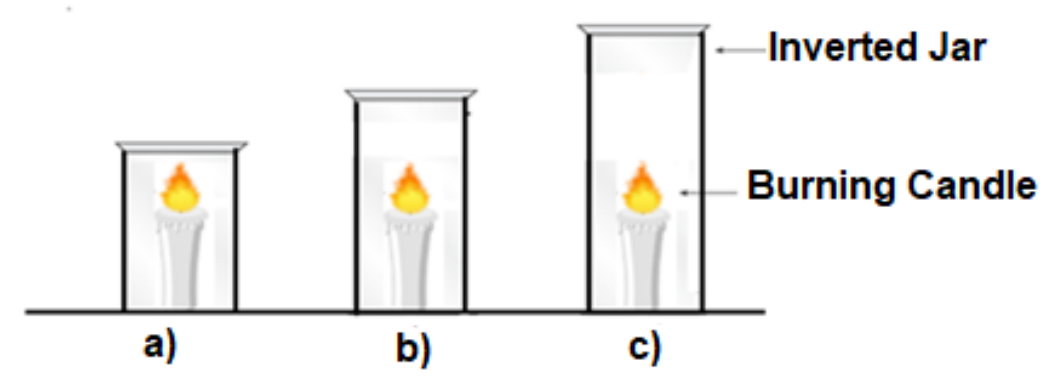


Figure 1.14 An inverted jar and a burning candle

Observations and Analysis:

1. What happens to the fire after some time?
2. Which gas jar candle fire is extinguished first? Why?
3. How does the amount of oxygen affect the burning time of a candle?
4. Discuss the conditions essential for combustion to take place.
5. What do you conclude from this experiment?

Write a laboratory report in groups and present to the rest of the class.

Experiment 1.3



Objectives : To demonstrate if plants store their food in their leaf.

Materials : Green leaf of plant, Beaker, Test tube, Test tube holder, Boiling water, Ethanol, Bunsen burner/Hot plate or stove, Tripod stand, Petri-dish, Dropper, Matches and 0.05N iodine solution.

Procedures

1. Take a green leaf from a plant which has been exposed to sunlight.
2. Heat a beaker half filled with water on the stove or hot-plate/Bunsen burner.
3. Place the leaf in boiling water and keep it there for about 15-20 minutes. This step kills the cells and renders them highly permeable.Take out the boiled leaf from the beaker and immerse it in a test tube containing ethanol.
4. Place the test tube in the hot water and keep it there until the leaf is decolorized. The alcohol is kept warm in a water bath.
5. Remove the test tube from the hot water.
6. Remove the decolorized leaf from test tube and place it back to the hot water in the beaker.
7. Pull out the leaf from the beaker and put it in a petri dish.
8. Add a drop of 0.05N iodine solution and allow the leaf to remain in the iodine solution for 5 minutes, and then wash it with water.

Observation and Analysis:

1. What do you observe in the leaf?
2. Why does it happen?
3. Do plants store their food in their leaf?

Write a laboratory report in groups and present to the rest of the class.

1.2.4. Indigenous action: Using local materials and methods (procedures) to conduct investigation

Project work

The objectives of this project is to relate indigenous units of measurements to metric unit, either an SI unit with appropriate prefix or a non-SI unit that is accepted to use with SI unit. You should bring and present the local names of indigenous measurement units in your locality by asking parents, elders and the community. To convert from indigenous methods of measuring instruments (unit) into metric unit, or SI unit you can use modern methods of measurements. Your teacher may guide you how to convert indigenous units of measurements to metric unit.

Exercise 1.3

Write the answer for the following questions

1. Why scientific investigations must be guided by ethical rules?
2. What are the common ethical disciplines in scientific investigations?
3. The process of obtaining information by using the senses is known as _____
4. Describe the last step of the scientific method.

KEY TERMS

- Accuracy
- Basic physical quantities
- Basic units (SI unit)
- Derived physical quantities
- Derived units
- Ethics in scientific
- Indigenous methods of measurements
- Investigation
- Modern methods of measurement
- Physical quantities
- Precision
- Prefixes
- Scientific Investigation
- Scientific Measurements
- Scientific methods

UNIT SUMMARY

- Measurement is the process of observing and recording objects or events.
- SI system means the international system of units, containing seven basic units.
- Mass is a measure of the quantity or amount of matter present in an object.
- Accuracy indicates how close a measurement is to the true value.
- Precision indicates how close the measurements are to each other.
- Investigations produce evidence that helps answer questions.
- The scientific method is a systematic approach to solve problems.
- A hypothesis is a possible explanation for the phenomenon you observed.
- Scientific investigations must be guided by ethical rules.
- The steps of scientific method include observation, question, hypothesis, experiment, results and conclusion.

REVIEW EXERCISE

I. Write true or false for the following questions.

1. Every measurement expressed interms of a number and a unit.
2. The mass of an object is measured with the help of a beam balance.
3. Forming a hypothesis is the first step of the scientific method.
4. A hypothesis always leads to the formulation of a law.
5. Scientific law is well-tested explanation for experimental results.

II. Choose the correct answer from the given alternatives for each of the following questions.

1. The symbols for units of length in order from largest to smallest are
   - A. m, cm, mm, km
   - B. mm, m, cm, km.
   - C. km, mm, cm, m.
   - D. km, m, cm, mm.

2. Scientific measurements are communicated using____.
   - A. a unit
   - B. both a numeric value and unit
   - C. either a numeric value or unit
   - D. a numerical value

3. The SI base unit for time is the:
   - A. day.
   - B. hour.
   - C. minute.
   - D. second.

4. Which of the following is not a fundamental quantity?
   - A. Length
   - B. Mass
   - C. Density
   - D. Time

5. Which of the following is a derived unit?
   - A. Meter
   - B. Newton
   - C. Kilogram
   - D. second

6. A student asks a question: How fast does the average person's hair grow? Which step of the scientific method did he just complete?
   - A. Step 1 - ask a question
   - B. Step 2 - gather background information
   - C. Step 3 - make a hypothesis
   - D. Step 4 - do an experiment

7. One micrometer is equal to:
   - A. 10^{-6} m
   - B. 10^{-8} m
   - C. 10^{-9} m
   - D. 10^{-12} m

8. Which of the following measurements are NOT equivalent?
   - A. 25 mg = 0.025 g
   - B. 24 dL = 2.4 L
   - C. 150 ms = 0.150 s
   - D. 84 cm = 8.4 mm

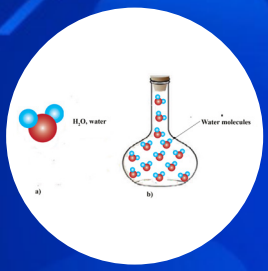
9. The amount of space taken up by an object is known as its _____.
   - A. mass
   - B. area
   - C. length
   - D. volume

10. How many grams are in a milligram?
   - A. 1,000,000
   - B. 0.001
   - C. 1,000
   - D. 0.01

III. Answer the following questions.

1. An explanation for a broad range of observations, facts, and tested hypotheses is called _____.
2. Change the following length, mass or volume measurements to the units shown in brackets.
   - a) 3.6m (cm)
   - b) 4500m (km)
   - c) 8500mL (L)
   - d) 0.325km (mm)
   - e) 8550 kg (g)
   - f) 1.6 µL (L)
   - g) 2 905 mg (kg)
   - h) 1.25 g (kg)

3. Change each of the following measurements to one in which the unit has an appropriate SI prefix.
   - a) 3.76×10^{3} m
   - b) 6.34×10^{-6} s
   - c) 1.09×10^{-3} g



UNIT TWO

COMPOSITION OF MATTER

Learning Outcomes

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

- *narrate the historical development of the atomic nature of substances;*
- *appreciate that atoms are the building blocks which make up all substances;*
- *demonstrate understanding of the idea that the identity of a substance is determined by its atomic structure;*
- *differentiate molecules of elements from molecules of compounds; and*
- *demonstrate scientific inquiry skills along this unit: communicating, asking questions, drawing conclusions, applying concepts.*

Main Contents

2.1. Early thinking about the composition of matter
2.2. Inside of an atom
2.3. Molecules

Introduction

Can you recall?

1. What is meant by matter?
2. What do you think matter is made up of?

In grade seven general science textbook, you learned about matter and particulate nature of matter, thus you are familiar with the concept of matter.

Do you think matter is the stuff that is all around you? Yes, you are right. Those all things you see and touch every day are matters and consist of small particles. These small particles do have some mass. But one never can see these small particles with eyes, even not with the best microscopes. However, the structure and behavior of small particles is the key for understanding both the physical and chemical properties of matter. Therefore, in this unit, you will learn the fundamental concepts of composition of matter in exploring the early thinking about an atom, the subatomic particles of the atom, atomic number and mass number, and molecules.

2.1. EARLY THINKING ABOUT THE COMPOSITION OF MATTER

After completing this section, the learners will be able to:

- *give a short history of the concept of the atom;*
- *compare and contrast the continuity and discreteness (discontinuity) theory of matter, and*
- *compare earlier conceptions of the structure of matter with their conceptions.*

Activity 2.1.

Perform this activity in group, and present your opinions to the class.

1. Prepare an aluminum foil and cut it into two halves and continue cutting.
2. How long could you continue cutting? Is there a limit or could you infinitely divide into smaller and smaller pieces? What do you conclude from this?
3. What is the fundamental building block proposed by the ancient Greek philosophers?
4. Debate on one of the following ideas assigned to your group.

   Idea 1: Matter is continuous.

   Idea 2: Matter is discrete

About 2500 years ago, the Greek philosophers thought about the nature of matter and its composition. They described matter as continuous or discrete. The Greek philosopher, Democritus (460-370 B.C.) argued that matter is made of small indivisible particles. He called these small particles 'atomos', meaning indivisible. Democritus also thought that matter is discrete (discontinuous). On other hand, Aristotle (384-322 B.C) argued that matter can be divided endlessly into smaller and smaller pieces; and he concluded matter is continuous. The ancient debate about matter is illustrated in Figure 2.1 below.

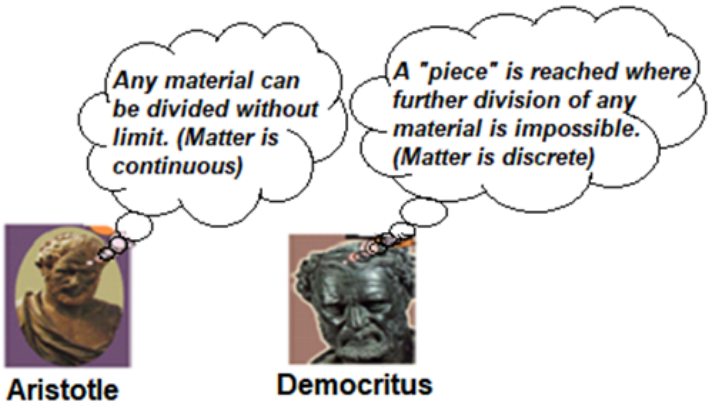


Figure 2.1 Ancient debates about the nature of matter

Based on the above debate, basic difference on the idea of continuity and discreteness of matter is summarized in Table 2.1 below.

Table 2.1 Comparison between the discrete and continuous theory of matter

Discreteness of Matter (Democritus)	Continuity of Matter (Aristotle)
• Matter is discrete	• Matter is continuous
• There is a limit to which matter is broken	• Matter is infinitely divisible
• Believed in the existence of atoms	• Rejected the idea of atoms

Although, Democritus' idea was not accepted by many of his contemporaries (notably Plato and Aristotle), somehow it suffered. Therefore, Democritus philosophy about matter was assumed to be "wrong" and Aristotelian view of the composition of matter were succeeded until John Dalton disproved Aristotelian view by experimental investigation. This confirmed that science-based ideas are continually being tested, modified and improved as new knowledge and explanations supersede existing knowledge and explanations.

An atom is the smallest individual particle of an element and does not exist freely in nature. The idea that matter is made up of fundamental particles were explained by atomic theory of matter. You will discuss more about atomic theory in grade 9 Chemistry.

Exercise 2.1

I. Choose the best answer from the given alternatives.

1. Among the following things, the one is a matter.
   - A. Water
   - B. Sound
   - C. Shadow
   - D. Light

2. Which of the following is **not** true about Democritus philosophy of matter?
   - A. Matter is discrete
   - B. Matter is continuous
   - C. An atom is indivisible
   - D. None of the above

3. One of the following agreed on continuity of matter.
   - A. Democritus
   - B. Aristotle
   - C. John Dalton
   - D. J.J. Thomson

II. Give short answer to the following questions.

1. According to Democritus, what is "atomos"?
2. What do you mean by a matter is "continuous?"
3. What is an atom?

2.2. INSIDE OF AN ATOM

After completing this section, the learners will be able to:

- *describe the structure of an atom as a nucleus containing protons and neutrons, surrounded by electrons in shells (energy levels);*
- *state the relative charge and approximate relative mass of a proton, a neutron and an electron;*
- *draw hydrogen atoms, including the location of the protons and electrons, with respect to the nucleus;*
- *differentiate between mass number and atomic number; and*
- *determine the number of protons, neutrons, and electrons in an atom.*

Activity 2.2.

Discuss the activity within a group and present your response to the class.

1. How could you describe the structure of an atom?
2. Draw the picture if you imagine what an atom look like?

2.2.5. Parts of an atom

Is there any particle smaller than an atom?

An atom has two regions such as the atomic nucleus and the electronic shells (energy levels or orbits). Atoms are made of even smaller particles called electrons, protons and neutrons.

How are these particles arranged in an atom?

The central part of the atom is called the nucleus. Protons and neutrons are present in the nucleus. Electrons revolve in shells around the nucleus like planets move around the sun. Note that shells are paths of the electrons take as they move around the nucleus.

Project work

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

First draw the diagrammatic representation of the structure of hydrogen atom on paper and next obtain atomic model of hydrogen atom by using locally available material.

(Hint: hydrogen atom has 1 electron, 1 proton only; draw a circle around the nucleus and add a symbol such as a dot for the electron).

Surrounding the nucleus, there is a region occupied by electrons. This region is very large compared with the size of the nucleus.

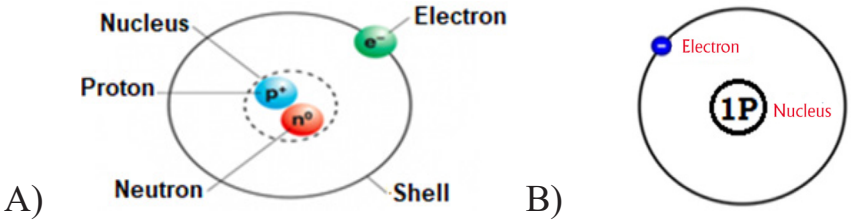


Figure 2.2 Diagrammatic representation of the structure of A) hypothetical atom (not to scale) and B) hydrogen atom

2.2.6. The Subatomic Particles

What are protons, electrons and neutrons?

An atom has a definite number of protons, electrons and neutrons. A proton is a positively charged subatomic particle in the atomic nucleus. The positive charge of the nucleus is due to the proton in it. An electron is a tiny negatively charged particle found outside the nucleus of an atom. Since, electrons are found outside the nucleus they are always available at the surface an atom. A neutron is electrically neutral particle located in the nucleus of an atom.

Relative mass, the charge and location of subatomic particles

Activity 2.3.

Explain the following questions.

1. How protons, neutrons and electrons are alike and different?
2. Is an atom neutral? Why?

When you compare the masses of electrons, protons and neutrons, what you find is that electrons have an extremely small mass, compared to either protons or neutrons. Proton has a mass 1837 times greater than that of electron. The mass of proton and neutron is approximately equal. Therefore, most of the mass of an atom is concentrated in the nucleus, assuming the mass of an electron to be negligible or almost zero compared with the masses of protons and neutrons.

Hence the nucleus is a heavy part of an atom. But the nucleus occupies a very small space as compared to the volume occupied by the electrons. Compare, the relative mass, charge and location of sub-atomic particles in ***Table 2.2*** below.

Table 2.2 Nature and location of sub-atomic particles

Particle	Actual mass (in gram)	Relative atomic mass (amu)	Electric charge	Location
Electron(e^-)	9.109×10^{-28}	1/1840	Negative	Outside the nucleus
Proton (P^+)	1.673×10^{-24}	1	Positive	Inside the nucleus
Neutron(^0n)	1.675×10^{-24}	1	Neutral/Zero	Inside the nucleus

You know that electrons are negatively charged and protons are positively charged, but what is amazing is that the positive charge on a proton is exactly equal in magnitude to the negative charge on an electron. Negative and positive charges of equal magnitude cancel each other out, and neutron is neutral. Therefore, an atom is neutral.

Atomic Number and Mass Number

What makes an atom of one element different from an atom of another element?

The significant difference on among atoms of different elements is in their subatomic composition. It is possible to distinguish between different elements by counting the number of protons. If an atom has only one proton, we know it is a hydrogen atom. An atom with two protons is always a helium atom.

What is the difference between atomic and mass number? How they can be represented with symbol of an element?

Indeed, the number of protons in the nucleus of an atom of any particular element is called the element's atomic number. It is also equal to the number of electrons around the nucleus if the atom is neutral. The physical and chemical property of the elements depends on proton number in atom of element.

$Z = p^+$ or $Z = e^-$ (in a natural atom)

The mass number of an atom is the total number of protons and neutrons in its nucleus.

Mass Number (A) = Number of protons + Number of neutrons

$A = p^+ + n^\circ$

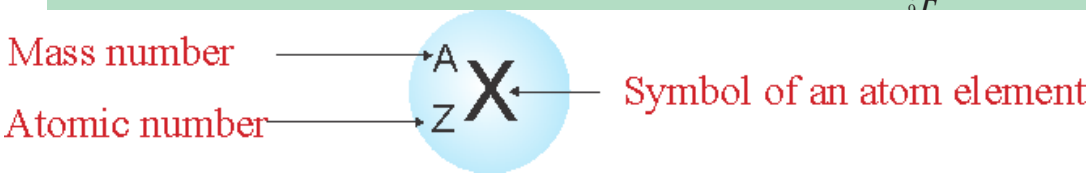
Mass number is designated by the letter 'A' whereas atomic number is designated by the letter 'Z'. However, both mass number and atomic number is always given in whole number.

Check point 2.1

Answer the Following Questions

1. Using the periodic table, write the symbolic notation and determine their number of protons, neutrons and electrons for the following elements. (*hint: in a periodic table, mass number is approximately equal to atomic mass*).
   - a) Lithium
   - b) Beryllium
   - c) Carbon
   - d) Nitrogen
   - e) Oxygen

2. Determine the atomic number, mass number, and number of protons for the following elements:
   - a) ${}^{11}_{5}B$
   - b) ${}^{20}_{10}Ne$
   - c) ${}^{19}_{9}F$



For example, ${}^{4}_{2}He$ is symbolic notation of helium and its atomic number is 2 and its mass number is 4.

Determination of the Electrons, Protons and Neutrons

How number of electrons, protons and neutrons can be determined?

We have seen how atomic number and mass number is determined in the above section. Since, the mass number is total number of protons and neutrons in an atom; then the number of neutrons is therefore the difference between the mass number and the atomic number. The number of neutrons in an atom is calculated by:

Number of neutrons = Mass number (A) – Atomic number (Z)

Example:

How many protons, electrons, and neutrons are in an atom of $^{19}_{9}F$?

Solution

No of neutrons= mass number - No of protons, or mass number – atomic number. Thus,

No of neutrons= A-Z or A- No of protons= 19-9=10

If an atom is not neutral, the number of electrons and protons are not equal.

Check point 2.2

Answer the Following Questions.

1. How many protons, electrons, and neutrons are in an atom of $^{23}_{11}Na$?
2. How many neutrons are in atom having 14 protons with mass number 28?

Exercise 2.2

I. Label each of the following statements as true or false.

1. All the mass of an atom is concentrated in the nucleus.
2. An atom is electrically neutral.
3. In an atom, number of electrons is necessarily equal to number of neutrons.
4. The nucleus is one of the fundamental particles of an atom.

II. Match terms under column 'A' to column 'B'.

Column A	*Column B*
1. Proton	A. Negatively charged
2. Electron	B. Neutral
3. Neutron	C. Positively charged

III. Fill the blank spaces.

1. Electron, proton, neutron are the types of_____in an atom.
2. Atomic number is the number of_____in an atom.
3. The central dense part of an atom is called _____.

2.3. MOLECULES

After completing this section, the learners will be able to:

- *define molecules;*
- *give examples of monatomic, diatomic and polyatomic molecule;and*
- *use models or particles model diagram to represent molecules of elements and compounds.*

Activity 2.3.

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

1. What is a molecule?
2. How molecule is differ from an atom?

A molecule is the smallest particle of an element or a compound that can exist freely in nature. Only a few elements, such as the gases helium, neon, argon etc. consist of a collection of individual atoms that move about independently of one another. In nearly all molecules, two or more atoms are bonded together in very small, discrete units (particles) that are electrically neutral.

2.3.1. Molecules of elements

What are molecules of elements?

Molecules of elements consist of single atom. They can be classified as monatomic, diatomic and polyatomic. Atoms of some elements such as helium (He), neon (Ne), argon (Ar) contain a single atom and are *monatomic molecules*.

Other molecules are formed with two atoms of an element and called *diatomic molecules*.

Examples: hydrogen (H_2), oxygen (O_2), and nitrogen (N_2). Hydrogen molecule is formed with combination of two hydrogen atoms as follows.

Hydrogen atom + Hydrogen atom → Hydrogen molecule

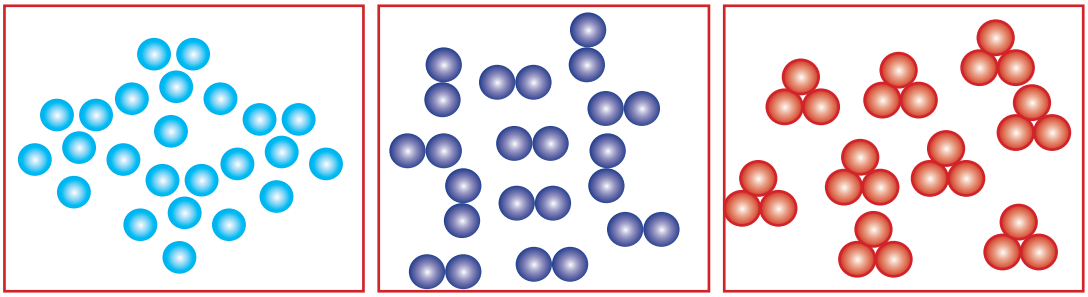
$$H + H \longrightarrow H_2$$

Can you list other monatomic and diatomic molecules?

Sometimes, more than two atoms of an element combine to form molecules of that element and called *polyatomic atomic molecules*.

Example: ozone (O_3), Phosphorus (P_4), and sulphur (S_8).

Therefore, the molecules which are formed with similar atoms, like hydrogen molecule (H_2) are called molecules of elements. These three kinds of molecules of element are illustrated in figure 2.3.



Helium, (He) Monoatomic molecule	Hydrogen, (H_2) Diatomic molecule	Ozone, (O_3) Triatomic molecule

Figure 2.3 Diagrammatic representations of molecules of element

2.3.2. Molecules of Compounds

What is a molecule of compound? How it differ from molecules of element?

When atoms of different elements combine with each other, the molecules of compounds are formed. A molecule of a compound contains at least two atoms. Water exists in molecular form and formed when an atom of oxygen combine with two atoms of hydrogen as shown in chemical equation and figure 2.4 below.

Hydrogen + Oxygen → Water

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

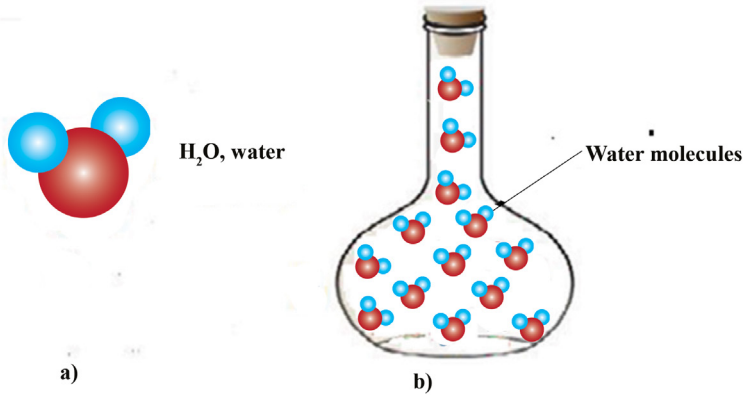


Figure 2.4 Schematic representations of a) structure of individual water molecule b) water molecules in steam.

Here, the atoms of oxygen and hydrogen are different because hydrogen and oxygen are different elements. Therefore, the molecules which are formed from two or more different atoms are called molecules of compound. Other molecules such as ammonia (NH_3), glucose ($C_6H_{12}O_6$) and carbon dioxide (CO_2) are molecules of compounds.

Can you list some other examples of molecules of compound?

Exercise 2.3

Give short answer to the following questions.

1. Define a molecule.
2. Consider the molecules shown below.

   i. Ar ii. CO_2 iii. N_2 iv. O_3 v. S_8 vi. H_2O vii. Cl_2 viii. HCl

   a) Classify the molecules as monatomic, diatomic or polyatomic molecules of element?
   b) Which of these molecules are molecules of elements?
   c) Which of them are molecules of compounds?

3. What is the difference between H and H_2?

KEY TERMS

- Atom
- Atomic number
- Electron
- Mass number
- Matter
- Matter discontinuity
- Molecules
- Neutron
- Nucleus
- Proton
- Subatomic particles

UNIT SUMMARY

- Democritus suggested that all matter in the universe was made up of tiny, indivisible particles.
- An atom is the smallest individual particle of an element and does not exist freely in nature.
- Electrons are a negatively charged, protons are a positively charged and neutrons are neutral.
- An atomic number is a number of protons. The mass number of an atom is the sum of the protons and neutrons in the atom.
- A molecule is the smallest particle of an element or a compound that can exist freely in nature.
- The molecules which are formed with similar atoms are called molecules of elements. Molecules formed with two or more different atoms are called molecules of compound.

REVIEW QUESTIONS

I. Label each of the following statements as true or false.

1. Neutral atoms must contain the same number of neutrons and protons.
2. An element's atomic number is equal to the number of protons.
3. A neutral atom with 4 protons must have 4 electrons.
4. O_3 is a molecule of compound.
5. According to Aristotle an atom is indivisible.
6. All matters are made up of an atom.

II. Choose the best answer from the given alternatives.

1. Which of the following has the smallest mass?
   - A. Proton
   - B. Electron
   - C. Neutron
   - D. None of them

2. The atomic number and mass number of Aluminum is 13 and 27, respectively. The number of proton, electron, and neutron respectively are:-
   - A. 13, 13 and 13
   - B. 13, 13 and 27
   - C. 27, 13 and 14
   - D. 13, 13 and 14

3. Identify the one which is **not** a molecule.
   - A. H_2SO_4
   - B. O
   - C. S_6
   - D. Cl_2
   - E. He

4. The atomic number of an atom is based upon the number of_____.
   - A. neutrons
   - B. protons and neutrons
   - C. electrons
   - D. protons

5. The central portion of an atom is called a/an_____ .
   - A. electron
   - B. proton
   - C. nucleus
   - D. Neutron

III. Fill in the blank space in the following questions.

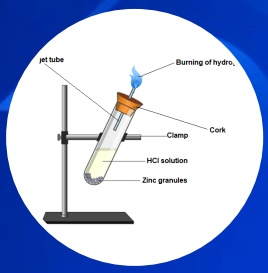
1. _____ and neutrons have approximately the same mass.
2. A molecule containing two or more different type of atoms is called_____.
3. A molecule containing more than two similar atoms is called_____.

IV. Give short answers for the following questions.

1. Compare the Democritus and Aristotle philosophies about atom.
2. What are the two main parts of an atom?
3. What is the difference between atomic number and mass number?
4. What are the fundamental sub-atomic particles?
5. Complete the following table.

Z	A	Number of Neutron	Number of Proton
	14		7
15	31		
	27	14	

6. Distinguish between molecules of element and compounds. Give at least three examples for each.
7. The atomic number and mass number of calcium are 20 and 40 respectively. Deduce the number of neutron present in the calcium nucleus.
8. Explain the following molecules and give examples for each.
   a) Monatomic molecules
   b) Diatomic molecules
   c) Polyatomic molecules



UNIT THREE

CLASSIFICATION OF COMPOUNDS

Learning Outcomes

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

- *explain the classification of compounds into organic and inorganic;*
- *write the formulas and name the first eight alkanes, alkenes and alkynes and list the uses of some important common organic compounds;*
- *classify oxides into different groups and give examples of each group;*
- *develop skills in identifying acidic, basic and neutral solutions;*
- *define, and apply the concept of neutralization;*
- *explain the safety precautions while working with acids and bases;and*
- *demonstrate scientific inquiry skills along with this unit: observing, classifying, comparing and contrasting, communicating, asking questions, designing experiment, drawing conclusion, applying concepts and problem solving.*

Main Contents

3.1 Introduction
3.2 Organic Compounds
3.3 Inorganic Compounds
3.4 Neutralization Reaction and Salts

Start-up Activity

Form groups and discuss the following and present to the class.

Assume that you are given two compounds (water and alcohol) in two different containers. Explain how you could distinguish between these two compounds.

Introduction

In Grade 7, you have learned about elements, compounds and chemical reaction. You have distinguished elements from compounds and how they are represented by symbols and formulae. You are also familiar with naming compounds and writing their formulas. In this section you will learn about compounds and their classifications.

3.1. INTRODUCTION TO COMPOUNDS

After completing this section, you will be able to:

- *define organic compounds as carbon containing compounds;and*
- *define inorganic compounds as compounds of elements other than carbon.*

Compounds are classified into two classes; organic and inorganic. Compounds obtained from living things (plants and animals) are organic compounds and compounds obtained from the constituents of the earth are inorganic compounds. Organic compounds are carbon containing compounds where as inorganic compounds are compounds of elements other than carbon including carbonates (CO_3^{2-}), hydrogen carbonates (HCO_3^-), carbonmonoxide (CO) and carbon dioxide (CO_2).

Activity 3.1.

Perform the following research activity and present to the class.

From different science books, discuss the historical origins of organic and inorganic; and their relationship between organic chemicals and living things.

Exercise 3.1

Answer the Following Questions

1. What are the differences between organic and inorganic compounds?
2. Classify each of the following compounds as organic or inorganic.
   a) Common salt (NaCl)
   b) Sugar ($C_{12}H_{22}O_{11}$)
   c) Carbon dioxide (CO_2)
   d) Alcohol (C_2H_5OH)

3.2. ORGANIC COMPOUNDS

After completing this section, learners will be able to:

- *define hydrocarbons and mention at least one source of hydrocarbons;*
- *write the general formula of alkanes, alkenes and alkynes;*
- *write the specific chemical formulas of the first eight members of alkanes, alkenes and alkynes;*
- *describe a homologous series and its general characteristics; and*
- *identify some common uses of organic compound.*

3.2.1. Hydrocarbons and its sources

Activity 3.2.

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

1. Which elements are constituents of hydrocarbons?
2. How hydrocarbons are named? Is it based on certain rules or randomly?

Hydrocarbons are organic compounds containing only hydrogen and carbon. The natural sources of hydrocarbons include coal, petroleum and natural gases which are formed from the remains of living organisms. The three major classes of hydrocarbons are alkanes, alkenes and alkynes. The name of a hydrocarbon is derived from the number of carbon atoms present (prefix) and the ending (suffix) that relate to their names. To find the base name of hydrocarbons (alkanes, alkenes and alkynes) use the following prefixes.

Table 3.1 Prefixes of the first eight hydrocarbons

Nº carbon atoms	1	2	3	4	5	6	7	8
Name	Meth-	Eth-	Prop-	But-	Pent-	Hex-	Hept-	Oct-

Nomenclature of Alkanes, Alkenes and Alkynes

Nomenclature of Alkanes

Alkanes are hydrocarbons with the general formula of C_nH_{2n+2}, where n = 1, 2, 3, etc. and stands for the number of carbon atoms in each alkane. For example, if n=1, the formula of alkane is $C_1H_{2\times1+2} = CH_4$. Any consecutive group of hydrocarbon differs from the next one in a series by a CH_2 unit called ***homologues series***.

$$CH_4 \xrightarrow{CH_2} C_2H_6 \xrightarrow{CH_2} C_3H_8 \xrightarrow{CH_2} C_4H_{10}$$

The names of alkanes end with the suffixes '-***ane***'. For instance, the formula of the alkane containing one carbon atom is CH_4. Therefore, n=1 prefix is 'meth-'

and we add the suffix '-ane' to the prefix. Thus, the name of the alkane becomes methane.

What is the formula and name of an alkane containing three carbon atoms (n=3)?



Check point 3.1

Answer the Following Questions.

1. Write the formula and name of an alkane containing 2, 4, 5, 6 and 8 carbon atoms.
2. Give the formula and name for the alkane homologues coming before and after C_7H_{16} and find their difference in the number of carbon and hydrogen atoms.

Nomenclature of Alkenes

Alkenes are hydrocarbons with the general formula of C_nH_{2n}, where **n = 2, 3, 4**, etc. For example, if n=5, the formula of the alkene is $C_5H_{2\times5} = C_5H_{10}$.

The names of alkenes end with the suffixes ***'-ene'***. The first member of alkene starts with two carbon atoms (n=2), C_2H_4. The prefix is '*eth-*' and we add the suffix '*-ene*' to the prefix. Thus, the alkene named as *ethene*. Similarly, the name of C_5H_{10} is pentene.

What is the formula and name of an alkene containing three carbon atoms (n=3)?

Check point 3.2

Answer the Following Questions.

1. Write the formula and name of an alkene containing 4, 5, 7 and 8 carbon atoms.
2. Give the formula and name for the alkene coming before and after C_6H_{12}; and find their difference in the number of carbon and hydrogen atoms.

Nomenclature of Alkynes

Alkynes are hydrocarbons with the general formula of C_nH_{2n-2}, where n = 2, 3, 4, etc. For example, if n = 4, the formula is $C_4H_{2\times4-2} = C_4H_6$.

The names of alkynes are obtained by changing the suffix '***-ane***' of alkanes to '-***yne***'. For example, the formula of alkyne containing four carbon atoms is C_4H_6. The prefix is 'but-' and the suffix is '-yne'. Combining the prefix and suffix gives butyne.

What is the formula and name of the first member of alkyne homologous series?

Check point 3.3

Answer the Following Questions.

1. Write the formula and name of an alkyne containing 3, 4, 5, 6 and 8 carbon atoms.
2. Give the formula and name for the alkyne coming before and after C_7H_{12}; and find their difference in the number of carbon and hydrogen atoms.

Uses of Common Organic Compounds

Activity 3.3.

Perform the following activity in group and present your opinion to the class.

List the sources of hydrocarbons that are found in Ethiopia and report to the class; and explain how they have made life more comfortable for human beings.

- ***Methane:*** Methane (CH_4) is mainly used as a fuel gas for cooking, heating and generating light. Methane is the major component of natural gas (~85%), commonly called Biogas, which is used as a domestic fuel.

- **Propane and butane*:*** Both propane and butane are gaseous alkanes marked as bottled gas and commonly known as "buta gas". It is mainly used for cooking and heating.

- ***Ethyne:*** One of the main uses of ethyne is to produce oxyacetylene flame, which is used in the cutting and welding of steel and iron at high temperature.



Figure 3.1 Ethyne produces oxyacetylene flame

- ***Ethanol:*** is used in alcoholic beverages. Nowadays, ethanol is mixed with petrol for an automotive fuel. It is used in hospitals and clinics for cleaning wounds; and as a solvent for many substances and in making perfumes and paints.

- ***Ethanoic acid (Acetic acid):*** Vinegar (Ethanoic acid) is used as food flavoring agent and preserving vegetables.

- ***Formalin:*** is used for preservation of biological specimens. It is also commonly used as an industrial disinfectant, and as a preservative in homes and medical laboratories as antiseptics, medicines, and cosmetics.

Exercise 3.2

Write your answers to the following questions.

1. Classify each of the following hydrocarbons as alkane, alkene or alkyne and write their names.
   a) C_5H_{10}
   b) C_3H_4
   c) C_4H_{10}
   d) C_8H_{18}
   e) C_6H_{10}

2. Write the molecular formulas of the following hydrocarbons and indicate their differences.
   a) Butane, butene and butyne
   b) Propane, propene and propyne

3. List common organic compounds and explain their uses.

3.3. INORGANIC COMPOUNDS

After completing this section, students will be able to:

- *classify oxides into metallic and nonmetallic;*
- *describe the properties of acidic oxides and basic oxides;*
- *predict the nature of common oxides;*
- *prepare sulphur dioxide in laboratory by burning sulphur in air;*
- *prepare magnesium oxide in laboratory by burning magnesium in air;*
- *define acid and base and describe their properties;*
- *name and write formulas for some common acids and bases;*
- *describe how indicators can be used to classify solutions as acidic or basic;*
- *investigate properties of bases/alkalis experimentally by preparing their own indicator by extracting the colour from a vegetable or flowers;*
- *investigate household chemicals using locally prepared indicators;*
- *explain the safety precautions while working with acids and bases;and*
- *create a safety booklet dealing with the handling of acids and alkali.*

Activity 3.4.

Perform the following activity and share your opinion with your group.

List some elements and inorganic compounds with which you are familiar in your daily activities.

Inorganic compounds are compounds consisting of mineral constituents of the earth or generally found in non-living things. Inorganic compounds are mostly found in nature as oxides (O^{2-}), carbonates (CO_3^{2-}), sulphides (S^{2-}), sulphates (SO_4^{2-}), chlorides (Cl^-) and nitrates (NO_3^-). Inorganic compounds can be classified into four groups according to their composition and their properties. These include oxides, acids, bases and salts.

3.3.1. Oxides

Oxides are binary compounds containing oxygen and any other element. Binary compounds are those consisting of only two elements.

Element + Oxygen → Oxide

Some examples of oxides are calcium oxide (CaO), aluminium oxide($Al_2O_{3)}$, sulphur dioxide (SO_2), carbon monoxide (CO), hydrogen oxide (water or H_2O), etc.

Types of Oxides

Most oxides are classified as metallic oxides and non-metallic oxides. Metallic oxides are binary compounds containing only metal and oxygen. Some examples of metallic oxides are Calcium oxide (CaO), Sodium oxide (Na_2O), Aluminium oxide (Al_2O_3), Magnesium (MgO), etc.

Non-Metallic Oxides are binary compounds containing only non-metals and oxygen.

Some examples of non-metallic oxides are Nitrogen dioxide, (NO_2), hydrogen oxide (H_2O), carbon dioxide (CO_2), sulphur dioxide (SO_2), etc. Based on their chemical behaviour oxides are classified in to acidic oxides and basic oxides.

Acidic oxides: Acidic oxides are oxides of non-metals. They are also called acid anhydrides. Acid anhydride means acid without water. Most non-metals form oxides that exhibit acidic properties and dissolve in water to give acidic solutions.

Examples of acidic oxides include; sulphur dioxide (SO_2,) nitrogen dioxide (NO_2,) carbon dioxide (CO_2), etc. It is important to note that all non-metal oxides are not necessarily acidic oxides.

What is the nature of phosphorous pentoxide, P_2O_5?

Basic oxides: Basic oxides are oxides of metals. They are also called basic anhydrides. Basic anhydride means base without water. Some metals form oxides which exhibit basic properties and dissolve in water to give alkaline (basic) solutions.

Some examples of basic oxides are sodium oxide (Na_2O), calcium oxide (CaO), magnesium oxide (MgO), etc. All metallic oxides are not necessarily basic oxides.

What is the nature of potassium oxide, K_2O?

Properties of oxides

i. An acidic oxides (acid anhydride) reacts with water to form an acid.

Acid oxide + Water → Acid

Example: SO_3 + H_2O → H_2SO_4

Sulphur trioxide — Water — Sulphuric acid

CO_2 + H_2O → H_2CO_3

Carbondioxide — Water — Carbonic acid

ii. A basic oxide or basic anhydride reacts with water to produce a base (Alkaline).

Basic oxide + Water → Base

Example: CaO + H_2O → $Ca(OH)_2$

Calcium oxide — Water — Calcium hydroxide

K_2O + H_2O → $2KOH$

Potassium oxide — Water — Potassium hydroxide

Preparation of Oxides

The common method for preparing oxides is direct combination of elements with oxygen. The following practical activity shows the preparation of oxides.

Experiment 3.1

Title: Preparation of Sulphur Dioxide

Objective: To prepare SO_2 and test whether it is an acidic oxide or a basic oxide.

Materials required: Sulphur, litmus paper (blue and red), gas jar, bunsen burner, deflagrating spoon.

Procedure:

1. Put some powdered sulphur in a deflagrating spoon and ignite.
2. When it starts burning, put it into a gas jar.
3. When the burning stops, add 5 mL of water to the gas jar and shake.
4. Put blue and red litmus paper, one after the other, in the jar.
5. Record your observations.



Figure 3.2 Burning sulphur in air

Observation and Analysis:

(f) What is the color of the flame when sulphur burns in air? What happens to the color of blue and red litmus papers in step 4?

(g) Write the chemical equation for this combustion reaction.

(h) Classify the oxide formed by the combustion of sulphur as acidic or basic.

Write a laboratory report in groups and present your findings to the class.

Experiment 3.2

Title: **Preparation of Magnesium Oxide**

Objective: To prepare magnesium oxide and test whether it is an acidic oxide or a basic oxide.

Materials required: Magnesium ribbon, red and blue litmus papers, bunsen burner, tongs, crucible.

Procedure:

1. Cut about 2 cm of magnesium ribbon.
2. Hold the ribbon with a tong and burn it over a flame from the Bunsen burner.
3. After burning, put the burning metal into a crucible and collect the product.
4. Add small amount of water to the resulting powder in the crucible and shake it. Test the solution with red and blue litmus paper and record your observations

Observation and Analysis:

(a) What is the color of the flame produced when magnesium burns in air?

(b) Write the chemical equation for the reaction.

(c) What happens to the color of the red and blue litmus papers?

(d) Is the resulting solution basic or acidic?



Figure 3.3 Burning of magnesium in air

Write a laboratory report in groups and present your findings to the class.

Exercise 3.3

Answer the Following Questions

1. Classify the following oxides as acidic or basic oxides. Give reasons for your classifications.
   a) SO_3
   b) K_2O
   c) N_2O_5
   d) BaO
   e) P_2O_5

2. Complete the following reaction.
   a) $CO_2 + H_2O \rightarrow ?$
   b) $Na_2O + H_2O \rightarrow ?$

3. Identify the anhydrides of the :
   a) HNO_3
   b) $Mg(OH)_2$
   c) H_2SO_4
   d) KOH

4. What products are formed when the following metals react with an excess Oxygen?
   a) Magnesium
   b) Zinc
   c) Lithium

3.3.2. Acids

Activity 3.5.

Form a group and perform the following activity.

Imagine a taste experiment using orange, lemon, tomato and grape fruit. They all taste alike. In what way would they taste alike, and why? What is the name of the acid in lemon and orange?

Acids are among the most familiar of all chemical compounds that we encounter every day. Citric acid in lemons, sour 'Tella' contains acetic acid, human

stomach contains hydrochloric acid and some insects such as bees and ants contain formic acid. It is important to remember that not all acids are harmful.

Can you mention the acids found in milk and soft drinks?

Acids are compounds that release hydrogen ions (H^+) when they are in aqueous solution.

Example: $HCl\,(g) \xrightarrow{H_2O} H^+\,(aq) + Cl^-\,(aq)$

Hydrochloric acid, HCl, nitric acid, HNO_3 and sulphuric acid, H_2SO_4 are the three common laboratory acids. These acids are called mineral acids.

Rules for writing and naming common acids

Acids are named based on their ***anion*** or the ion attached to the hydrogen. In simple binary acids, one ion is attached to hydrogen. Names for such acids consist of the prefix "***hydro-***", the first syllable of the anion, and the suffix ***"-ic"***. These anions usually have the ending "-ide". For example, HCl, which is hydrogen (H) and chlorine (Cl), is called hydrochloric acid (HCl).

Hydro + Base name of non-metal + ic acid

Example: HBr, contains the anion ***bromide*** named as ***hydrobromic acid.***

How do you name HI?

Acids containing polyatomic ions are named as follows.

If the polyatomic ion ends in ***–ate***, change the ending to ***–ic acid***
If the polyatomic ion ends in ***–ite***, change the ending to ***–ous acid***

Examples:

a. HNO_3, contains the polyatomic ion nitr***ate***, is called ***nitric acid***.
b. HNO_2, contains the polyatomic ion nitr***ite***, is called ***nitrous acid***.

Check point 3.4

Answer the Following Questions.

1. Name the following acids.
   a) HF b) H_2SO_4 c) H_2CO_3
2. Write the formula of the following acids.
   a) Sulfurous acid
   b) Phosphoric acid
   c) Nitric acid.

Acid- base Indicators

An indicator tells us whether a substance is acidic or basic in nature by showing changes in colour. The common indicators available in laboratories are litmus, phenolphthalein, methyl orange or methyl red and universal indicators.

The pH Scale

Substances can be classified as acidic, basic, or neutral based on their pH values. pH (***Power of hydrogen***) is a measure of acidity or basicity of a solution. pH scale is ranging from 0 (very acidic) to 14 (very basic/alkaline). Acids have a pH value less than seven and bases have a pH value greater than seven. The pH of a neutral solution equals seven.

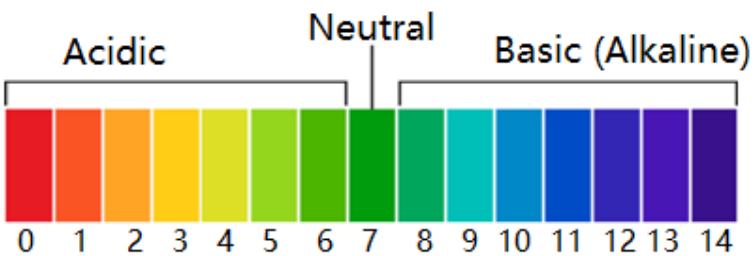


Figure 3.4 The pH scale

Properties of Acids

i. Acids have a sour taste: The sour taste of many unripe fruits, lemon, vinegar and sour milk is caused by the acids present in them. Never taste mineral acids because they are corrosive.

ii. Acids change the colour of indicators: Indicators show the presence of an acid or a base with specific color changes when placed in a solution. Acids change blue litmus and methyl orange solution to red and in phenolphthalein becomes colourless. The following practical activity shows the effect of acids on indicators.



Experiment 3.3

Title: **Effect of acids on acid-base indicators**

Objective: To investigate the effect of dilute hydrochloric acid and sulphuric acid on the colors of litmus paper, phenolphthalein and methyl orange.

Materials required: Blue and red litmus papers, phenolphthalein, methyl orange, test tubes, test tube rack, dilute HCl and H_2SO_4.

Procedure:

1. Pour about 5 mL of dilute HCl into three test tubes.
2. Hold the first test tube in inclined position and put blue and red litmus papers turn by turn into it and see if there is any colour change.
3. Add few drops of phenolphthalein in the second and few drops of methyl orange in the third and observe if there is colour change.

4. Repeat the above procedure using dilute H_2SO_4 solution.

Observation and analysis

Record your findings on table. Write a laboratory report in groups.

Table 3.2: Effects of acid on Indicators

Acid	Color of the indicator in the acid solution		
	Litmus	Phenolphthalein	Methyl orange
Dilute HCl			
Dilute H_2SO_4			

iii. ***Reaction of Acids with metals:*** Dilute acids react with active metals like zinc, magnesium and aluminum to form salts and liberate hydrogen gas. Very active metals like sodium, potassium, and calcium react very violently with dilute acids, so care should be taken.

Active Metal + Dilute Acid → Salt + Hydrogen

Example:

$$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$$

Calcium — Hydrochloric acid — Calcium chloride — Hydrogen gas

The following practical activity demonstrates the reaction of acids on metals.

Experiment 3.4



Title: **Reaction of an acid with a metal**

Objective: To investigate the reaction of zinc metal with hydrochloric acid.

Materials required: A test tube, zinc granules, dilute hydrochloric acid, match box rubber stopper and a test tube holder.

Procedure:

1. Add a few zinc granules in a test tube.
2. Pour about 5 mL of dilute HCl into a test tube as shown in *Figure 3.2*.

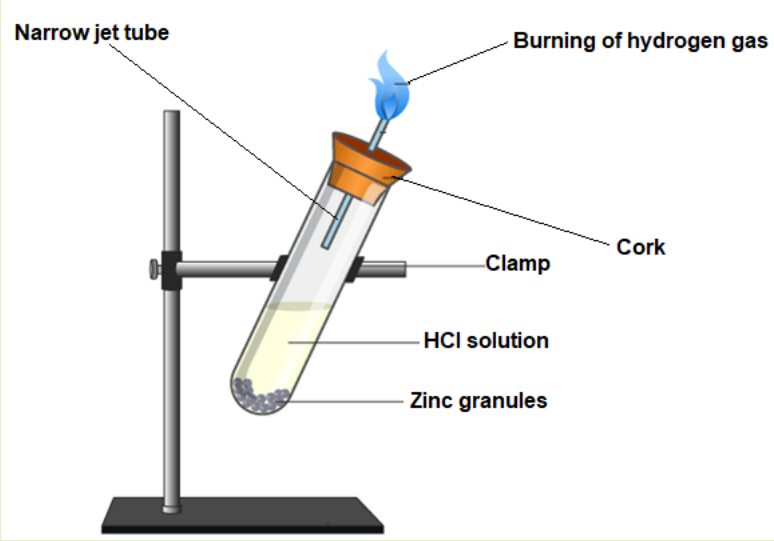


Figure 3.5 Reaction of zinc with hydrochloric acid

3. Remove the rubber stopper and introduce the lighted splint in to the mouth of the test tube and record your observations.

Caution! Note that you should hold the test tube and the lighted splint away from Yourself and others!

Observation and analysis:

(a) What happens when you drop zinc metal into the test tube containing dilute HCl?

(b) What is the colour of the gas?

(c) What happens when the lighted splint is held inside the mouth of the test tube?

(d) Write the chemical equation for the reaction between zinc and hydrochloric acid.

Write a laboratory report in groups and present to the rest of the class

iv. Reaction of Acids with Carbonates and Hydrogen Carbonates: Acids react with metal carbonates and hydrogen carbonates to form salts, water and carbon dioxide gas.

Acid + Carbonate → Salt + Water + Carbon dioxide

Example:

$2HCl\,(aq) + Na_2CO_3(s) \rightarrow 2NaCl\,(aq) + H_2O(l) + CO_2(g)$

Hydrchloric acid *Sodium carbonate* *Sodium chloride* *Carbon dioxide*

Acid + Hydrogen carbonate → Salt + Water + Carbon dioxide

Example:

$HCl\,(aq) + 2NaHCO_3\,(aq) \rightarrow Na_2CO_3\,(aq) + 2H_2O\,(l) + 2CO_2(g)$

Hydrchloric acid *Sodium bicarbonate* *Sodiom carbonate* Water *Carbon dioxide*

The following practical activity demonstrates the reaction of acids with carbonates and hydrogen carbonates.

Experiment 3.5



Title: **Reactions of acids with carbonates and hydrogen carbonates**

Objective: To investigate the reactions of carbonates and hydrogen carbonates with dilute hydrochloric acid and sulphuric acid.

Materials required: test tube, boiling tube fitted with cork, thistle funnel, delivery tube, sodium carbonate, sodium hydrogen carbonate, dilute HCl and freshly prepared lime water (calcium hydroxide solution).

Procedure:

1. Take the boiling tube and add about 0.5 g sodium carbonate to it.
2. Take about 2 mL of freshly prepared lime water in a test tube.
3. Add about 3 mL dilute HCl to the boiling tube containing sodium carbonate.
4. Immediately fix the cork filled with a delivery tube.
5. Dip the other end of the delivery tube in the lime water.
6. Observe the lime water carefully.
7. Repeat the above procedure for sodium hydrogen carbonate and dilute H_2SO_4.

Observation and analysis:

(a) When dilute HCl is added to sodium carbonate or sodium hydrogen carbonate, what gas is evolved?

(b) What happens to the lime water the gas passing to it? Why is that so?

(c) Write the chemical equation that occurred on the reactions.

Write a laboratory report in groups and present to the rest of the class.

v. Acids neutralize bases: Acids react with bases to form salts and water. This reaction is called neutralization reaction.

Acid + Base → Salt + Water

Example: HCl + NaOH → NaCl + H_2O

Hydrchloric acid *Sodium hydroxide* *Sodium chloride* *Water*

The following practical activity demonstrates the neutralizing effect of an acid on a base.

Experiment 3.6

Title: Neutralizing effect of an acid on a base.

Objective: To investigate the neutralizing effect of HCl on sodium hydroxide.

Materials required: A test tube, dropper, methyl orange or phenolphthalein solution indicators, solution of sodium hydroxide and dilute hydrochloric acid.

Procedure:

1. Take about 2 mL solution of sodium hydroxide in a test tube.
2. Add a drop of phenolphthalein indicator to it and observe the colour.
3. With the help of a dropper add dilute hydrochloric acid drop wise and stir the solution constantly till the colour disappears.
4. Now add a few drops of NaOH solution. The colour of the solution is restored.

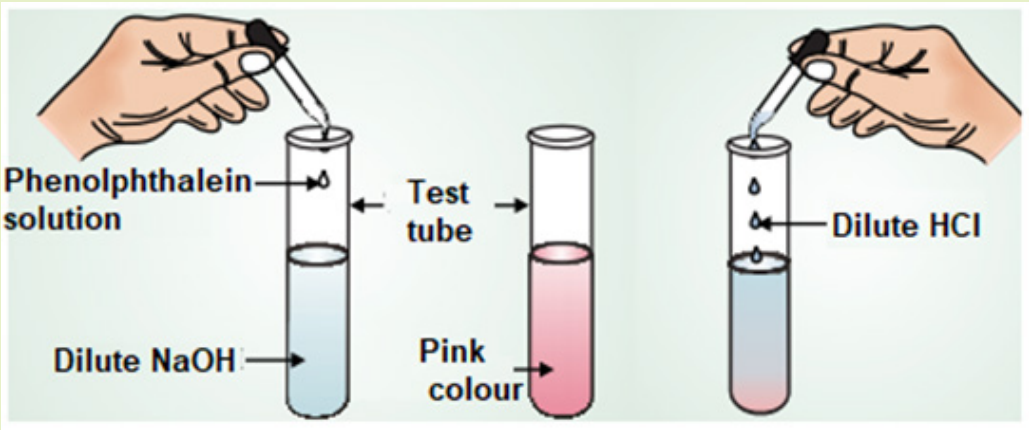


Figure 3.6 Reaction between NaOH and HCl

Observation and analysis

(a) What colour appeared when phenolphthalein is added to the solution of NaOH?

(b) Why does the colour disappear on adding HCl?

(c) What will happen when sodium hydroxide has reacted with hydrochloric acid?

(d) Write the balanced equation for the reaction that takes place in this experiment.

Write a laboratory report in groups and present your findings to the class.

Exercise 3.4

Write the Answer for the Following Questions.

1. Which ion is a characteristic of acids in water solution?
2. What will happen if you add the following on hydrochloric acid, HCl?
   a) Phenolphthalein
   b) Blue litmus
   c) Methyl orange
3. An acid reacts with a substance **Z** with the liberation of CO_2 gas. What can be the nature of **Z**?
4. List the properties of acids.
5. Complete the following reaction
   a) $Zn(s) + HCl(aq) \rightarrow ?$
   b) $HCl(aq) + CaCO_3(s) \rightarrow ?$
   c) $HNO_3(aq) + KOH(aq) \rightarrow ?$

3.3.3. Bases

Activity 3.6.

Perform the following activity and share your opinion with the class.

When plants are partly burned, ash is formed. When the ash is dissolved in water, it gives a solution which tastes bitter and feels slippery when rubbed between the fingers. Why do you think this happens?

Bases are chemical compounds that we encounter every day and used in industry and at home. Sodium hydroxide, NaOH, used in washing soaps and detergents; potassium hydroxide, KOH in bathing soaps, calcium hydroxide, $Ca(OH)_2$ neutralizes acidic soil, etc. Bases are substances that react with acids to form salts. Bases which are soluble in water are called ***alkalis.*** An alkali is a substance that releases hydroxide ion (OH^-) when dissolved in water.

For example: $NaOH\ (aq) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$

Sodium Hydroxide — *Sodium ion* — *Hydroxide ion*

Some of the example of bases include sodium hydroxide, potassium hydroxide, calcium hydroxide and magnesium hydroxide.

What is the name of the base used to neutralize excess acidity in our stomach?

Naming Bases

The names of bases end with ***hydroxide***. Start with name of the ***cation*** (***metal ion*** or ***ammonium ion***, NH_4^+) followed by name of the ***anion (hydroxide ion).***

Metal (cation) name + hydroxide (OH^-)

Example: $Na^+ + OH^- \rightarrow NaOH$

Sodium ion — *Hydoxide ion* — *Sodium hydroxide*

Check point 3.6

Answer the Following Qustions.

1. Name the following bases.
   a) $Mg(OH)_2$ b) $Al(OH)_3$ c) $Ca(OH)_2$
2. Write the formula of the following bases.
   a) Potassium hydroxide
   b) Iron(III) hydoxide
   c) Ammonium hydroxide

Properties of Bases

i. Bases are slippery to the touch and have a bitter taste in aqueous solutions: Strong bases such as NaOH and KOH are very corrosive. So they should be neither brought in to contact with the skin nor tasted.

ii. Bases change the colour of indicators: Bases turn red litmus to blue, methyl orange solution to yellow and Phenolphthalein to pink. The following practical activity demonstrates the effect of a base on indicators.

Experiment 3.7

Title: **The effect of a base on indicators**

Objective: To study the effect of a base on indicators

Materials required: Red and blue litmus papers; phenolphthalein solution, methyl orange, calcium hydroxide, test tubes, test tube holder and rack.

Procedure:

1. Take four clean test tubes.
2. Add about 5 mL calcium hydroxide solution in each of the test tubes and label the test tubes as 1, 2, 3, and 4 as shown in *Figure 3.4*.

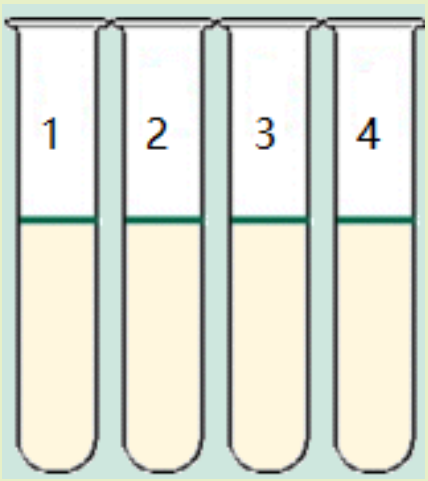


Figure 3.7 Testing the effect of base on indicator

3. Put red litmus paper, blue litmus paper, 2 drops of phenolphthalein solution and 2 drops of methyl orange solution in test tubes 1,2,3 and 4 respectively. Observe the colour change and record your observation.

Observation and analysis:

What happens to the colours of the red litmus paper, blue litmus paper,phenolphthalein and methyl orange solutions after the addition of calcium hydroxide (Lime water) solution?

Write a laboratory report in groups and present your to the rest of the class.

iii. Bases neutralize acids: Bases react with acids to form salt and water.

Base + Acid → Salt + Water

Example: $KOH\ (aq) + HCl\ (aq) \rightarrow KCl\ (aq) + H_2O\ (aq)$

Potassium hydroxide *Hydrchloric acid* *Potassium chloride* *Water*

Experiment 3.8

Title: **Neutralizing effect of a base on an acid.**

Objective: To investigate the neutralizing effect of NaOH on HCl.

Materials: test tube, dropper, methyl orange or phenolphthalein solution indicators, solution of sodium hydroxide and dilute hydrochloric acid.

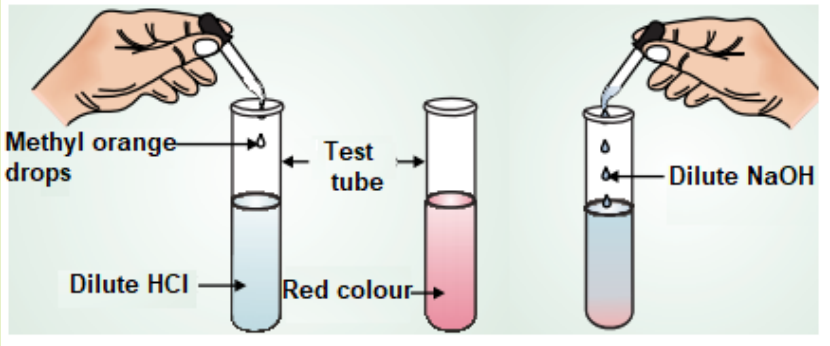


Figure 3.8 Reaction between hydrochloric acid and sodium hydroxide.

Procedure:

1. Take about 2 mL solution of HCl in a test tube.
2. Add a drop of methyl orange solution indicator to it and observe the colour.
3. With the help of a dropper add dilute NaOH acid drop wise and stir the solution constantly till the colour disappears.
4. Now add a few drops of HCl solution. The colour of the solution is restored.

Observation and Analysis

(a) What colour appeared when methyl is added to the solution of HCl?

(b) Why does the colour disappear on adding NaOH?

(c) Write the balanced equation for the reaction that takes place in this experiment.

Write a laboratory report in groups and present your findings to the class.

Investigation using local indicators

Project Work

The objective of this project work is to investigate household chemicals using locally prepared indicators. In group, with guidance, you should prepare your own acid-base indicators by extracting the colour from different plants (flowers, fruits, vegetables) and investigate the presence of acid and base in different house hold chemicals such as vinegar, baking soda, lemon, etc. found in your local areas and present your result to the class using a table (chart).

Safety precautions while working with acids and Bases

It is very important to avoid contact with acids and bases with any part of your body or clothing. The following safety precautions are useful in handling acids and bases in school laboratories or anywhere while working with them.

- If a concentrate acid is spilled or splashed on your skin, wash thoroughly the affected part with water, and then wash it with 10% Na_2CO_3 solution.
- If an acid enters your eye, wash thoroughly with plenty of water.
- If you accidentally drink corrosive acids, take a base such as $Mg(OH)_2$.
- If you drink corrosive base, neutralize it by drinking 1 - 2% dilute solution of acetic acid or lemon juice.
- Never add water into concentrated acids! Instead *add acid to water*.
- If a base is spilled on your skin wash the affected area with plenty of water and then treat the affected part with a weak acid such as dilute acetic acid.
- If a base comes into contact with your eyes, wash the eyes with cold water.

Assignment

In groups, conduct an investigation using science books or internet; search and develop a safety booklet on the correct ways of handling acids and alkalis.

Exercise 3.5

Answer the Following Questions

1. Indicate whether each of the following is a property of acids, bases, or both acids and bases.

   a) Have a sour taste
   b) Taste bitter
   c) React with metals
   d) Turns litmus paper red
   e) Feels slippery
   f) Turns litmus paper blue

2. What measures should you take if:
   a. an acid accidentally enters your eyes?
   b. you accidentally drink a base?
3. Write a least two important properties of bases.
4. What ion is a characteristic of all bases in water solution?
5. complete the following reaction

   a) $NaOH\ (aq) + HCl\ (aq) \rightarrow\ ?$
   b) $Mg(OH)_2\ (aq) + HNO_3 \rightarrow ?$

3.4. NEUTRALIZATION REACTION AND SALTS

After completing this section students will be able to:

- *identify some everyday uses of neutralization;*
- *define salt and give its examples;and*
- *name and write formulas for some common salts.*

Activity 3.7.

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

What is the importance of neutralization in daily life?

3.4.1. Neutralization Reaction

A neutralization reaction is ***the reaction between an acid and a base to form salt and water***. Neutralization reactions are very useful in our daily activities. Some of the applications of neutralization in our daily activities are as follows.

i. Neutralization at Home

We use neutralization for most of the activities in our home for different purposes. Baking powder is usually used to help the dough rise to bake bread. Conditioner is used with shampoo to prevent small scales on hair. Toothpaste contains bases that neutralize the acid produced by bacteria in our mouth.

Can you mention other applications of neutralization reaction in home?

ii. Neutralization in Health

Our stomach contains hydrochloric acid. The excess acid in the stomach is neutralized by taking antacid like milk of magnesia, $Mg(OH)_2$. The sting of an ant and bee contains formic acid. When an ant or bee bites, it injects the acidic liquid into the skin. The effect of the sting can be neutralized by rubbing moist baking soda ($NaHCO_3$). Wasp stings are alkaline and can be neutralized with vinegar.

Can you mention other applications of neutralization reaction in health?

iii. Neutralization in Agriculture

Excessive use of chemical fertilizers results in increased acidity of the soil. When the soil is acidic, it is treated with powdered lime (CaO), limestone ($CaCO_3$) or ashes of burnt wood. If the soil is basic, organic matter is added to it. The acidic gas from the decomposition of compost neutralizes the alkalis in basic soil.

Can you list other applications of neutralization reaction in agriculture?

The ability of plants to take nutrients from the soil into their roots is affected by the pH content of the surrounding soil particles. When organic materials, such as dead leaves, animal wastes, decay, organic acids, etc are produced and these lower the pH of the soil so, over the years, soil naturally becomes more acidic. For the soil to produce good yields of crops, it is necessary to raise the pH by spreading lime in the form of limestone, $CaCO_3$, quick lime, CaO or slaked lime, $Ca(OH)_2$.

Why it is necessary to adjust the pH of the soil?

In agriculture different crops require different nutrients in different proportions and, as a result each crop grows best in soil within a particular pH range. Maintaining proper soil pH is one of the most important aspects of soil fertility management. Soil pH is a measure of active acidity based on the concentration of hydrogen ions (H+) in soil solution. Soil pH directly affects the life and growth of plants because it affects the availability of all plant nutrients. Between pH 6.0 and 6.5, most plant nutrients are in their most available states. A nutrient must be soluble and remain soluble long enough to successfully travel through the soil solution in to the roots.

The best pH ranges for growing different crops are for example: potatoes 5.5 – 6.5, oats 5.5 – 7.0 and beans 6.0 – 7.5.

Practical Activity

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

1. Create a written or digital display to exhibit the use of neutralization reactions in daily life.
2. Using a pH meter in your school laboratory, perform a measurement on the pH of different soil samples taken from different locations.

3.4.2. Salts

What is a salt? Does common salt (sodium chloride) is the only salt?

The term 'salt' does not refer only to the table salt (sodium chloride, NaCl) which we use to make our food. The word 'salt' applies to a large group of compounds. Salts are widely used as raw materials in chemical industries, as fertilizers, and building materials, etc. A salt is a compound consisting of the positive ion of base and the negative ion of an acid. Sodium sulphate (Na_2SO_4) is a salt that contains sodium ion (Na^+), derived from NaOH and the sulphate ion (SO_4^{2-}), derived from H_2SO_4. Some examples of salts are sodium chloride, (NaCl), calcium carbonate ($CaCO_3$), potassium nitrate (KNO_3) and Sodium bicarbonate, ($NaHCO_3$).

Naming and Writing Formula of Salts

Salts are named by writing a prefix with a cation name followed by base name of an ion such as ***-ate***, ***-ite*** and ***–ide***.

Name of Cation + Base Name of Anion + ide/ ate/ite

***Example*:**

The formula and name of the compound formed from Mg^{2+} and Cl^{-} is:

For each ion of Mg^{2+} ion one Cl^{-} ions is needed; so write $2Cl^{-}$ and deduce the formula as:

$Mg^{2+} + 2Cl^{-} \rightarrow MgCl_2$ (***Magnesium chloride***)

For writing and naming a salt containing polyatomic ions, the ***positive ion*** is named first followed by the name of the ***polyatomic ion***.

- Polyatomic anions end with ***–ate***: includes NO_3^{-} (nitrate), PO_4^{3-}(phosphate), CO_3^{2-} (carbonate), and SO_4^{2-} (sulphate).

  Examples: *$NaNO_3$sodium nitrate, Potassium carbonate, K_2CO_3, etc*

- Polyatomic anions end in ***–ite***: includes NO_2^{-}, nitrite and SO_3^{2-}, sulphite.

  Examples: Potassium sulphite, K_2SO_3, Sodium nitrite, $NaNO_2$,etc.

- Polyatomic anions with hydrogen attached use the prefix ***-hydrogen (or bi)***: HCO_3^{-}(hydrogen carbonate *(bicarbonate))*, HSO_4^{-} (*hydrogen sulfate)* and HPO_4^{-} (*hydrogen phosphate)*.

  Example: $(NH_4)_2HPO_4$, diammonium hydrogen phosphate (DAP)

Uses of salts

Activity 3.8

In this activity you are expected to perform the following tasks in groups by reading different Science reference books and present to the class.

Prepare a table and write the formula and important uses of:

a) sodium chloride
b) calcium carbonate
c) sodium bicarbonate
d) potassium nitrate
e) diammonium phosphate (DAP)

Exercise 3.6

Answer the Following Questions.

1. Name the following salts.
   a) Na_2SO_4
   b) K_2CO_3
   c) $Mg_3(PO_4)_2$
   d) $NaHCO_3$

2. Write the formula of the following salts.
   a) Calcium sulphate
   b) Sodium carbonate
   c) Ammonium phosphate
   d) Potassium nitrate

3. Name the base and the acid from which the positive and the negative ions are derived in each of the following salts.
   a) Sodium nitrate
   b) Calcium chloride
   c) Potassium sulphate

4. Mention and explain the importance of neutralization in daily activities?

5. How do you treat if the soil is too acidic and too basic?

KEY TERMS

- Acid
- Acidic oxide
- Alkane
- Alkene
- Alkyne
- Base (Alkali)
- Basic oxide
- Homologous series
- Hydrocarbon
- Inorganic compound
- Metallic oxide
- Naming salts
- Neutralization reactions
- Nomenclature
- Non metallic oxide
- Organic compound
- Oxide
- Salt

UNIT SUMMARY

- Organic compounds are carbon-containing compounds except the oxides of carbon, carbonates, and hydrogen carbonates.
- Hydrocarbons are organic compounds that contain only carbon and hydrogen.
- Alkanes are hydrocarbons with the general formula $\mathbf{C_nH_{2n+2}}$ where 'n' is the number of carbon atoms in the molecule.
- Alkenes are hydrocarbons with the general formula $\mathbf{C_nH_{2n}}$ where 'n' is the number of carbon.
- Alkynes are hydrocarbons with the general formula $\mathbf{C_nH_{2n-2}}$ where 'n' is the number of carbon.
- Inorganic compounds are classified as oxides, acids, bases, and salts.
- Oxides are classified as acidic and basic oxides depending on their properties.
- Acids are compounds that release hydrogen ions in water solution.
- Salts are mainly prepared by neutralization reactions.
- Neutralization reactions have different applications in everyday life and industrial Processes. Neutralization reactions are very useful in our daily activities such as in home, health and agriculture.

REVIEW EXERCISE

I. Match the items under column 'A' with those under column 'B'.

Column "A"	*Column "B"*
1. Bottled gas used as fuel.	A. Ethyne
2. A fuel to produce flame used for cutting and welding metals.	B. Formalin
3. A constituent of all alcoholic beverages.	C. Methane
4. Organic chemical used to preserve biological specimens.	D. Butane
5. A chemical used as food flavoring agent.	E. Ethanoic acid
6. Major component of natural gas called Biogas	F. Octane
	G. Ethene
	H. Ethanol

II. Choose the correct answer from the given alternatives for each of the following questions.

1. A molecule with the formula C_3H_8 is a(an):
   - A. propene
   - B. propane
   - C. propyne
   - D. ethane

2. When a drop of vinegar solution is put on the blue litmus paper, it turns;
   - A. red
   - B. blue
   - C. colourless
   - D. no change

3. What must be added when the soil is too basic?
   - A. Organic matter
   - B. Quick lime
   - C. Slaked lime
   - D. Lime stone

4. The correct formula of octene is:
   - A. C_8H_{18}
   - B. C_8H_{14}
   - C. C_8H_{16}
   - D. C_8H_{20}

5. Which of the following feel soapy on touching?
   - A. Acid
   - B. Base
   - C. Salt
   - D. None of these

6. The formula of sodium carbonate is:
   A. $NaHCO_3$
   B. Na_2SO_4
   C. Na_2CO_3
   D. $NaHPO_4$

7. Which of the following salts is used as a baking powder?
   A. $(NH_4)_2HPO_4$
   B. $NaHCO_3$
   C. $CaCO_3$
   D. KNO_3

8. Which one of the following pairs of compounds produces calcium sulphate?
   A. CaO and HCl.
   B. $Ca(OH)_2$ and HNO_3.
   C. CaO and H_2O.
   D. $Ca(OH)_2$ and H_2SO_4.

9. Which of the following are **not** the characteristics of a base?
   A. A base changes the colour of an indicator.
   B. A base produces hydrogen ions in water.
   C. A base has a bitter taste.
   D. A base can neutralize acids.

10. Which one of the following compounds is used as a fertilizer?
   A. $Mg(OH)_2$
   B. NaCl
   C. HCl
   D. NH_4NO_3

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

1. Deduce the molecular formula of:
   a) butyne
   b) propene
   c) hexane
   d) octyne
   e) heptene

2. Write the names and formulas of the acids and bases required to prepare each of the following salts.
   a) Potassium phosphate
   b) Sodium sulphate
   c) Magnesium carbonate

3. Write the name and the formula of a salt used in:
   a) our diet.
   b) making construction materials
   c) making gun powder

General Science

Student Textbook

Grade 8

Federal Democratic Republic of Ethiopia
Ministry of Education

Sidaama National Regional State
Education Bureau