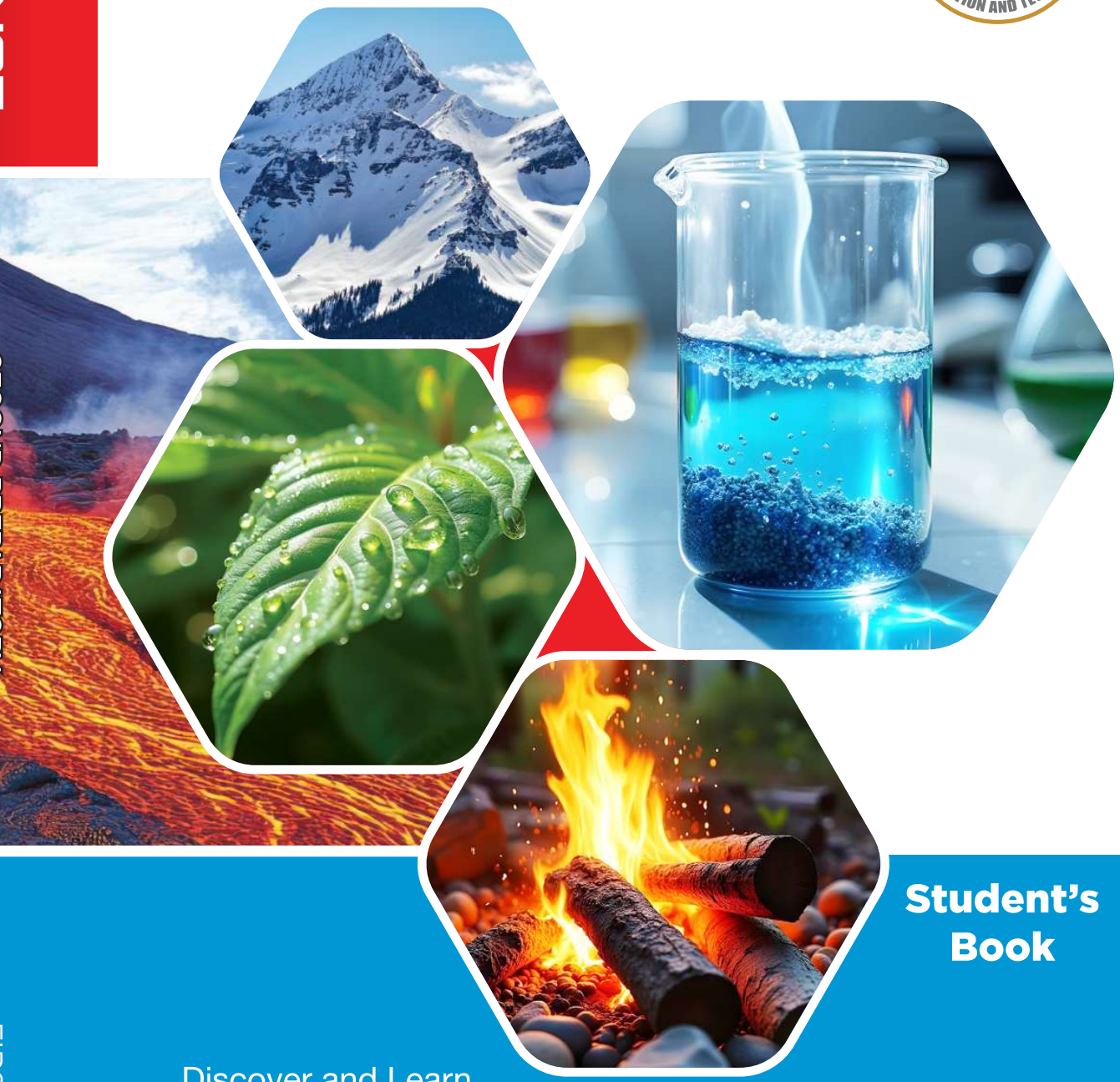

Student's Book

Discover and Learn

SCIENCE

Second Preparatory - First term

2025 - 2026

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Student's Book

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Introduction

Dear student,

We are pleased to present this Science textbook to our second-grade preparatory students, and to emphasise the role of science in the development and progress of society. Science is not just a subject to be studied, It is a way of thinking that helps them to understand the world more deeply and make well-informed decisions based on precise knowledge. Learning science is an active process based on discovery, research, experimentation, thinking, and practising different scientific processes such as observation, interpretation, communication, predicting, experimenting and drawing conclusions. Reflecting this philosophy, the curriculum has been entitled : 'Discover and Learn!'

This book aims to foster students' love of exploration and experimentation, encouraging critical thinking, collaboration, and questioning—guiding them to discover answers through observation, hands-on experiments, and diverse activities that make scientific concepts engaging and fun. This book also aims to help students develop a deep understanding of scientific concepts, apply scientific knowledge in new situations, solve problems, develop scientific research and inquiry skills, encouraging skills in asking questions, designing experiments, and analyzing information, develop innovative solutions, and enhance understanding of the relationships between science, technology, engineering,and mathematics, and preparing students to be lifelong learners, capable of meeting future challenges.

To achieve these goals, this book covers different fields of science such as chemistry, physics, biology, and space science into cohesive, interconnected units that also align with other subjects. This promotes a comprehensive and integrated understanding of how these fields intersect in the real world. The topics covered in this curriculum address key concepts in the fields of matter, energy, living things, and space, which helps to encourage scientific inquiry.

The curriculum relies on active learning strategies in the implementation of its lessons, addresses many scientific and social issues and cementing values. The lessons are equipped with knowledge resources, communication and information technology, encouraging research and self-learning skills, developing critical thinking skills, and helping students reflect on and assess their understanding of what they are studying and learning.

We hope that you will find inspiration in this book to encourage you to pursue your scientific curiosity. Always remember that scientists were once just curious children like you. They searched for answers to their questions and discovered new wonders. Maybe you will be the scientists who discover what no one has discovered before!

In presenting this book, we hope that it will be of benefit to you.

And God is the source of all success.
The Authors

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UNIT 1

Matter and Energy

The lessons

Lesson one : States of Matter.

Lesson two : Changes in States of Matter.

Lesson three : Internal Energy and Temperature.

Lesson four : Methods of Heat Transfer.

Learning Outcomes :

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

1. Relate the cohesive force between molecules of gases, liquids, and solids to their properties.
2. Conclude that converting matter from one state to another doesn't change its components or make new materials
3. Design a model to describe changes in the state of matter (gaseous, liquid, and solid) under the effect of change in temperature (due to gain or loss of thermal energy).
4. Verify that the kinetic energy of particles of matter in their different states changes when energy is transferred from it or to it.
5. Verify that the relationship between temperature and total energy of a system depends on type, state and mass of the matter.
6. Practically identifies ways of energy transfer (conduction, convection and radiation).
7. Describe applications of conduction, convection and radiation through common examples.

Lesson **one**

States of Matter

Lesson Terminology :

- Matter.
- Fluids.
- Particle.
- Particle Theory.
- Interparticle Spaces.
- Brownian Motion.
- Diffusion.
- Compressibility.
- Plasma State.
- Fluid Flow.

Lesson Objectives :

By the end of the lesson, the student should be able to :

1. Classify materials into solids, liquids and gases.
2. Compare the physical properties of matter in its fundamental states.
3. Use particle theory to describe the behavior of matter in its solid, liquid and gaseous states.
4. Explain some physical properties of matter in different states in terms of particle theory.
5. Appreciate the role of scientists in discovering the plasma state and its applications.

Included skills, Values, and Issues :

- **Skills** : Observation - Predicting - Concluding - Practical practices.
- **Value** : Collaboration.
- **Issue** : Technological justice.

Cross-Cutting Concepts :

- Cause and effect.

Lesson Preparation :

The given figure shows the three states of matter. This lesson explores ideas that will help you answer these questions:

- What are the differences between the three states of matter?
- Is there a fourth state of matter?

States of Matter and Their Properties

- Scientists try to observe patterns and common properties of materials around us, which facilitates materials classification and study, such as the classification of the chemical elements and the classification of the living organisms.
- Matter is classified according to its physical state into **three common states:**
  - Solid state. - Liquid state. - Gaseous state.
- **The properties of matter differ according to its physical state, as shown in the following activities :**

Cumulative knowledge :

- Matter is anything that has mass and occupies space.
- Mass of a substance is a constant quantity that doesn't change from one place to another.

1 Shape and fluidity

Activity 1 Conclude

Consider the following figures, **then answer:**

Figure (1)

Figure (2)

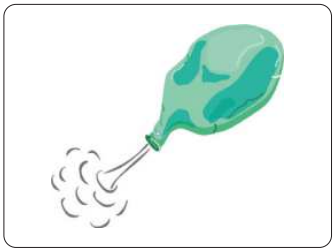


Figure (3)

Which of the states of matter shown in Figures (1 – 3) :

1. Its shape changes when it is transferred from the container that contains it. .....
2. Has the ability to flow (fluidity). .....
3. Has a fixed shape. .....

2 Volume and compressibility

Activity 2 Practical

1. Bring three identical syringes and use a plug to seal the nozzle of each of them tightly.
2. Put equal amounts of air, water, and fine sand into the syringes (Figure 4).
3. Press the piston of each syringe gradually.
4. Note the change in the volume of the matter inside each syringe as pressure is applied to the piston.

What do you notice? .....

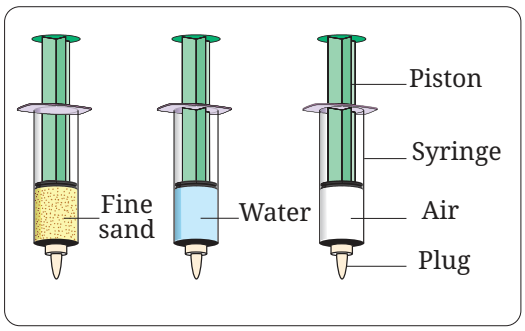


Figure (4)

3 Diffusibility

Activity 3 Practical

Materials and Tools Used:

• Water. • Potassium permanganate. • Glass flask.

Steps:

1. Put a quantity of water in the glass flask.
2. Add a few crystals of potassium permanganate slowly to the water (Figure 5).

What do you notice? .....

.....

Figure (5)
Potassium permanganate in water

From your notes in activities (1) to (3), mark (✔) or (✘) in the spaces in Table (1) :

Table (1)

State of matter / Property	Solid	Liquid	Gas
Change in shape when the container is changed	.....	.....	.....
Fluidity	.....	.....	.....
Compressibility	.....	.....	.....
Change in volume	.....	.....	.....
Diffusibility	.....	.....	✔

It can be concluded from the above that:

- The behavior of matter differs according to its physical state. **Solid matter**, such as wood and iron, has a fixed shape and its volume doesn't change when it is transferred from one place to another. **Liquids**, such as water and oil, can be poured from one container to another and take the shape of the container that holds them, but their volume remains unchanged.
- **Gases** are similar to liquids in fluidity, and changing their shapes depending on the shape of the container that holds them. Therefore, liquids and gases are classified into one group known as **Fluids**, and the flow of liquids varies according to their viscosity.
- The compressibility of gases, which means the possibility of changing their volume by increasing the pressure exerted on them.
- The particles of matter diffuse from a region of high concentration to a region of low concentration, and diffusion occurs very rapidly in gases and with an average speed in liquids and a very slow speed in solids.
- The speed of diffusion depends on the temperature of the diffusion medium, where the speed of molecules with less mass is greater than the speed of molecules with greater mass.

Evaluate Your Understanding

From Figure (6):

Which of the following best describes what happened inside the bottle?

(a) The air was compressed.

(b) The air has diffused.

(c) The volume of air increased.

(d) The air flowed out.

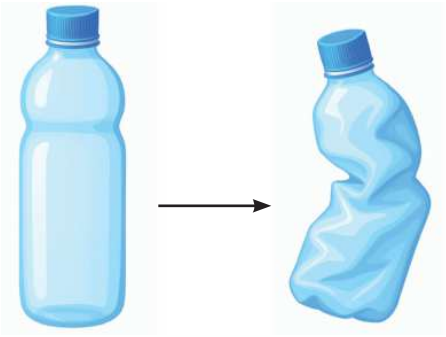


Figure (6)

The particle model of matter

Lets imagine ourselves on a journey inside matter, wandering among tiny units called particles.
Imagine particles as tiny spheres that make up everything, such as water, air, and blocks of metals (Figure 7).

What does make the properties of matter vary depending on its physical state?

We can explain many of the physical properties of matter in terms of the behavior of its particles.

Cumulative knowledge

- Particles can be monatomic or polyatomic molecules.
- Polyatomic molecule is formed by the bonding of two or more atoms together by chemical bonds.

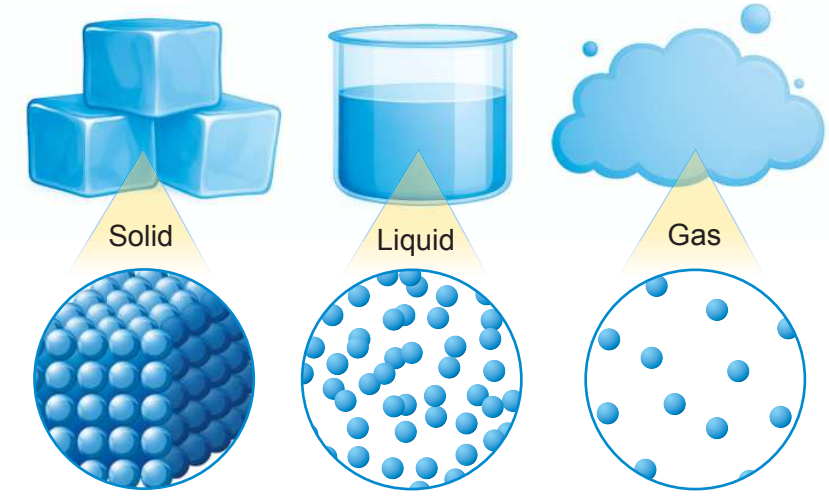


Figure (7)

Particles (molecules) that make up matter in its three states

Particle theory of matter

Scientists always try to explain different natural phenomena by making assumptions in an attempt to understand how things work. When these assumptions succeed in explaining many phenomena, they become **a scientific theory.**
One of the theories that has succeeded in explaining much of the behavior and properties of matter is **the particle theory of matter**.

Assumptions of the particle theory of matter

1. All matter is made up of particles which are so tiny that they cannot be seen with naked eye.
2. Particles of the same substance are identical, and their types differ from one substance to another.
3. There are attraction forces between the particles of a substance, and the particles store potential energy due to these forces of attraction between them.
4. There are interparticle spaces between the particles of a substance that vary depending on its physical state.
5. The particles of a substance have kinetic energy, whereas they are in a state of continuous motion in straight lines, and the way the particles move and their speed differ depending on the state of the matter.

Explanation of the Properties of the States of Matter

The properties of the states of matter differ according to the forces of attraction between the particles (Figure 8).

In **the solid state**, the forces of attraction between particles are **very strong**, so that they are tightly bound together, and the interparticle spaces are very small. The particles cannot move from their position, but they **vibrate in their fixed position** without moving to another position, causing the solid matter to have **fixed shape and volume.**

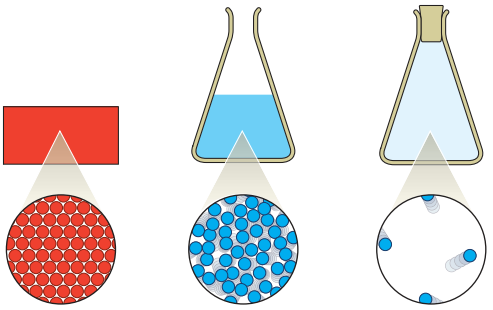


Figure (8)

In **liquids**, the forces of attraction between particles are **relatively weak**,which allows them to move more freely, but they are sufficient to hold them together, and the interparticle spaces are relatively greater, which explains the ability of the liquid to **flow** and take the shape of the container.

In **gases**, however, the forces of attraction between particles are **very weak,** so gas particles move randomly and completely freely.

When relatively large particles are present in fluids, such as dust in air or pollen grains in water, collisions occur between the molecules of the fluid and these particles, making these particles move randomly in all directions. This is known as **Brownian motion**, named after the scientist **Brown** who discovered this phenomenon.

This explains the ability of gas to **diffuse** and take the shape and the volume of the container.

Gas is **characterised by the compressibility**, as the large interparticle spaces between gas particles allow the volume of the gas to be reduced by increasing the pressure exerted on it, without changing the size of the particles themselves.

Cross-Cutting Concepts: Cause and Effect

The difference in the forces of attraction between molecules **(Cause)** leads to differences in the properties of matter **(Effect)**.

Designing a Particle Model of Matter Structure

Scientific and Engineering Practices

Modelling is a way of presenting a simplified representation of objects that are either too tiny to be seen or too massive to be comprehended, which helps us to understand objects and the relationships between them.

- **Use what is available in your environment,** such as corks (Figure 9) or grains such as lentils or rice, or use a computer program to work on models that illustrate the physical composition of matter.
- **Evaluate the accuracy** of the models presented with your classmates.

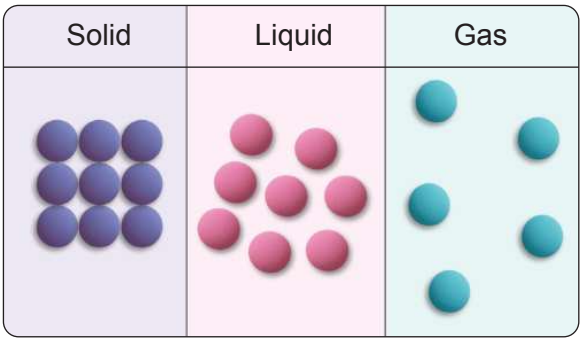


Figure (9)

Evaluate Your Understanding

Study Figures (10) : (12) :

Figure (10)

Figure (11)

Figure (12)

Explain according to the particle theory of matter :

1. The difficulty of breaking a piece of rock (Figure 10).

.....

2. The possibility of dissolving a quantity of table salt in water (Figure 11).

.....

3. The reason for the diffusion of smoke from a candle wick in the air (Figure 12).

.....

Plasma state

When gases are ionized, they are converted into positively charged ions and negatively charged free electrons.

This state is known as **plasma**, which is the fourth state of matter, characterized by high electrical conductivity.

Most matter in outer space exists in the plasma state, where the matter found in the Sun, stars and cosmic nebulae are in the plasma state, and plasma also exists in lightning and the aurora borealis (Aurora) (Figure 13).

Figure (13)
The Aurora Phenomenon

Research Activity

Search multiple sources of knowledge, including the Internet and your school library, about the phenomenon of the Aurora, Include answers to the following questions:

- Where can the Aurora be observed on Earth? What does it look like?
- Why is the Aurora formed in those areas?
- Why cannot the Aurora be seen in other areas of our planet?

Technological **Application**

The plasma state is used in air conditioners (AC) (Figure 14) to improve air quality in enclosed spaces, where gases are passed through a high electric field to convert their atoms into positively charged ions and negatively charged electrons, where the charged gas ions work to break down harmful air pollutants, germs and viruses, **this makes** the air more pure.

Figure (14)
Plasma air condition system

Issue for Discussion

Generalizing the use of plasma air conditioners to achieve technological justice among different segments of society.

Evaluation Questions on Lesson one

1 Choose the correct answer for questions (1) – (4).

(1) Air and water are similar in that they both .....

(a) have mass.
(b) can be seen.
(c) have a fixed shape.
(d) have a fixed volume.

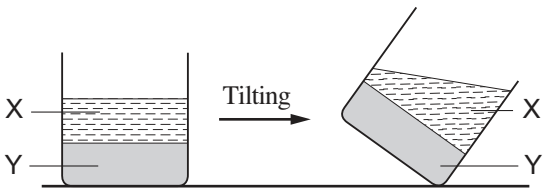
(2) You have two groups of substances, which are:

- **Group (X):** Oil, wood and marble.
- **Group (Y):** Oxygen, nitrogen and hydrogen.

Which of the following represents one of the properties of groups (X) and (Y)?

Choices	Group (X)	Group (Y)
(a)	Occupy space	Do not occupy space
(b)	Have fixed shape	Do not have fixed shape
(c)	Have fixed volume	Do not have fixed volume
(d)	Can be compressed	Cannot be compressed

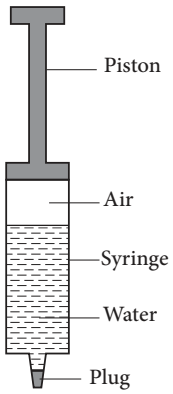
(3) When a container containing two substances (X) and (Y) is tilted, their positions become as follows:



Which of the following determines the state of substances (X) and (Y)?

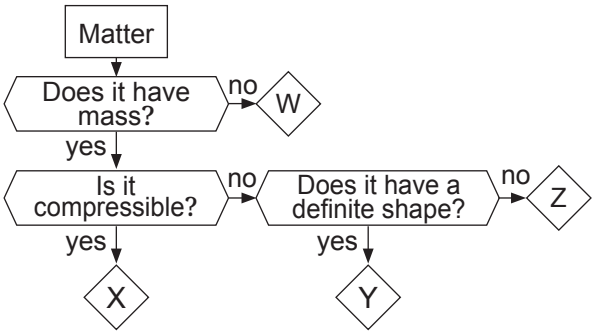
(a) (X): Solid , (Y) : Liquid.
(b) (X): Liquid, (Y) : Liquid.
(c) (X): Liquid, (Y) : Solid.
(d) (X): Solid , (Y) : Gas.

(4) In the opposite figure: What happens to the volume of each of water and air respectively when the piston of the syringe is pressed?



(a) Decreases, decreases.
(b) Remains unchanged, increases.
(c) Remains unchanged decreases.
(d) Increases, decreases.

2 From the following chart:



Match each of W, X, Y and Z with the appropriate option below:

- Juice.
- Air.
- Light.
- Heat.
- Iron.
- Carbon dioxide.

3 The following two figures represent two states of matter:

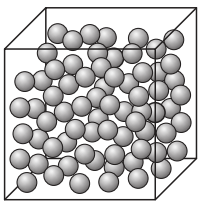


Figure (1)

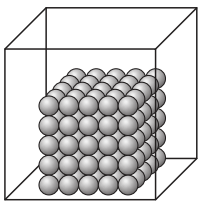


Figure (2)

(1) Which of the two figures represents a fluid, and what is its state?

(2) Compare the states of matter shown in the two figures, in terms of :

1- The forces of attraction between particles.
2- The movement of particles.

Lesson **Two**

Changes in the States of Matter

Lesson Terminology :

- Energy.
- States of Matter.
- Melting.
- Freezing.
- Evaporation.
- Boiling.
- Condensation.
- Deposition.
- Sublimation.
- Melting Point.
- Boiling Point.

Included Skills, Value, and Issue :

- **Skills :** Practical practices - Graphs - Interpretation.
- **Value :** Rationalizing energy consumption.
- **Issue :** Melting of the ice of the two poles and flooding of coastal cities.

Cross-Cutting Concepts :

- Cause and Effect.

Lesson Objectives :

By the end of the lesson, students should be able to :

1. Conclude the effect of heat on the change in the physical state of matter.
2. Draw a graph showing the relationship between temperature and the states of matter.
3. Identify the factors that affect the melting and boiling points of a substance.
4. Explain that the conversions in the states of matter are reversible processes.
5. Distinguishe between boiling, evaporation and sublimation.
6. Identify the factors affecting the rate of evaporation.

Lesson Preparation :

Here is a figure of an iceberg :

This lesson explores ideas that will help you answer these questions :

- What are the physical changes which occur in the matter ?
- Is the energy stored in ice different from that stored in water ?
- What is the difference between normal ice and dry ice ?

In our daily life,we can observe many conversions of matter from one state to another when it gains or loses a quantity of thermal energy (heat).

The change in the physical state of matter

Activity 1 Practical

Tools and materials used :

- **Glass beaker.**
- **Thermometer.**
- **Pieces of ice.**
- **Glass rod for stirring.**
- **Heat source.**
- **Stopwatch.**

Steps :

1. Put the ice cubes and the thermometer in the beaker, then gently heat it with the heat source (Figure 1).
2. Stir at equal intervals of time and record the thermometer reading each time till the ice completely melt.
3. Continue heating, and record the water temperature at equal intervals until the water reaches its boiling point.

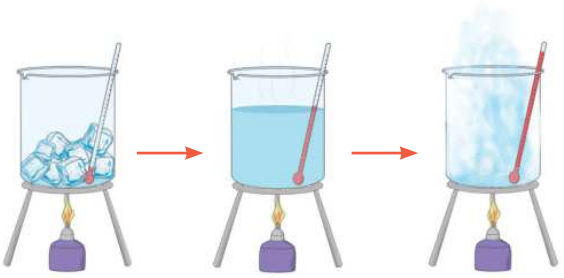


Figure (1)

4. Let the water boil for several minutes, then record the thermometer reading.
5. Record the thermometer reading in the following table :

Table (1)

Time (min)	1	2	3	4	5	6	7	8	9	10
Thermometer reading (°C)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

6. Draw a graph representing the change in water temperature during heating over time in minutes. (Figure 2).

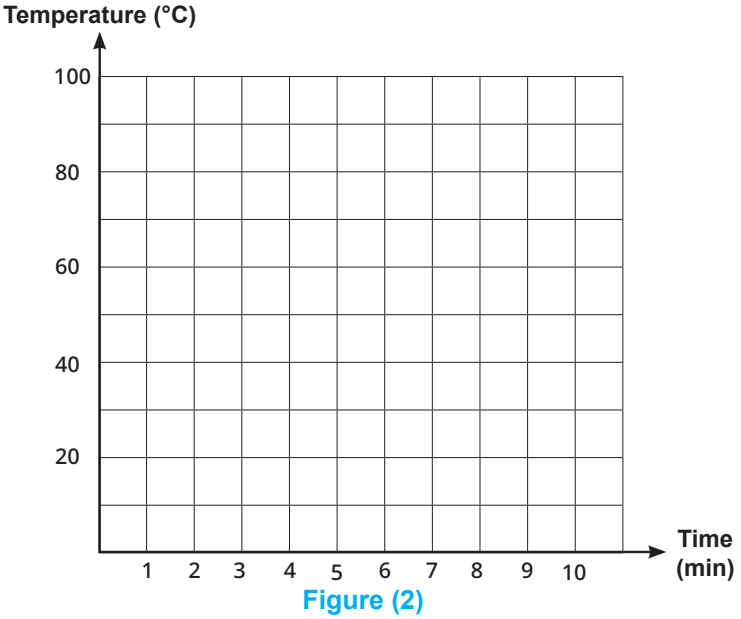


Figure (2)

(Figure 3) shows the heating curve of water in its three fundamental states under certain conditions:

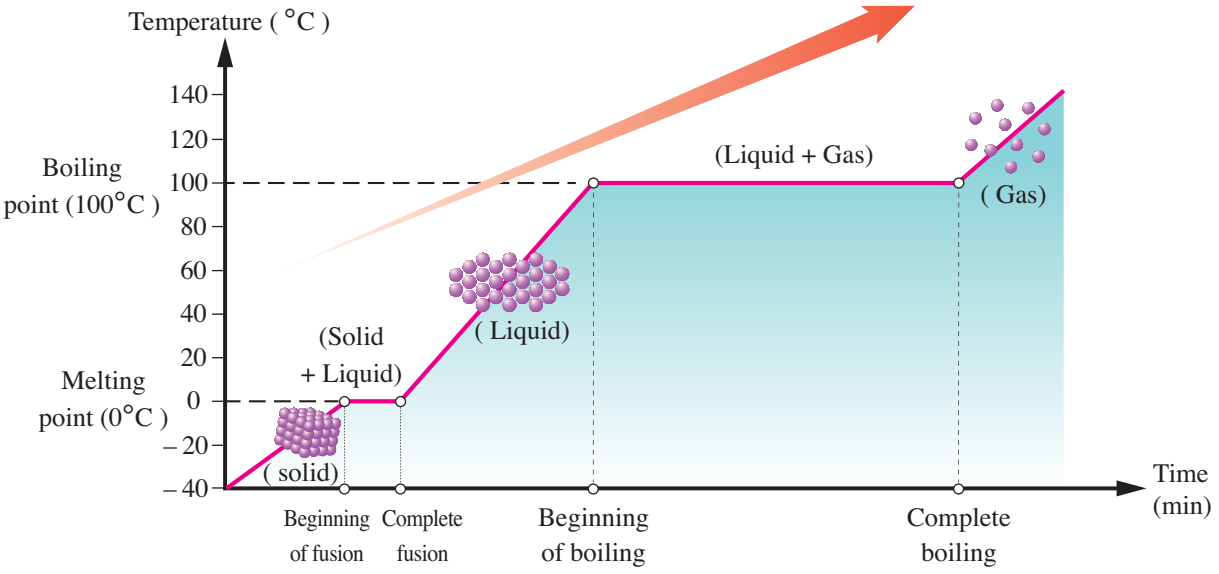


Figure (3)

Water heating curve

From graph (3), we can conclude the following :

- When ice gains a quantity of thermal energy, its temperature gradually rises till it reaches the melting point, which is equal to 0°C at normal atmospheric pressure.
- At the melting point, ice (solid) starts to turn into water (liquid), and the temperature remains constant till complete melting.
- As water continues to gain more thermal energy, its temperature gradually rises till it reaches its boiling point, which is 100°C at normal atmospheric pressure. The temperature of both the liquid water and its vapour remains constant till complete evaporation.

Explanation :

- When a substance in one of its physical states gains thermal energy, the kinetic energy of its particles increases, causing the temperature of the substance to rise (Figure 4).
- When a substance loses thermal energy in one of its states, the kinetic energy of its particles decreases, and therefore the temperature of the substance decreases.
- During the melting and boiling processes, the temperature of the substance remains constant, and the thermal energy which is gained by the substance weakens the attractive forces between the particles of the substance, so the substance converts from one physical state to another.

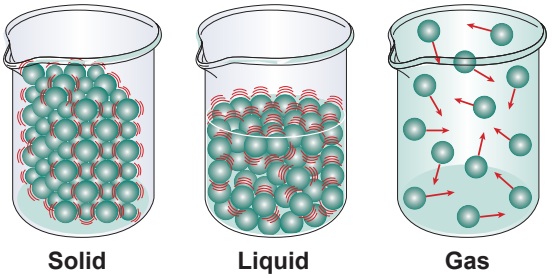


Figure (4)

The kinetic energy of particles increases when their temperature increases

Issue for Discussion

The impact of melting of the ice of the two poles on coastal cities.

Evaluate Your Understanding

From chart (1) :

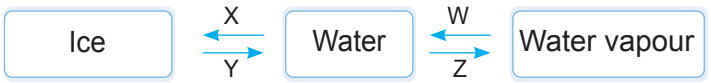


Chart (1)

Determine the two processes in which the kinetic energy of the particles of matter increases.

.....

Factors affecting the melting and boiling points of the substances

Each pure substance has fixed melting point and boiling point at normal atmospheric pressure, **which are affected by several factors, including :**

(1) Atmospheric pressure. (2) The degree of purity of the substance.

1 Atmospheric pressure

Atmospheric pressure affects the melting and boiling points of substances.

In case of water, as the atmospheric pressure on pure water increases higher than the normal pressure, its boiling point becomes higher than 100°C and its freezing point (the melting point of ice) becomes lower than 0°C

And as the atmospheric pressure decreases, (as on the mountains peaks) decreases lower than the normal pressure, the boiling point of water becomes lower than 100°C, where the temperature decreases by 1°C for every 300 m of altitude. (Table 2) shows some values of the boiling point of pure water at different altitudes above sea level.

'Note that the values are for illustration only'.

Table (2)

Elevation above sea level	Atmospheric pressure	Boiling point of pure water
0 m	1 atm	100°C
1800 m	0.8 atm	94°C
3000 m	0.69 atm	90°C
4800 m	0.56 atm	84°C

Technological **Application**

Pressure cooker (steam pot)

The pressure cooker (Figure 5) works by trapping water vapour (steam) inside it during cooking, which increases the pressure inside it.

As a result, the water boils at a boiling point higher than that in the regular pot, thus reducing the cooking time and helping to save fuel.

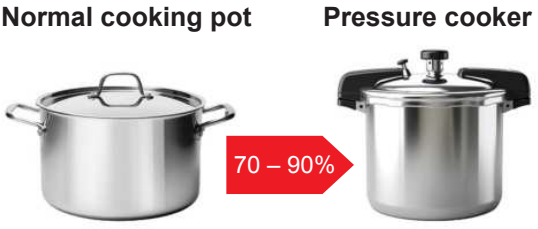


Figure (5)
The pressure cooker saves energy

2 Degree of purity of the substance

Impurities affect the attraction forces between the particles of a pure substance, which results in changing the amount of energy required to change its state, and thus changes both the melting point and boiling point of this substance.

The degree of the increase in the boiling point of the solution and the decrease in its freezing (melting) point depends on its concentration.

The purity of a substances is verified by comparing its melting point or boiling point with their fixed values in its pure state.

Mathematical Understanding

▶ When 180 g of glucose is dissolved in 1 litre (1 L) of distilled water to form a solution, the boiling point of this solution rises by 0.5°C, and its freezing (melting) point decreases by 1.86°C

Scientific Skills: Interpretation

Table (3) shows the boiling and melting points of three pure substances (X), (Y) and (Z):

Table (3)

Substance	(X)	(Y)	(Z)
Boiling point	84°C	125°C	315°C
Melting point	5°C	25°C	102°C

• **Identify the physical states of these substances at 100°C, with explanation.**

.....

.....

.....

.....

Conversions of The Matter are Reversible Processes

• You may notice water droplets found on a cold glass surface or dew on plant leaves in the early morning, where water vapour condenses when it loses heat due to contact with a cold surface and turns into liquid droplets (Figure 6).

Water also freezes in the freezer of the fridge when it loses heat (thermal energy) (Figure 7).

Figure (6)
Condensation of water vapour by heat loss

Figure (7)
Water freezing in the freezer of the fridge due to heat loss

• In **the melting process**, a solid substance gains a quantity of thermal energy either by heating or from the surrounding medium and converts to liquid state (Figure 8).

• In **the boiling process**, a liquid substance gains a quantity of thermal energy by heating and converts to gaseous state (Figure 9).

Figure (8)
Melting of ice cream by gaining thermal energy

Figure (9)
Boiling of water by gaining thermal energy

Are these two processes reversible?

The conversion of matter from one state to another is a reversible process. Melting and freezing processes are reversible processes, as are evaporation and condensation.

The conversion of a substance from one state to another is a physical change that is not accompanied by a change in the composition of its molecules or the formation of new substances. For example, water molecules (H_2O) do not break down into hydrogen and oxygen molecules when they change from one physical state to another.
In chemical changes, there is a change in the composition of the substance, and new substances are formed.

The conversions of matter can be illustrated in (Figure 10) :

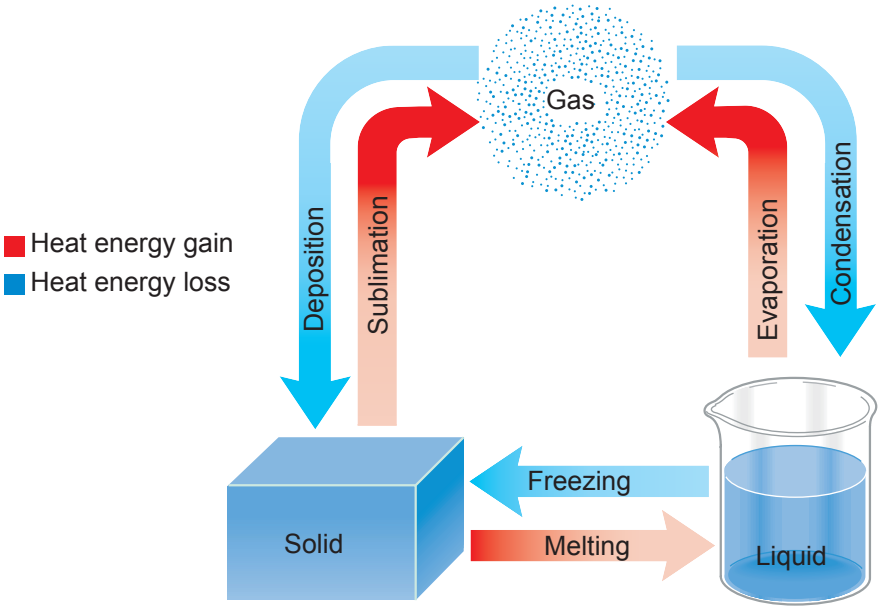


Figure (10)
Conversions of matter

Cross-Cutting Concepts : Cause and Effect

Loss of thermal energy of water vapour molecules in air (Cause),
leads to its condensation in the form of fog, dew or clouds (Effect).

The change of matter from the solid state to the gaseous state directly without passing through the liquid state is known as sublimation,
as in the sublimation of dry ice (Figure 11), which is carbon dioxide in its solid state and the sublimation of iodine element.
While the change of a substance from the gaseous state directly to the solid state without passing through the liquid state is known as deposition as in the formation of frost.

Figure (11)
Dry ice sublimation

Evaluate Your Understanding

Complete Table (4) based on your understanding of the change processes in the states of matter :

Table (4)

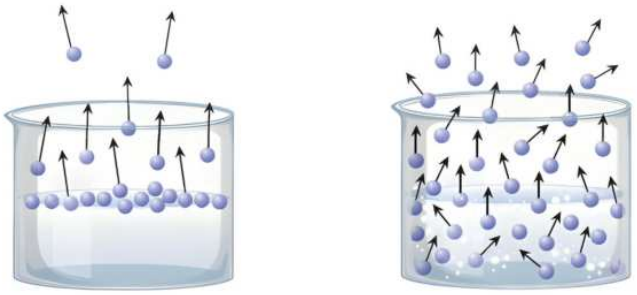
	Melting	Boiling	Condensation	Freezing
(1) Does the matter gain or lose thermal energy ?	.....	.....	.....	.....
(2) What happens to the attraction forces between the particles?	.....	.....	.....	.....
(3) What happens to the interparticle spaces?	.....	.....	.....	.....
(4) What state does matter change to ?	.....	.....	.....	.....

Boiling and Evaporation

- In the boiling process, the liquid turns into vapour at a certain temperature called the boiling point, at which point the bonds between the molecules of the liquid break down.
  You can notice that leaving wet clothes exposed to the air makes them dry without reaching the boiling point (Figure 12).

Figure (12)

- Water evaporates at temperatures less than its boiling point. The molecules of the surface of water evaporate without forming air bubbles, as these molecules gain thermal energy from the surrounding medium that enables them to overcome the attractive forces of other water molecules, escape into the air, and converts to the gaseous state (Figure 13).



Evaporation process Boiling process

Figure (13)

Factors Affecting the Rate of Evaporation of Liquids

Activity 2 Compare

Figure (14) – (17) show different cases of water evaporation under different conditions.

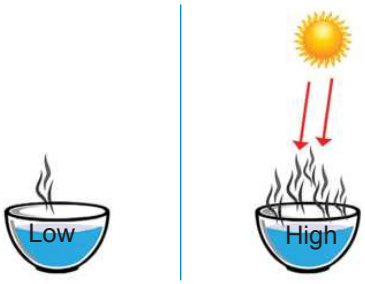
Cumulative knowledge

- **Controlled variable :** A factor that remains constant during an experiment.
- **Independent variable (cause) :** The factor that is changed during the experiment.
- **Dependent variable (effect):** The factor that changes depending on the independent variable.

1 Identify the factor affecting the rate of water evaporation in each case in terms of its illustrative figure :

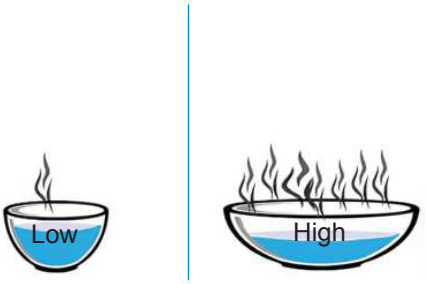
- Figure (14): .....
- Figure (15): .....
- Figure (16): .....
- Figure (17): .....

2 Identify the variables in the four cases shown in the following figures.



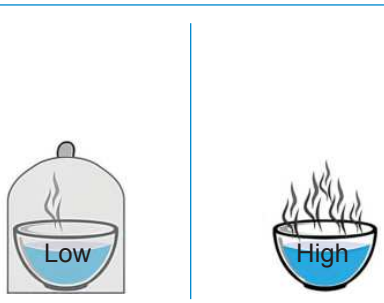
Increased temperature increases the rate of evaporation
Figure (14)

.....



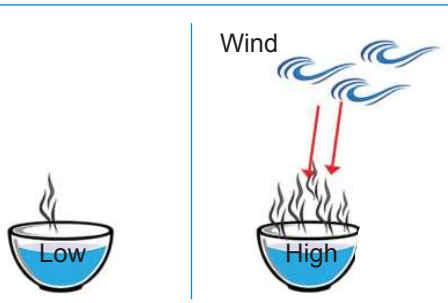
Increasing the surface area of the liquid increases the rate of evaporation
Figure (15)

.....



Increased humidity reduces the rate of evaporation
Figure (16)

.....



Air currents increase the rate of evaporation
Figure (17)

.....

It is clear from the previous that:

The rate of evaporation increases when :

- Temperature increases, because the kinetic energy of molecules increase, thereby increasing the number of molecules that have sufficient energy to escape from the surface of the liquid.
- The surface area of the liquid exposed to air increases, as the number of molecules that can gain heat energy from the surrounding medium increases and be released from the surface of the liquid.
- The humidity (water vapour found in the air) decreases.
- Air currents increase.

Evaluate Your Understanding

According to your understanding to the factors affecting the rate of evaporation, Explain the following :

1. Wet clothes dry faster during the day when the Sun is shining than at night.

.....

2. Feeling uncomfortable in hot, humid weather. .....

Integration with Hydrology (Science of studying water)

The change of water from one state to another, such as evaporation, condensation, freezing, and melting, are fundamental processes in the water cycle in nature.
The water cycle in nature directly affects many weather factors (Figure 18).

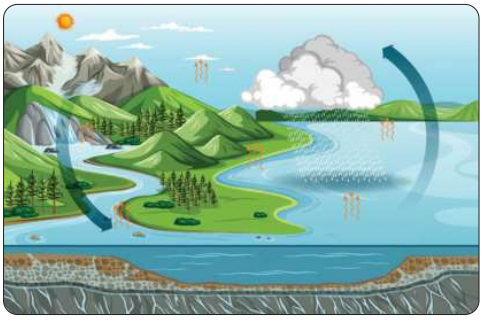


Figure (18)
The Water Cycle in Nature

Technological Application

Instant coffee

Instant coffee is named as such because it dissolves quickly in water compared to regular coffee. It is manufactured by exposing sprayed concentrated coffee extract to extremely hot dry air (around 250°C),where the increase in the surface area of the spray droplets exposed to hot air increases the rate of evaporation and the formation of solid instant coffee crystals.

Figure (19)
Instant coffee

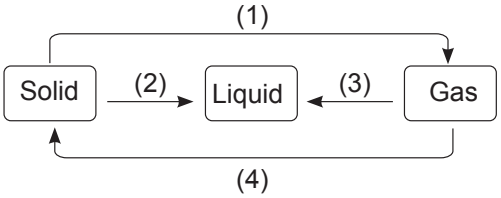
Research Activity

Search multiple sources of knowledge, including the Internet and your school library, for practical applications of boiling and condensation processes in obtaining different products from the fractional distillation of crude petroleum (oil) and the uses of each of these products.

Evaluation Questions on Lesson Two

1 **Choose the correct answer for questions (1) – (3).**

(1) In the following chart :



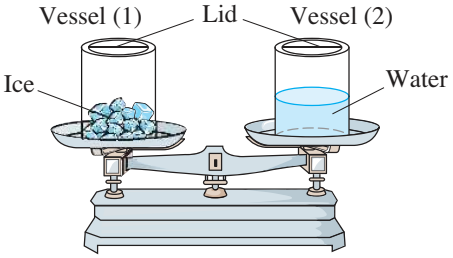
Which of the following represents the process of sublimation ?

(a) (1) (b) (2) (c) (3) (d) (4)

(2) The same change in physical state occurs in the processes of .....

(a) boiling and condensation.
(b) boiling and evaporation.
(c) freezing and condensation.
(d) freezing and evaporation.

(3) The experiment shown in the following figure was conducted :



The two pans of the balance were equal at the beginning of the experiment, After several minutes, the pan holding the vessel (1) moved down, because .....

(a) the ice cubes in the vessel (1) melted.
(b) the water in the vessel (2) evaporated.
(c) condensation of water vapour inside the vessel (2).
(d) condensation of water vapour outside the vessel (1).

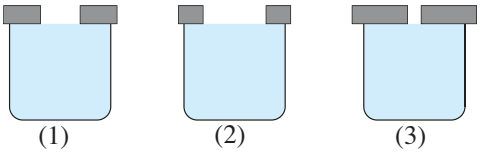
2 **Compare between** the processes of evaporation **and** boiling in two points.

3 **The following table shows the physical state of four substances at different temperatures :**

The substance	At 30°C	At 50°C	At 90°C
(W)	Liquid	Gas	Gas
(X)	Solid	Liquid	Gas
(Y)	Solid	Solid	Liquid
(Z)	Liquid	Liquid	Gas

Which substance(s) has a boiling point greater than 50°C? Explain your answer.

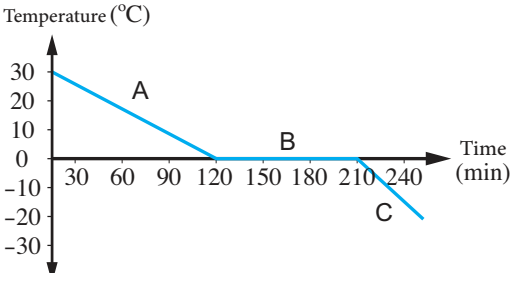
4 **The vessels shown in the figure below contain equal quantities of water :**



(1) Why does the quantity of water in the three vessels decrease after several hours ?

(2) Which of these vessels will contain the least amount of water after several hours ? Explain your answer.

5 **The following graph shows the change in temperature of a quantity of water over time :**



Identify the letter(s) of the parts of the curve at which heat is lost, **with explanation.**

Lesson **Three**

Internal Energy and Temperature

Lesson Terminology :

- System.
- Heat.
- Temperature.
- Internal Energy.
- Specific Heat

Included Skills, Value, and Issues :

- **Skills** : Sorting - Practical practices.
- **Value** : Self-protection.
- **Issues** : Human activity and global warming.

Cross-Cutting concepts:

- System and its models.

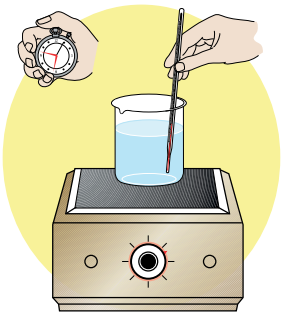
Lesson Objectives :

By the end of the lesson, the student should be able to :

1. Understand the concept of systems and their types.
2. Understand the concept of temperature.
3. Identify the factors that affect the quantity of change in temperature of a substance.

Lesson Preparation :

The shown figure illustrates the process of heating a sample of water in a beaker. This lesson explores ideas that help you answer these questions :



- Why is the beaker of water described as an open system ?
- What is the relationship between the heating time and the quantity of heat that gained by water ?
- What is the difference between the concepts of heat and temperature ?

The concept of a system

• **A system** is any part of the universe that is under study, where changes in energy and matter are observed.

Each system has boundary that distinguishes it from the surroundings.

• The matter in a system may be solid, liquid, gas, or a mixture of them.

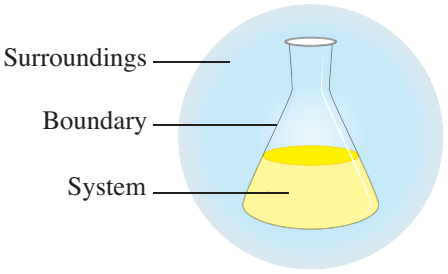


Figure (1)
System

The system may be :

An open system in which both energy and matter are exchanged with the surroundings or **a closed system** in which only energy is exchanged with the surroundings while matter is not exchanged, or **an isolated system** in which neither energy nor matter is exchanged with the surroundings.

Activity 1 Classify

Figures (2) - (4) represent different systems:

Figure (2)

Figure (3)

Figure (4)

Fill in the blanks of (Table 1) to classify these systems according to their types (open, closed or isolated), **and state the reason for the classification:**

Table (1)

System	Type of system	Reason for classification
1- Open container containing boiling water (Figure 2)	.....	.....
2- Soft drink can placed in ice (Figure 3)	.....	.....
3- Thermos flask containing a hot drink (Figure 4)	.....	.....

The Concept of Temperature

- According to the particle theory of matter, systems are composed of particles, each of which has kinetic energy and potential energy, the summation of these two energies is known as **internal energy of the system**, the internal energy of the system increases with increasing the kinetic energy of its particles, or their potential energy, or both of them.
- The potential energy of solid particles is the highest, while the potential energy of gas particles is almost zero.
- **Temperature of a system**, simply represents how **hot** or **cold** the system is, and is considered a measure of the average kinetic energy of its particles.

Mathematical understanding

- The average of several values (in mathematics) equals one of these values, if they were all equal.
- The average kinetic energy of the particles in a system is equal to the kinetic energy of a single particle if the kinetic energies of all particles were equal.
- Average kinetic energy of particles = $\frac{\text{Total kinetic energy of all particles}}{\text{Number of particles}}$
- Internal energy of the system = Kinetic energy + Potential energy (for all particles)

- An increase in the average kinetic energy of the particles in the system leads to an increase in its temperature, so hot water particles have a higher average kinetic energy than in cold water particles.

If we assume that the kinetic energies of all particles are equal, then the temperature of this substance or system is a measure of the kinetic energy of one of the particles.

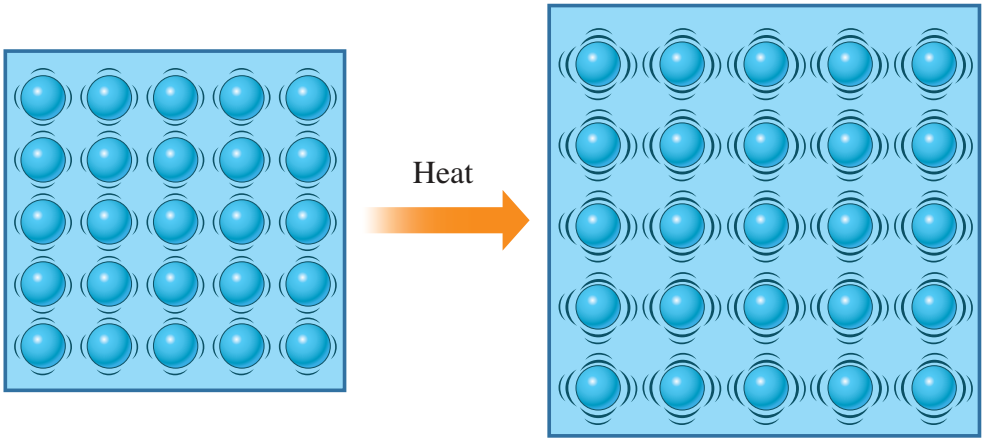


Figure (5)

The internal energy of a solid system increases when it gains thermal energy

Cross-Cutting Concepts : System and its models

Matter is a system containing molecules, the change in its internal energy affects its temperature.

Evaluate Your Understanding

1 Use the following concepts to complete the statements below :

Speed of particles	Internal energy	Quantity of heat	Kinetic energy of particles	Temperature

(1) When water is heated in a beaker, it gains .....

(2) ..... that form water increases, and therefore, the ..... increases.

(3) ..... of water increases, when the ..... increases.

2 Figure (6) shows two containers containing two different masses of water at the same temperature.

Mark (✔) for the property they have in common :

(1) Number of particles. ( )

(2) Average kinetic energy of particles. ( )

(3) Internal energy. ( )

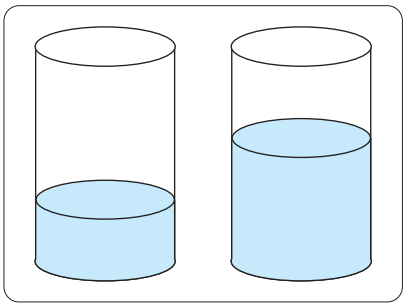


Figure (6)

Factors affecting the change in temperature of objects

• Heat transfer from or to an object (system) can be indicated from the change in its temperature, gaining heat by an object or system raises its temperature, while losing heat lowers its temperature.

So ... What are the factors which affect the amount of change in temperature of an object (system) when it gains or loses a quantity of thermal energy ?

1 Mass of the substance

Activity 2 Practical

Materials and Tools Used:

- Two different masses of water in two beakers (A) and (B).
- Two thermometers.
- A heat source (flame).
- Holder.
- Stopwatch.

Steps :

1. Use the thermometer to measure the temperature of water in each beaker (Figure 7).
2. Make the flame steady, in order for the heating time to become a measure for the quantity of heat gained by the water.
3. Heat all beakers for the same period of time.
4. Record the thermometer reading in each beaker in Figure (8).

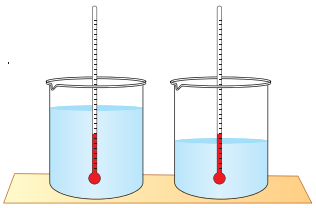


Figure (7)

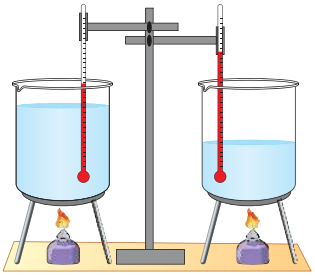


Figure (8)

What do you observe ?

- In beaker (A) : .....
- In beaker (B) : .....

Laboratory safety precautions

- Safety and security rules must be observed when handling heat sources.
- Heating activities should be carried out under the supervision of a teacher.

Conclusion :

The amount of the change in temperature of different masses of the same substance varies when they gain or lose the same quantity of the thermal energy.
The change in temperature of the substance increases as its mass decreases, where the thermal energy gained by substance is distributed over fewer particles, so the average kinetic energy increases by a greater extent.

Evaluate Your Understanding

(Figure 9) shows four beakers containing different quantities of water at different temperatures. Four metallic blocks of equal masses and temperature (80°C) were placed in them.

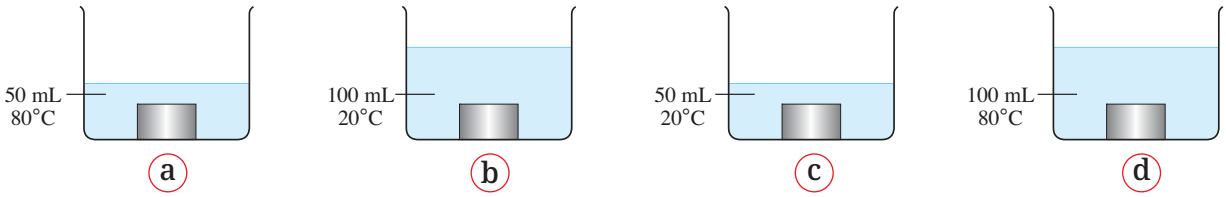


Figure (9)

In which of these beakers is the temperature of water greater ? **Explain your answer.**

.....

2 Type of the substance

Activity 3 Practical

Materials and tools used

- Two equal masses of water and oil in two beakers (A) and (B).
- Two thermometers.
- A heat source (flame).
- Holder.
- Stopwatch.

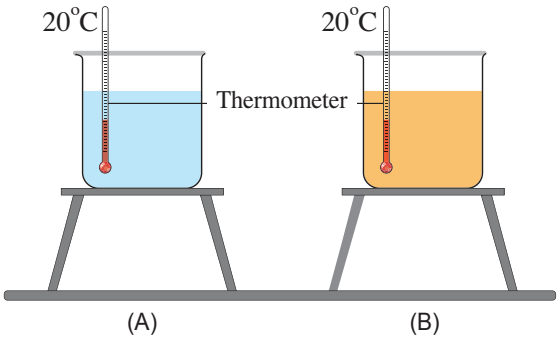


Figure (10)

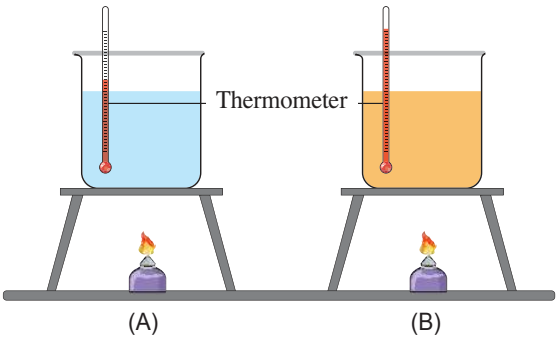


Figure (11)

Steps :

1. Use the thermometer to measure the temperature of each of water and oil (Figure 10).
2. Make the flame steady, in order for the heating time to become a measure for the quantity of heat gained by each of water and oil.
3. Heat the water and oil for the same period of time.
4. Record the thermometer readings for both the water and the oil (Figure 11).

What do you observe?

- In beaker (A) : .....
- In beaker (B) : .....

5. **Identify the following from the experiment :**
   - The independent variable : .....
   - The dependent variable : .....
   - The controlled variable : .....

Conclusion :

- The amount of the change in temperature varies for equal masses of the different substances, when they gain or lose the same quantity of thermal energy.

Temperature of a mass of oil rises by a greater extent than an equal mass of water when they gain the same quantity of thermal energy.

Evaluate Your Understanding

You have two equal masses of water and oil at 20°C, they were heated by **a uniform** heat source.

Which of these two liquids takes longer time to reach 60°C? Explain.

.....

3 State of the substance

Activity 4 Practical

Materials and tools used

- Two equal masses of water and ice.
- A heat source (flame).
- Holder.
- Two thermometers.
- Stopwatch.

Steps :

1. Use the thermometer to measure the temperature of water and ice.
2. Make the flame steady, in order for the heating time to become a measure for the quantity of heat gained by each of water and ice.
3. Heat the water and the ice for the same period of time (figure 12).
4. Record the thermometer readings for both water and ice.

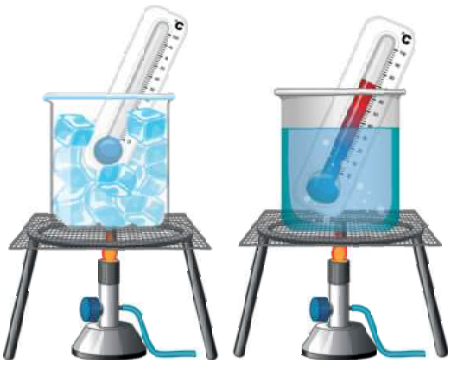


Figure (12)

What do you observe?

.....

5. **From the experiment, identify each of the following :**

- The independent variable : .....
- The dependent variable : .....
- The controlled variable : .....

Conclusion :

- The amount of the change in temperature of equal masses of different states of the same substance varies when they gain or lose the same quantity of thermal energy. The increase in the temperature of a mass of ice is greater than the increase in the temperature of an equal mass of water when they gain the same quantity of thermal energy.

The quantity of heat required to raise the temperature of 1 kilogram of a substance by 1°C **is called specific heat.** Table (2) shows the approximate values of specific heat for some substances. **These values are for illustration only:**

Table (2)

The substance	Mercury	Copper	Iron	Aluminum	Corn oil	Ice	Water
Specific heat (J/kg°C) (at room temperature)	140	385	450	900	2000	2090	4180

Evaluate Your Understanding

From Table (2):

1. **Which substance requires the greatest quantity of heat** to raise the temperature of 1 kilogram of it by 1°C?

.....

2. **Which is better thermally** for making heating utensils... Copper **or** aluminum? **Explain your answer.**

.....

3. **Why** is mercury used in the manufacture of thermometers?

.....

4. **Why** does water make up such a large percentage of the human body?

.....

Life Application

Water is an excellent cooling liquid because of its high specific heat, it absorbs large quantities of heat energy without a significant increase in its temperature, so it is used in the cooling system connected to car engines, known as **the radiator** (Figure 13) to protect them from damage.

Figure (13)
Radiator

Evaluation Questions on Lesson Three

1 Choose the correct answer for questions (1) - (3).

(1) The internal energy of water increases when .....

(a) the temperature of water changes from 70°C to 60°C

(b) water vapour condenses on a plant leaf.

(c) a quantity of water is heated from 20°C to 30°C

(d) it is placed in a refrigerator.

(2) Four equal masses of different metals, (at 25ºC), were heated for 10 minutes using the same heat source.
The temperature of each metal is recorded in the following table :

Metal	(1)	(2)	(3)	(4)
Temperature after heating	59°C	62°C	55°C	70°C

Which of these metals is best used in the manufacture of cookware that can withstand high temperatures ?

(a) (1)

(b) (2)

(c) (3)

(d) (4)

(3) What are the tools used to find the specific heat of a substance?

(a) Balance and stopwatch.

(b) Balance and thermometer.

(c) Stopwatch and thermometer.

(d) Balance, stopwatch and thermometer.

2 Compare between two equal masses of asphalt and water exposed to the Sun for the same period of time, in terms of:

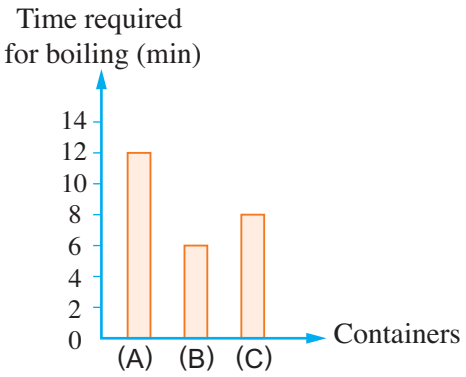
(1) Internal energy.

(2) Temperature.

3 Does the relative stability of sea water temperature mean that it does not absorb heat energy ? Explain.

4 Slowly pumping air into a car tyre does not raise the temperature. Does the average kinetic energy of the air molecules inside the car tyre increase or remain unchanged ? Explain.

5 Three different quantities of water were heated in three identical containers. The graph below shows the time taken by each quantity to reach boiling point:



(1) Which of these containers contains the least amount of water ?

(2) What is the independent variable and what is the controlled variable in this experiment ?

Lesson **Four**

Methods of Heat Transfer

Lesson Terminology :

- Conduction.
- Thermal Conductivity.
- Convection.
- Sea Breeze.
- Radiation.
- Electromagnetic Waves.
- Infrared Rays.
- Thermography.

Included Skills, Value, and Issue :

- **Skills :** Practical practices - Observation - Interpretation.
- **Value :** Collaboration.
- **Issue :** Thermal insulation of buildings.

Cross-Cutting Concepts :

- Cause and Effect.

Lesson Objectives :

By the end of the lesson, students should be able to :

1. Practically identify the methods of heat transfer (conduction, convection, and radiation) from or to an object.
2. Describe the applications of conduction, convection, and radiation in heating and cooling processes using common examples.

Lesson Preparation :

- **The figure represents different methods of heat transfer. This lesson explores ideas that will help you answer the following questions:**
- What is the method of heat transfer in (1) and (2) ?
- What is the state of the matter in which heat is transferred with method (2) ?
- What is the difference between methods (1) and (3) of heat transfer ?

Heat transfer

When a cup containing a hot drink (its temperature is 70ºC) is placed in a room at a temperature of 25ºC (Figure 1) The drink cools quickly.

What is the reason for this?

Figure (1)

Activity 1 Practical

Materials and Tools Used :

- 2 glass beakers.
- Tap water.
- Heat source.
- Thermometer.
- Metal block suspended by a string.

Steps :

1. Put tap water in beaker (1) and measure its temperature using the thermometer.
2. Heat another quantity of tap water in beaker (2) till boiling.
3. Immerse the metal block in the boiling water in beaker (2).
4. Predict the direction of heat transfer.

   .....

5. Transfer the metal block from the boiling water in beaker (2) to the cold water in beaker (1), (Figure 2).
6. Predict the direction of heat transfer.

   .....

7. Measure and record the temperature of the water in beaker (1) after placing the metal block in it.

   What do you observe ?

   .....

8. Is your observation matching your prediction? .....

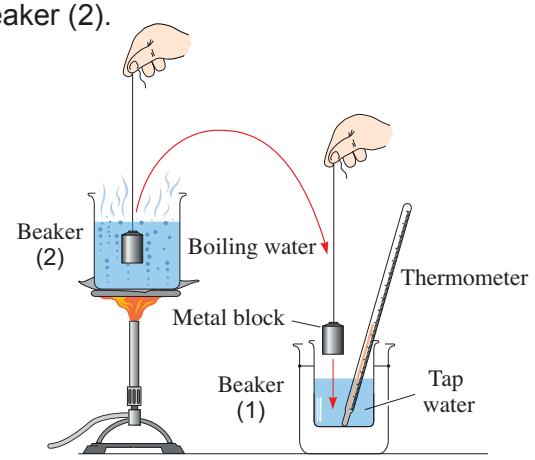


Figure (2)

Conclusion :

- When two non-isolated systems with different temperatures come into contact, energy is transferred from the system with the higher temperature to the system with the lower temperature.
- The energy that is transferred from one system to another due to their difference in temperature is called heat (thermal energy).
- Heat continues to **transfer (flow)** between the two systems till they reach the same temperature, **i.e.,** they reach thermal equilibrium.

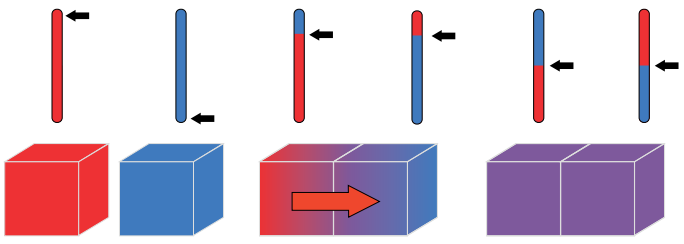


Figure (3)

Heat continues to flow when in contact until thermal equilibrium is reached

Evaluate Your Understanding

From Figure (4):

(1) In which of the three cups is the average kinetic energy of the water molecules the highest ? **Explain your answer.**

.....

(2) Choose : What is the possible temperature of the water in cup (C) ?

(a) 28ºC (b) 30ºC

(c) 55ºC (d) 110ºC

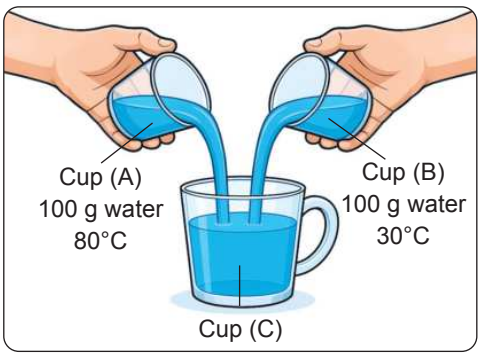


Figure (4)

Cross-Cutting Concepts : Cause and Effect

When two objects with different temperatures come into contact (Cause), Heat is transferred from the object with the higher temperature to the object with the lower temperature (Effect).

Methods of heat transfer

Heat is transferred by three methods: (1) **Conduction.** (2) **Convection.** (3) **Radiation.**

First Heat transfer by conduction

Activity 2 Observe and Explain

Steps :

(1) Put three different spoons in a beaker of boiling water, one made of metal, one made of wood, and one made of plastic (figure 5).

(2) Carefully touch the tip of each spoon after one minute of placing it in the water. Which spoons feel hot when touched?

.....

(3) How do you explain this heat transfer based on the particle theory of matter?

.....

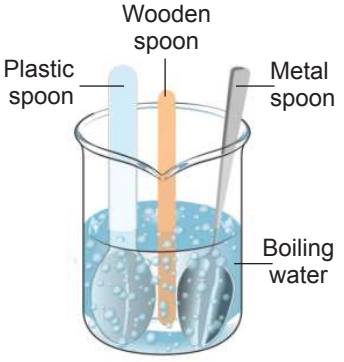


Figure (5)

- Heat is transferred through solid objects along the length of the object from one point to another or from the object with the higher temperature to the object with the lower temperature (figure 6). This method is known as thermal conduction.

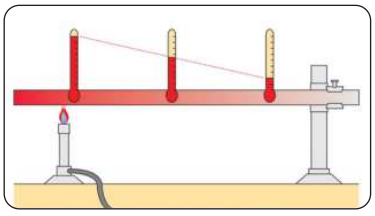


Figure (6)

Heat transfer by conduction

Explanation of heat transfer by conduction

- When one end of a metal rod is heated, the average kinetic energy of its particles increases, causing them to vibrate to a greater extent.

Some of the energy of these particles is transferred when they collide with neighbouring particles, which increases the kinetic energy of these neighbouring particles, and in the same manner, part of the energy is transferred to the next particles, without the particles moving from their position (Figure 7).

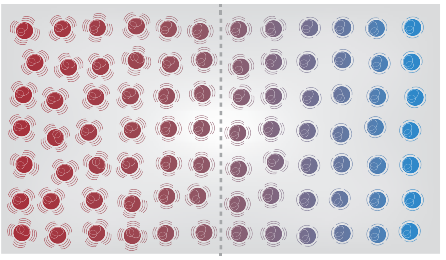


Figure (7)
Heat transfer by particle vibration

Activity 3 Practical

Materials and Tools Used :

- Two iron and copper rods of the same dimensions.
- Metal pins.
- Two holders.
- Wax.
- Heat source.
- Stopwatch.

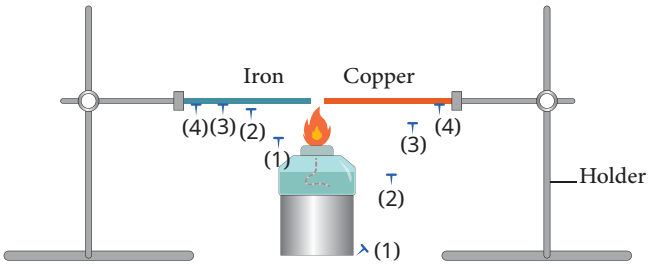


Figure (8)

Steps :

1. Hang both of the two rods horizontally on the holders.
2. Use wax to attach the pins to each rod at equal distances.
3. Place the heat source under each end of the rods (figure 8).
4. Record the time (in seconds) it takes for each pin to fall from the moment the flame is lit in Table (1).

Table (1)

Time required for a pin to fall (s) / Number of the pin	(1)	(2)	(3)	(4)
From iron rod	.....	.....	.....	.....
From copper rod	.....	.....	.....	.....

Conclusion :

.....

Thermal conductors and thermal insulators

Thermal conductivity is a measure for the extent to which a substance can conduct heat through it, the substances differ in their thermal conductivity. Metals are good conductors of heat and are called thermal (heat) conductors. substances with very low thermal conductivity, such as wood and plastic, are considered poor conductors of heat and are called thermal insulators.

Integration with Mineralogy (Studying metals)

Diamond (Figure 9) is the best thermal conductor among the natural elements, followed by silver then copper.

Figure (9)

Life Applications

1. Cooking utensils are made of metals due to their high thermal conductivity, while their handles are made of plastic or wood because of their low thermal conductivity (Figure 10).

Figure (10)

2. It is preferable to use thermal insulators,such as polystyrene panels between hollow clay bricks during constructing the building walls (Figure 11).This prevents rapid changes in temperature inside the buildings when the outside temperature changes, which reduces the cost of air conditioning inside the buildings.

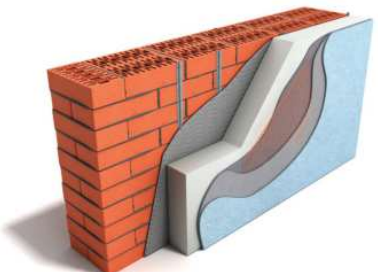


Figure (11)
Wall insulation

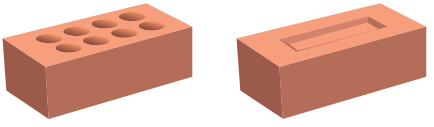
3. Electronic devices such as computers (Figure 12) and smartphones have cooling systems that use good thermal conductors such as silver to dissipate the heat generated in the internal components, which may lead to poor performance or even damage.

Figure (12)

Evaluate Your Understanding

Imagine that you are working as an engineer.
Which one of the two types of clay bricks shown in Figure (13) would you prefer to use in the construction of the exterior walls of the building, bearing in mind that the thermal conductivity of clay is approximately 20 times that of air. Explain your answer.

.....



(A) (B)

Figure (13)

Issue for Discussion

The economic and environmental effects of thermal insulation in buildings.

Second Heat transfer by convection through convection currents

Have you ever noticed an eagle flying high in the air without flapping its wings? (figure 14)

Any object floating in the air needs what supports its presence in the air, which equals the force of Earth's gravity that pulls it downwards.

The eagle remains flying in the air like this thanks to warm air currents rising from the Earth's surface, called convection currents.

Figure (14)

Activity 4 Practical

Materials and Tools Used :

• Water. • Potassium permanganate. • Beaker. • Flame.

Steps :

1. Place a beaker containing a quantity of water over the flame.
2. Drop a crystal of purple potassium permanganate into the beaker.
3. What do you observe during the heating process (Figure 15) ?

.....

Figure (15)

Explanation of convection currents :

• When a container of water is placed on a heat source, the water particles at the bottom of the container gain thermal energy, they move faster and further away from each other, resulting in decreasing the density of the hot water, which rises to the top. At the same time, the cold water which has higher density sinks to the bottom to replace the hot water.

Heat transfer by this method is known as convection currents, which occurs with the movement (the currents) of liquid and gaseous (fluids) particles. (Figure 16).

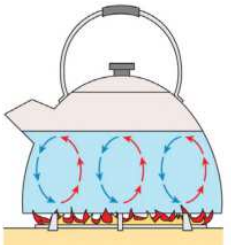


Figure (16)
Convection currents

Life Applications

1. The space heater is placed on the floor of the room.

Heat is transferred from the space heater to the air around it, causing the warm air to rise and the cold air to descend to replace the warm air. and thus the heat is distributed throughout the room (Figure 17).

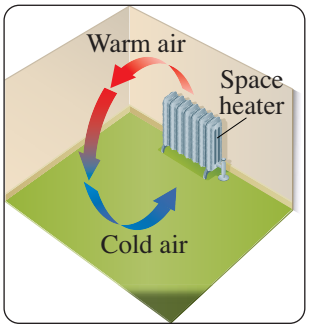


Figure (17)

② Sea breeze :

A natural phenomenon that occurs because the temperature of land rises faster than the temperature of water during the day, as the specific heat of land is lower compared to that of water. So, the air in contact with land heats up more than the air above the surface of the water. The air above the surface of the land becomes of lower density (lighter) and rises to be replaced by cooler air from the sea, forming what is known as sea breeze (Figure 18). The effect of this phenomenon is more perceptible (can be felt) in summer than in spring or autumn.

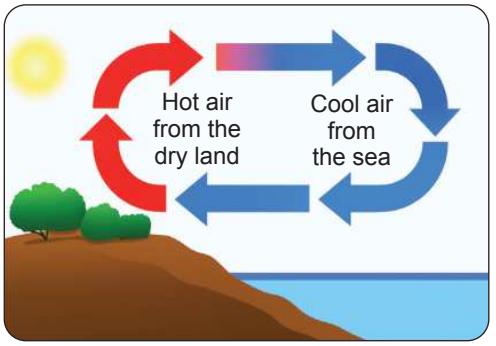


Figure (18)
Sea breeze

Evaluate Your Understanding

From (Figure 19):

① **How does heat transfer from the heater to each of the following :**

(1) Object (X) : .....

(2) Object (Y) : .....

② **Which of the two objects (X) and (Y)** its particles have greater average kinetic energy?

.....

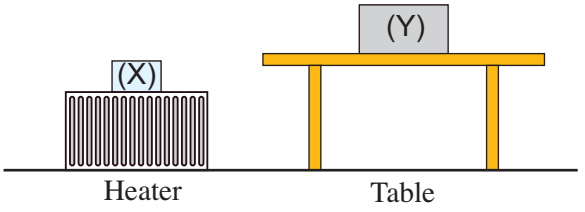


Figure (19)

Third Heat Transfer by Radiation

Heat is transferred by conduction and convection methods, through the particles of matter. However, **have you** ever thought about how heat is transferred from the Sun to Earth's surface despite the millions of kilometres of empty space between them? (Figure 20)

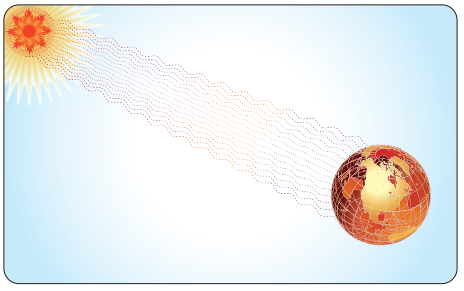


Figure (20)
Transfer of heat from the Sun to the Earth by radiation

Solar radiation consists of electromagnetic waves that travel through space at very high speed, reaching 300,000 km/s in all directions. Some of these waves are visible, such as light, and some are invisible, such as infrared rays, which have a thermal effect.

When substances absorb infrared rays, their temperature rises, which is why you feel warm when you are exposed to the solar radiation.

Hot objects are also sources of infrared radiation, opaque dark objects can absorb infrared radiation better than light-colored objects or shiny objects, which is why firefighters wear shiny silver clothing, while the pipes of the solar heaters are painted black.

Technological Application

Thermographic camera is a camera (device) that can detects the thermal radiation emitted by objects (infrared rays) and converts it into coloured images, these colours depend on changes in the temperature of the object (Figure 21).

These cameras are used for imaging in the dark and for detecting the temperature of objects.

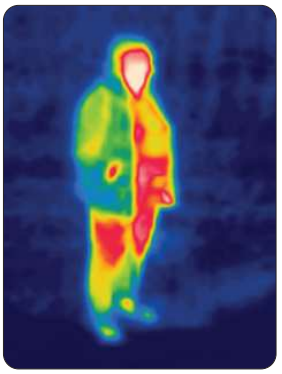


Figure (21)
Thermal imaging

Integration with Biology

Snakes are able to hunt their prey at night because they have sensory receptors at the front of their heads which enable them to detect infrared rays emitted by their prey (Figure 22).

Figure (22)

Evaluate Your Understanding

From Figure (23), identify the methods by which heat is transferred indicated by numbers (1) - (3).

(1) : .....

(2) : .....

(3) : .....

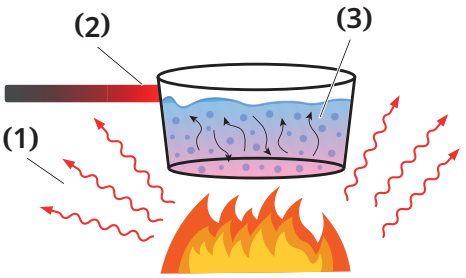


Figure (23)

Evaluation Questions on Lesson four

1 Choose the correct answer for the questions (1) - (5).

(1) When a tray of pies is removed from the oven and placed on a metal surface, ...

(a) the pie absorbs heat from the tray.
(b) the heat is transferred from the tray to the surrounding air only.
(c) heat is transferred from the pie to the air and the tray.
(d) heat is transferred from the tray to the air and the metal surface.

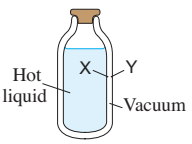
(2) A lemon drink its temperature is 20ºC was placed with a cube of ice, and after two minutes, the temperature of the drink became 8ºC, the temperature of the remaining part of the ice cube was .....

(a) 0ºC (b) 2ºC (c) 4ºC (d) 8ºC

(3) What happens to the cold air outside a kettle when it comes into contact with its hot outer surface?

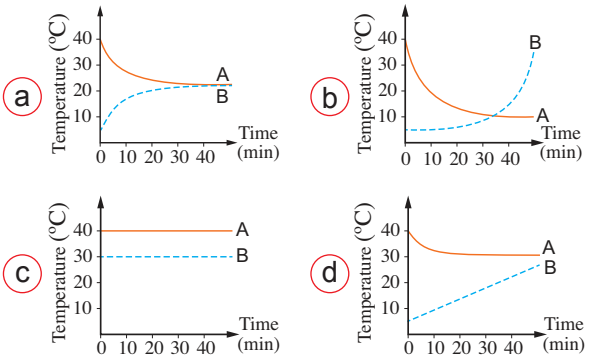
(a) Its density decreases and it sinks downwards.
(b) Its density decreases and it rises upwards.
(c) Its density increases and it sinks downwards.
(d) Its density increases and it rises upwards.

(4) The opposite figure shows a thermos flask with two walls X and Y, containing a hot liquid. Which of the following is correct?

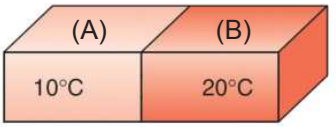


(a) Heat is transferred from X to Y by conduction and convection.
(b) Heat is transferred from Y to X by conduction only.
(c) Heat is transferred from X to Y by radiation only.
(d) Heat is transferred from Y to X by radiation and convection.

(5) (A), (B) are two equal quantities of water, temperature of (A) is 40ºC and that of (B) is 5ºC. Which of the following graphs shows the change in temperature when they are mixed together?



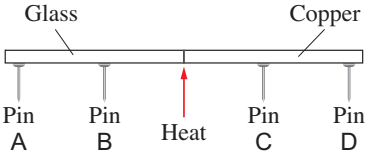
2 From the following figure :



(1) When does the thermal equilibrium occur between the two objects (A) and (B), which are made of the same material and have the same mass?

(2) What is the expected temperature of the two objects when thermal equilibrium occurs?

3 The following figure shows four pins fixed with wax in two copper and glass rods that are heated by a single heat source.



Which pin will fall first? Explain your answer.

4 Give reasons for the following :

(1) The concept of heat is different from the concept of temperature.

(2) Placing polystyrene panels between the bricks of the walls.

UNIT 2

Matter and Chemical Reactions

The lessons

Lesson one : Chemical Reactions

Lesson two : Chemical Equations

Lesson three : Nutritional Chemistry

Learning Outcomes :

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

1. Recognize the mechanism of chemical reactions.
2. Deduce the occurrence of chemical reactions from laboratory observations.
3. Analyze and explain information related to the properties of substances before and after the reaction, by giving examples of reactions involving the burning of sugar or the reaction of fats with sodium hydroxide in soap making.
4. Design models at the molecular level for some molecules, including drawings, three-dimensional structures represented by balls and sticks, or computer representations showing different molecules composed of different types of atoms (or using open source software) such as ChemSketch and ChemDraw.
5. Build a simple balanced chemical equation using words and chemical symbols, using the given molecular formulas.
6. Design and use a model to describe that the total number of each type of atoms in a chemical reaction is constant and does not change, in accordance with the law of conservation of matter (conservation of mass).
7. Recognize the importance of carbohydrates and proteins as natural chemicals in nutrition and industry.

Lesson **One**

Chemical Reactions

Lesson Terminology:

- Physical Change.
- Chemical Change.
- Chemical Reaction.
- Reactants.
- Products.

Included Skills, Values, and Issue :

- **Skills** : Practical practices - Analysis - Interpretation - Observation - Conclusion.
- **Values :** Collaboration - Rationalizing consumption.
- **Issue** : Health awareness.

Cross-Cutting Concepts :

- Cause and Effect.

Lesson Objectives :

By the end of the lesson, the student should be able to :

1. Understand the concept of chemical reactions.
2. Understand the mechanism of chemical reactions.
3. Conclude evidence of chemical reactions.
4. Explain the properties of substances before and after a chemical reaction.
5. Give real-life examples of chemical reactions.

Lesson Preparation :

The figure here shows the change of the colour of a piece of meat after cooking.

This lesson explores ideas that help you answer these questions :

- Why does the colour and texture of meat change after cooking ?
- What can you conclude from the smells that accompany the cooking process?
- Is cooking meat simply mixing components, or does it involve irreversible changes ? Why ?

From your previous study, you learned the difference between physical changes and chemical changes:

- A physical change is a change in the state or shape of a substance without changing its chemical composition,such as the melting of ice (Figure 1).
- Chemical change is a change that results in new substances with different chemical properties from those of the original substances, such as the combustion of wood (Figure 2). This change occurs when the original substances react chemically to make new compounds.

What is a chemical reaction?

How can we tell when it occurs (detect its occurrence) ?

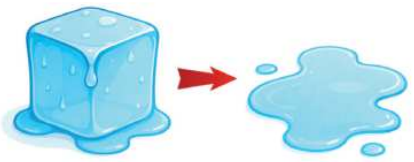


Figure (1)
Melting of ice

Figure (2)
Wood combustion

The Concept of Chemical Reaction

Activity 1 Practical

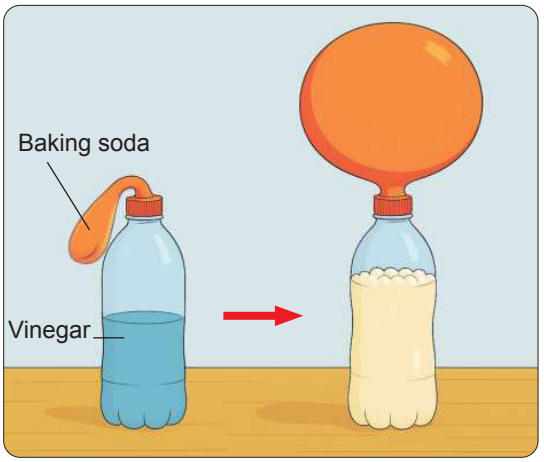
Materials and Tools Used :

- Baking soda (sodium bicarbonate).
- Vinegar (dilute acetic acid).
- Empty bottle.
- Balloon.
- Spoon.

Steps :

1. Put two tablespoons of baking soda in the balloon.
2. Put a quantity of vinegar in the bottle.
3. Secure the balloon opening over the mouth of the bottle tightly, taking care not to spill any baking soda from the balloon.
4. Lift the balloon and let the baking soda fall into the vinegar below (Figure 3).

   What do you observe?



Figure(3)
The reaction of vinegar with baking soda

.....

5. What happens to the balloon?

.....

6. Is a new substance formed?

.....

7. Is this change physical or chemical? Why?

.....

It can be concluded from the previous that :

- A chemical reaction occurrs between baking soda (sodium bicarbonate) and vinegar (dilute acetic acid) causing effervescence and the evolution of carbon dioxide gas.

A chemical reaction is defined as the process of breaking the bonds between atoms of the reacting substances (reactants) and forming new bonds between atoms of the produced substances (products).

A chemical reaction occurs when reactants combine, decompose, or are replaced by new reactants to form new products. This takes place through :

(1) Breaking the bonds between atoms of the reacting substances (the reactants).

(2) The atoms are rearranged and combined forming new bonds to form new substances (the products) that have different properties from the original substances (Figure 4).

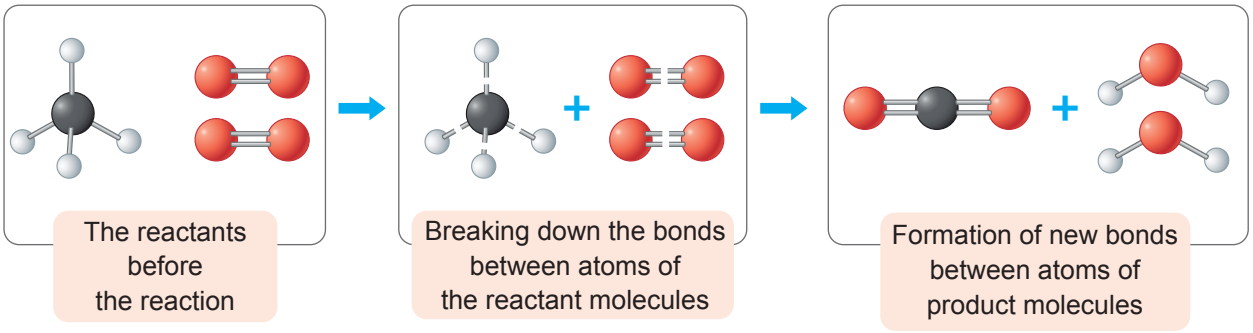


Figure (4)
The chemical reaction

Evaluate Your Understanding

Classify the following changes into physical changes and chemical changes:

(1) Dissolution of sugar in water. .....

(2) Conversion of milk to yogurt . .....

(3) Combustion of wax. .....

(4) Melting of wax. .....

(5) Rusting of an iron nail. .....

(6) Burning of a piece of bread in the oven. .....

(7) Limewater turns milky when carbon dioxide gas passes through it. .....

(8) The colour of a Universal indicator strip is changed when it is brought close to ammonia gas. .....

Indications of the occurrence of a chemical Reaction

There are many different indications which can indicate the occurrence of a chemical reaction. Team up with your classmates - under the supervision of your teacher - **to conduct the following experiments in the laboratory** to identify these indications.

1 Formation of a precipitate

Activity 2 Practical

Materials and Tools Used:

- Sodium chloride solution.
- Silver nitrate solution.
- Test tube.
- Dropper.

Steps :

1. Put a small quantity of sodium chloride solution in the test tube.
2. Add drops of silver nitrate solution gradually.

What do you observe? .....

What do you conclude? .....

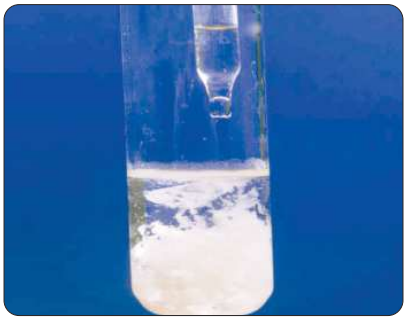


Figure (5)
Reaction accompanied by precipitate formation

Adding silver nitrate solution $AgNO_3$ to sodium chloride solution $NaCl$ **causes** the occurrence of a chemical reaction, **indicated by** the formation of a white precipitate of silver chloride $AgCl$ which does not dissolve (insoluble) in water and its colour is changed into violet when it is exposed to sunlight (Figure 5).

2 Colour change

Activity 3 Practical

Materials and Tools Used:

- A zinc plate.
- Copper sulphate solution.
- A beaker.

Steps :

1. Put copper sulphate solution in the beaker.
2. Put the zinc plate in the solution.

What do you observe? .....

What do you conclude? .....

Figure (6)
Reaction accompanied by a colour change

Placing the zinc plate in the copper sulphate solution **causes** a chemical reaction, **indicated by** the disappearance of the blue colour of the copper sulphate solution $CuSO_4$, due to the formation of colourless zinc sulphate solution $ZnSO_4$ and reddish brown copper is deposited over the zinc plate (Figure 6).

3 Evolution of gas

Activity 4 Practical

Materials and Tools Used:

- Magnesium strip.
- Dilute hydrochloric acid.
- Test tube.

Steps :

1. Put magnesium strip in the test tube.
2. Add an amount of dilute hydrochloric acid.

What do you observe? .....

What do you conclude? .....

Figure (7)
Reaction accompanied by evolution of a gas

Adding dilute hydrochloric acid HCl to magnesium Mg **causes** the occurrence of a chemical reaction, **indicated by** the formation of bubbles of hydrogen gas H_2 (Figure 7).

4 Emission of light and heat

Activity 5 Practical

Materials and Tools Used:

- Magnesium strip.
- Water.
- Tongs.
- Flame.

Steps :

1. Hold one end of the magnesium strip with the tongs.
2. Light one end of the strip by using the flame.
3. Is the powder resulting from the combustion (burning) of magnesium soluble in water ?

What do you observe? .....

What do you conclude? .....

Figure (8)
Reaction accompanied by bright light

Burning of magnesium Mg in air (Figure 8) **leads to** the occurrence of a chemical reaction, **indicated by** the glow of the strip with a bright light accompanied by heat emission, while the strip itself turns into a white powder of magnesium oxide MgO which is soluble in water.

Laboratory Safety Precautions

- Use a protective mask to avoid damage from the bright light.
- Do not touch the formed white powder immediately after the reaction, as it will be hot.
- Hold the magnesium strip with heat-resistant tongs to avoid burns during its combustion.
- Handle acids with extreme caution, especially concentrated acids.

Cross-Cutting Concepts : Cause and Effect

A chemical reaction occurs (Cause), leading to the formation of a precipitate, a colour change, evolution of a gas, emission of light and heat, extinguishing a lit match or re-ignition of a glowing splint (Effect).

Critical Thinking

Do the changes shown in the figures (9) and (10) represent the occurrence of chemical reactions?
How can this be indicated?

Figure (9)

Figure (10)

1. A glass bottle filled to the brim with water and tightly closed is broken when placed in the freezer of the fridge (Figure 9).

.....

2. An orange goes rotten (Figure 10).

.....

The properties of substances before and after chemical reaction

Do the properties of substances change before and after chemical reactions?

To answer this question, we will conduct the following activity:

Activity 6 Practical (Analyze and Explain)

Figure (11)

Figure (12)

Sugar burning

Steps :

1. Put a quantity of table sugar in a spoon (Figure 11).
2. Slowly heat the sugar by placing the spoon over the flame (Figure 12).
3. Observe the changes that occur **and record them in the following table:**

Figure (13)

Reaction of oil with caustic soda

Steps :

1. Pour 100 mL of oil into a 250 mL glass beaker (Figure 13).
2. Add 30 mL of caustic soda solution (concentrated sodium hydroxide solution) to the oil drop by drop.
3. Heat the mixture using a suitable heat source from 40ºC to 50ºC, with stirring the components well in one direction (clockwise).
4. Observe the changes that occur **and record them in the following table:**

Table (1)

Reaction	Properties of substances Before reaction	Properties of substances After reaction	Did a chemical reaction occur?	Indication of the chemical reaction
Sugar burning	.....	.....	.....	.....
Reaction of oil with caustic soda	.....	.....	.....	.....

It can be concluded from the previous that:

•Heating sugar gradually converts it into a brown melt, and when this melt burns, a chemical reaction occurs and the reaction is **indicated by** a strong odour (caramel smell), a change in colour, evolution of smoke, and the formation of a new substance (carbon).

• Adding oil to a solution of caustic soda while heating **causes** a chemical reaction that can be **indicated by** a change in consistency and the formation of a new substance (soap).

Enterpreneurism

Collaborate with your colleagues to start an entrepreneurial project to make soap at home.

Chemical reactions in daily life

Many chemical reactions occur in our daily life, including the following:

Figure (14)

1 When eggs are fried, a chemical reaction occurs, causing a change in the colour and texture of both white and yellow parts.

Figure (16)

3 When iron is exposed to oxygen in moist air, it goes rusty, causing the colour of the iron to change.

Figure (15)

2 When an apple is cut, a chemical reaction occurs with the atmospheric oxygen, causing the apple to turn brown.

Figure (17)

4 When fireworks are lit, a chemical reaction occurs, accompanied by the emission of light and heat.

Issue for Discussion

The harmful health effects of frying food or charring it during grilling.

Research Activity

Search multiple sources of knowledge, including the Internet, for examples of chemical reactions that occur in everyday life (such as cooking, cleaning or industry).
Describe the reactants and products, and explain how the occurrence of reaction can be indicated (e.g., colour change, evolution of a gas, emission of light and heat, etc.)

Evaluation Questions on Lesson One

1 Choose the correct answer for the questions (1) - (5).

(1) Which of the following expresses a chemical change?

(a) Iodine sublimation.
(b) The conversion of charcoal to ash.
(c) The heating of an iron rod.
(d) The melting of ice.

(2) The combustion (burning) of table sugar is indicated by the formation of .....

(a) a solid matter and evolution of smoke.
(b) a white precipitate and evolution of smoke.
(c) green solution and reddish brown gas.
(d) white powder and bright light.

(3) The following reactions were carried out:

(1) Burning a strip of magnesium.
(2) Adding hydrochloric acid to magnesium.
(3) Adding sulphuric acid to baking soda.

Which of these reactions is accompanied by the release of gas?

(a) (1) only. (b) (2) only.
(c) (1), (3). (d) (2), (3).

(4) Soap is formed by the reaction of .....

(a) oil with solid sodium hydroxide.
(b) oil with sodium hydroxide solution.
(c) oil with hydrochloric acid.
(d) oil with silver nitrate solution.

(5) All chemical reactions are accompanied by the following, except .....

(a) breaking down the bonds between the molecules of the reactants.
(b) forming bonds between the molecules of the products.
(c) the formation of new substances.
(d) the release of heat.

---

2 Copper chloride solution reacts with sodium hydroxide solution to form sodium chloride solution and copper hydroxide compound, which is insoluble in water.
How can the occurrence of this reaction be indicated, based on what you have studied?

---

3 **Compare between** the properties of table sugar before **and** after combustion.

---

4 **What type of change does occur to each of** a piece of apple and a piece of ice when left in the air?
How can this be indicated?

---

5 **You have the following substances:**

- $AgCl$
- $NaCl$
- $AgNO_3$
- $NaNO_3$

Identify the reactants and products from these substances.

---

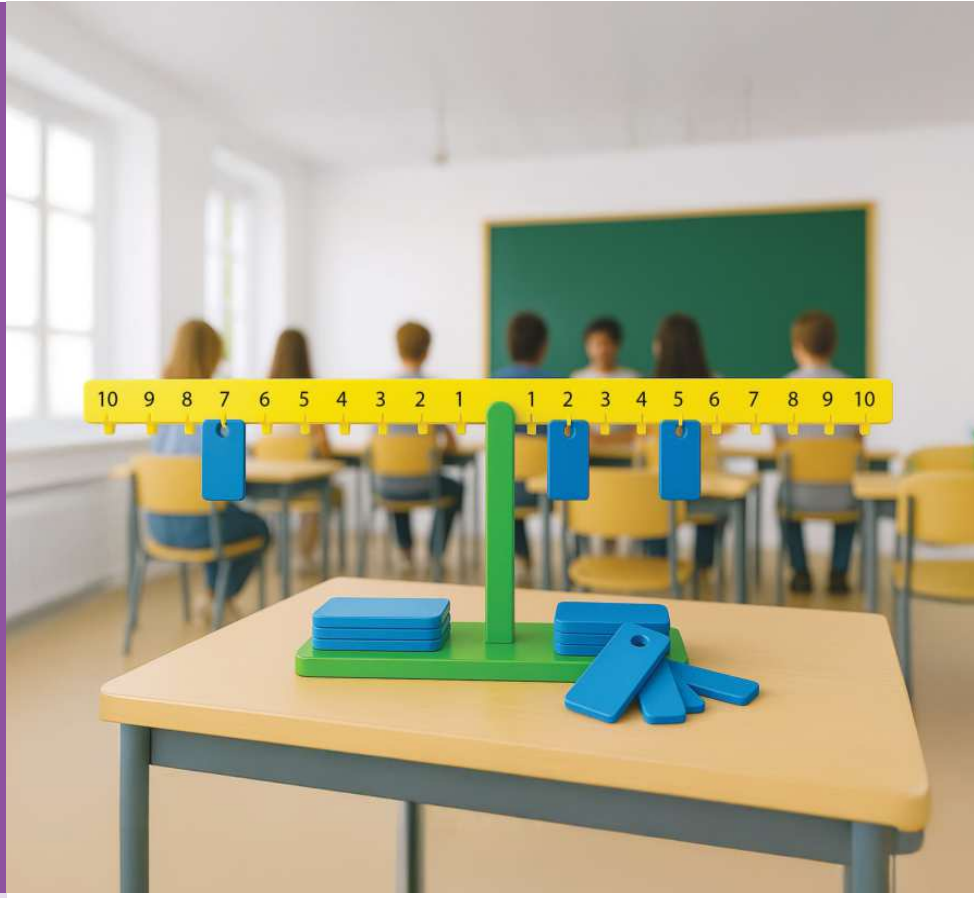
6 $NaOH$ solution is added to each of copper sulphate solution and iron sulphate solution, separately.
How can they be distinguished despite the formation of a precipitate in both cases?

---

7 **Apply the concept of chemical reaction to** the reaction of producing ammonia gas NH_3 from nitrogen gas N_2 and hydrogen gas H_2

Lesson **Two**

Chemical Equations



Lesson Terminology:

- Chemical Equation.
- Balanced Chemical Equation.
- Reactants.
- Products.
- Solid.
- Liquid.
- Gas.
- Aqueous Solution.
- Law of Conservation of mass.
- Coefficients.
- Subscripts.

Included Skills, Values and Issues :

- **Skills** : Practical practices - Observation - Conclusion.
- **Values :** Collaboration - Accuracy.
- **Issues :** Waste Management and Recycling.

Cross-Cutting Concepts:

- Systems and their models.

Lesson Objectives :

By the end of the lesson, students should be able to:

1. Recognize the concept of chemical equations.
2. Deduce the law of conservation of mass (conservation of matter).
3. Determine the relation between the law of conservation of mass and balancing of a chemical equation.
4. List the steps for balancing a chemical equation.
5. Balance chemical equations.
6. Design models at the molecular level for some molecules during a chemical reaction.

Lesson Preparation :

The shown figure represents the products of the reaction between ammonia and oxygen gases.

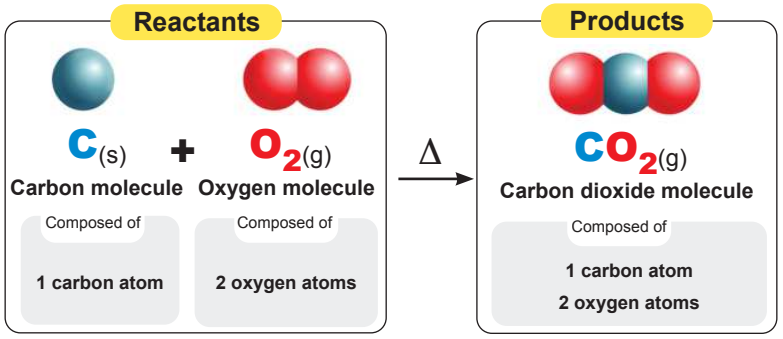
This lesson explores ideas that will help you answer the following questions:

- How can a chemical reaction be expressed using a symbolic equation?
- Does the figure represent a balanced equation?
- How is the symbolic equation balanced?
- How does the balanced equation satisfy the law of conservation of mass?

Expressing a chemical reaction with a word equation does not clarify the number of molecules or atoms present in the reaction mixture, **so it is expressed** with a symbolic chemical equation.

Symbolic chemical equation

A chemical equation is a symbolic representation of a chemical reaction, showing the reactants and products by using symbols and molecular formulas, with the simplest integer ratio of the number of molecules or atoms entering and resulting from the reaction (Figure 1).



(Figure 1)
Example of a chemical equation

- The symbols and formulas of the reactants are written on the left side of the equation, and the symbols and formulas of the products are written on the right side, below each of them is a subscript symbol that expresses the physical state in which it exists in the reaction, as shown in (Table 1).

The reactants and products are linked by an arrow that indicates the direction of the reaction, and the reaction conditions, if found, are written on the arrow, such as the use of substances known as catalysts that increase the speed of the reaction without being consumed or changed, as shown in (Table 2).

Table (1)

Symbol	Physical state
(s)	Solid or precipitate that is insoluble in water
(ℓ)	Liquid
(g)	Gas
(v)	Vapour
(aq)	Aqueous solution (a substance dissolved in water)

Table (2)

Symbol	Meaning
Δ	Heat (heating)
cat.	Use of a catalyst
dil.	Using dilute acid
conc.	Using concentrated acid

Evaluate Your Understanding

Solid sodium bicarbonate reacts with dilute hydrochloric acid with an effervescence to form a solution of sodium chloride, water, and carbon dioxide gas.
Represent this reaction using a symbolic equation.

.....

Balancing the chemical equations and the law of conservation of mass

Experiments have proved that there is a relation between the substances that enter into a chemical reaction and the substances that result from it, and that they are subject to special laws known as the laws of chemical combination, including the conservation of mass (conservation of matter).

The Law of Conservation of Mass

Activity 1 Practical

Materials and Tools Used:

- **Calcium chloride solution.**
- **Sodium sulphate solution.**
- **Test tube.**
- **Sensitive balance.**
- **Flask.**
- **Stopper.**

Steps:

1. Put a quantity of calcium chloride solution in the test tube and a quantity of sodium sulphate solution in the flask.

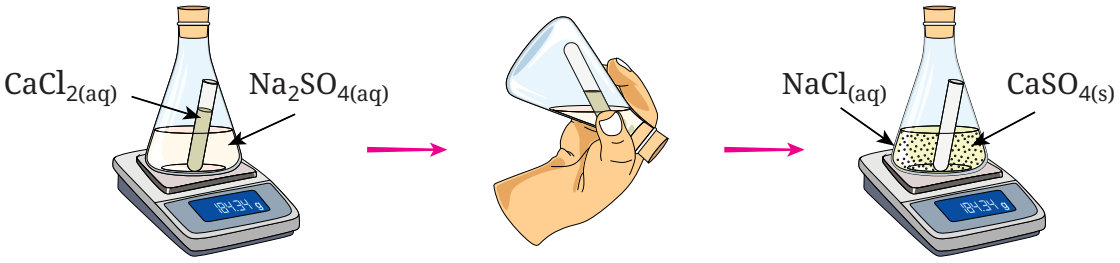


Figure (2)

2. Place the test tube in the flask carefully so that the two solutions do not mix.
3. Cover the flask with the stopper.
4. Find the mass of the flask with the test tube inside.

.....

5. Turn the flask upside down to cause a reaction between the two solutions.
6. Find the total mass again after the occurrence of the reaction.

.....

7. Compare between the total mass before **and** after the reaction (Figure 2).
   What do you observe?

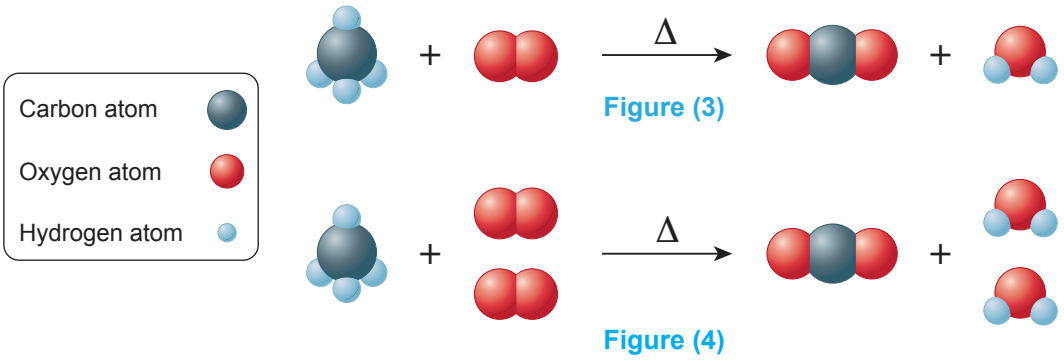
.....

Conclusion:

The mass of the reactants did not change despite the occurrence of the chemical reaction which is accompanied by the formation of calcium sulphate precipitate.
This indicates that the total mass of the substances involved in the chemical reaction **is equal to** the total mass of the substances resulting from it.
This is called the law of conservation of mass.

Activity 2 Observe and Conclude

One of the two figures (3) or (4) represents the combustion (burning) reaction of methane gas CH_4 in oxygen gas O_2 to form carbon dioxide gas CO_2 and water vapour H_2O



1 **Complete (Table 3)** with the appropriate numbers of atoms of reactants and products in both figures:

Table (3)

Element	Figure (3)		Figure (4)	
	Number of atoms in reactants	Number of atoms in products	Number of atoms in reactants	Number of atoms in products
C	.....	.....	.....	.....
H	.....	.....	.....	.....
O	.....	.....	.....	.....

2 What do you notice about the numbers of atoms in reactants and products in both figures?

.....

3 Which figure expresses the balanced equation of the reaction and why?

.....

Conclusion:

A symbolic chemical equation is considered balanced when the number of atoms of each element in the reactants is equal to the number of atoms of the same element in the products.

From the above, it can be concluded that:

When a chemical reaction occurs, the reactants are neither destroyed, nor are new substances created from nothing. Rather, the atoms of the reactants are rearranged to form new products with the same number of atoms of each element, which fulfils the law of conservation of matter.

Issue for Discussion

Waste management and recycling.

A profile of the scientist

Antoine Lavoisier

French chemist, philosopher, economist, and biologist, Lavoisier was the first to formulate the law of conservation of mass. He was also the first to prove that oxygen is an essential element in combustion, and he gave oxygen its name. He developed the modern system for naming chemical substances and was known as the father of chemistry for his emphasis on precise experimentation.

Figure (5)
Scientist Antoine Lavoisier

How to balance a chemical equation

The symbolic equation is balanced by applying the law of conservation of mass, by following these steps:

1. Write the correct molecular formulas of all reactants and products in the form of a symbolic equation.
2. Count the number of atoms for each element in the reactants and products.
3. If the numbers of atoms are not equal, adjust one of the coefficients preceding the molecular formulas of the compounds or the symbols of the elements and repeat the process of counting the numbers of the atoms.
   If the inequality persists, repeat the adjustment of the coefficients, even more than once. Take care not to write the coefficient if it is equal to 1 and not to alter the subscripts (Figure 6) under the symbols of the elements that make up the molecule and represent their number in a single molecule.

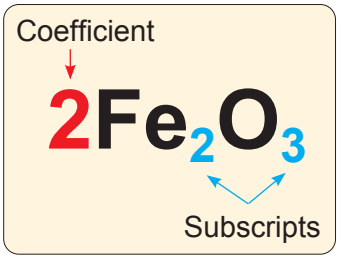
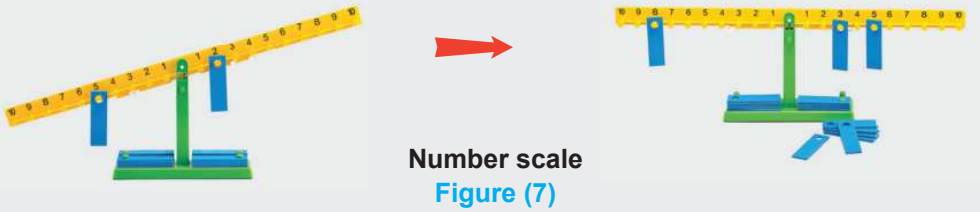


Figure (6)
Subscripts and coefficient

4. Check the balance of the equation to ensure that the number of atoms for all elements on both sides of the equation are equal, taking into account that the ratio between the coefficients of the balanced chemical equation should be as simple as possible.

Mathematical understanding

- **The balance of a chemical equation is similar to number scale (figure 7) in terms of adjusting the coefficients.**



Number scale
Figure (7)

Example

Write a balanced symbolic equation of the reaction of hydrogen gas with nitrogen gas to form ammonia gas.

Idea of answering :

Step (1) Write the correct molecular formulas in the form of an equation (Figure 8).

Step (2) Calculate the number of atoms of each element in the reactants and products, Table (4):

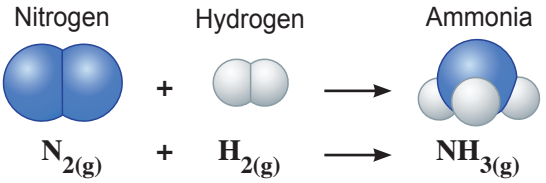


Figure (8)

Table (4)

Element	Number of atoms in reactants	Number of atoms in products
H	2	3
N	2	1

The coefficients of this equation do not represent a balanced equation, **because** the number of atoms of each element in the reactants is **not equal to** the number of atoms of the same element in the products.

Step (3) Change the coefficient of ammonia to 2 to balance the number of nitrogen atoms (Figure 9), and recalculate the number of atoms (Table 5):

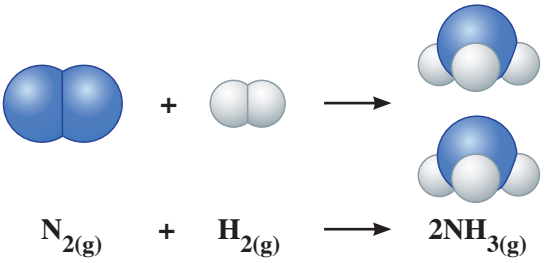


Figure (9)

Table (5)

Element	Number of atoms in reactants	Number of atoms in products
H	2	6
N	2	2

The coefficients of this equation do not represent a balanced equation. Why?.....

Step (4) Change the coefficient of hydrogen to 3 to balance the number of hydrogen atoms (Figure 10), and recalculate the number of atoms (Table 6):

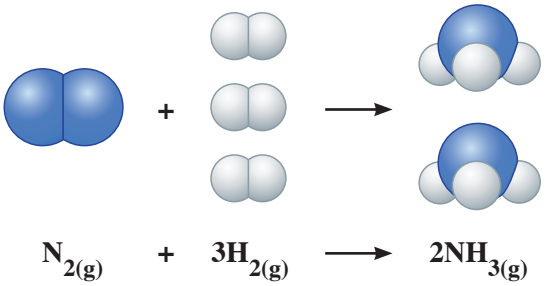


Figure (10)

Table (6)

Element	Number of atoms in reactants	Number of atoms in products
H	6	6
N	2	2

Step (5) Check the balance of the equation by equalling the numbers of atoms on both sides of the equation.

Answer : Balanced symbolic equation: $N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$

Evaluate your understanding

Place the correct coefficient in each cell to fulfill the balancing of the following equations:

1. $\square H_2 + \square I_2 \longrightarrow \square HI$
2. $\square Al + \square O_2 \longrightarrow \square Al_2O_3$
3. $\square Mg + \square O_2 \longrightarrow \square MgO$
4. $\square C_6H_{12}O_6 + \square O_2 \longrightarrow \square CO_2 + \square H_2O$

Designing models at the molecular level for certain molecules

Collaborate with your classmates to design molecular models of some molecules and chemical reactions (Figure 12) using Lego cubes (Figure 11).

Design a model of the combustion reaction of methane in oxygen (Figure 13).

Lego cubes
Figure **(11)**

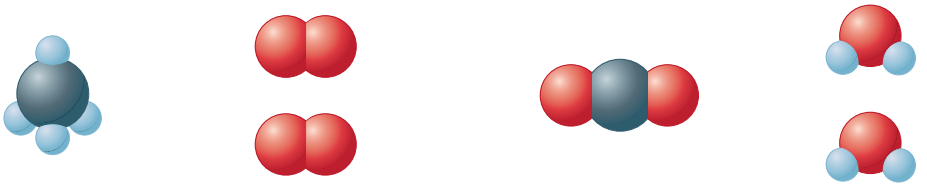


Figure (12)

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$$

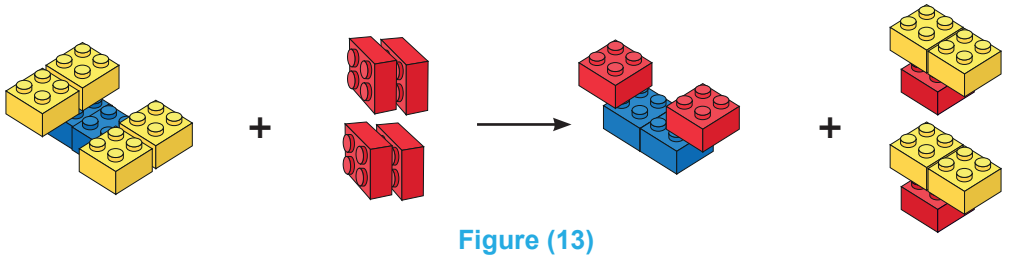


Figure (13)

Cross-Cutting Concepts : Systems and their models

A chemical equation is a symbolic model of what happens during a chemical reaction. It represents a mental representation of what's happening at the molecular or atomic level. Which are levels that can't be seen by the naked eye.

Information and Communication Technology

Use open source software to automatically balance chemical equations, such as PhET Simulation.

Evaluation Questions on Lesson Two

1 Choose the correct answer for the questions (1) - (4).

(1) In the balanced equation:

$$PCl_5 + 4H_2O \longrightarrow H_3PO_4 + 5HCl$$

What is the total number of coefficients of reactants molecules and the total number of subscripts of the products respectively?

(a) 5 , 7 (b) 5 ,10

(c) 9, 5 (d) 6 , 5

(2) Which of the following expresses the physical state of the substances of the reaction between magnesium metal and hydrochloric acid to form magnesium chloride solution and hydrogen gas?

(a) $Mg_{(g)} + HCl_{(\ell)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$

(b) $Mg_{(g)} + HCl_{(aq)} \longrightarrow MgCl_{2(\ell)} + H_{2(g)}$

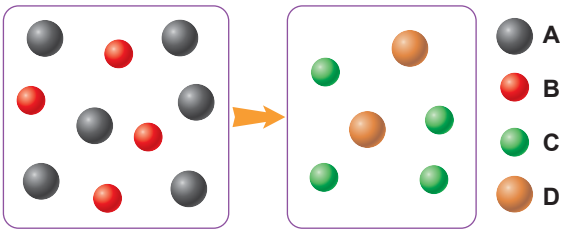
(c) $Mg_{(s)} + HCl_{(\ell)} \longrightarrow MgCl_{2(\ell)} + H_{2(\ell)}$

(d) $Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$

(3) Which of the following verifies the law of conservation of mass when magnesium reacts with oxygen to form magnesium oxide?

Choices	MgO	O_2	Mg
(a)	15.36 g	3.2 g	4.8 g
(b)	1.6 g	4.8 g	3.2 g
(c)	8 g	3.2 g	4.8 g
(d)	7.4 g	4.8 g	3.2 g

(4) The following figure illustrates a chemical reaction:



What is the balanced symbolic equation which represents this reaction?

(a) $6A + 4B \longrightarrow 4C + 2D$

(b) $6A + 4B \longrightarrow C + D$

(c) $A + 2B \longrightarrow 2C + D$

(d) $3A + 2B \longrightarrow 2C + D$

2 Balance the following symbolic equations:

(1) $C + O_2 \longrightarrow CO$

(2) $O_3 \longrightarrow O_2$

(3) $KOH + H_3PO_4 \longrightarrow K_3PO_4 + H_2O$

(4) $N_2O_5 \longrightarrow N_2O_4 + O_2$

3 Write the balanced symbolic equations expressing the following reactions, including the physical state of the substances and the reaction conditions:

(1) Combustion of ethane gas C_2H_6 in oxygen to form condensed water vapour and carbon dioxide.

(2) Heating mercury oxide powder HgO strongly to form mercury and oxygen gas.

(3) Reaction of magnesium with dilute sulphuric acid to form magnesium sulphate salt dissolved in water and hydrogen gas bubbles.

Lesson Three

Nutritional Chemistry

Lesson Terminology:

- Nutrition.
- Carbohydrates.
- Glucose.
- Fat.
- Protein.
- Starch.
- Iodine Solution.
- Benedict Solution.
- Sudan (IV) Solution.
- Biuret Solution.
- Enzymes.
- Amino Acid.

Included Skill, Value and Issue :

- **Skill :** Practical practices.
- **Value :** Staying healthy.
- **Issue :** Plant-based diets.

Cross-Cutting Concepts :

- Energy and Matter.

Lesson Objectives :

By the end of the lesson, students should be able to:

1. Identify the composition of carbohydrates, fats and proteins.
2. Practically detect the presence of carbohydrates, fats and proteins in food.
3. Identify the importance of carbohydrates, fats and proteins in nutrition and industry.
4. Explain the relation between carbohydrates and fats.

Lesson Preparation :

The given figure shows egg whites (albumen) and egg yellow (yolk). This lesson explores ideas that will help you answer these questions:

- What nutrients are found in most meals?
- How can the presence of fats and proteins be detected in eggs?
- Why are eggs an essential part of athletes' meals?

- **Nutritional chemistry** is a branch of chemistry that studies the types of nutrients in food, **including:**

  ① Carbohydrates. ② Fats. ③ Proteins.

First Carbohydrates

- Carbohydrates are organic chemical compounds composed of carbon, hydrogen, and oxygen.

  The most important sources of carbohydrates are bread, potatoes, rice, grains, vegetables, and some fruits such as grapes and apples (Figure 1).

  They are responsible for the sweet taste of food.

Figure (1)
Foods rich in carbohydrates

Chart (1) shows the divisions of carbohydrates according to their chemical composition:

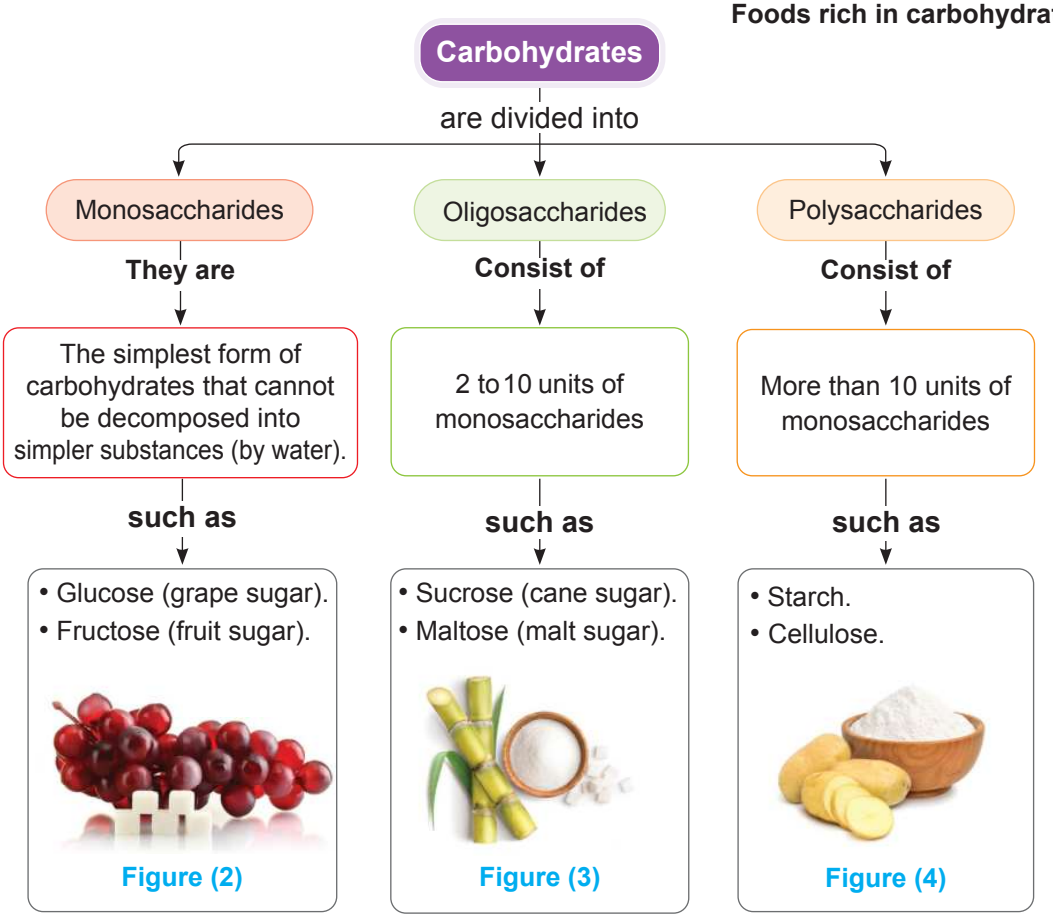


Chart (1)

Disaccharides are oligosaccharides, each molecule of which consists of two monosaccharides with one water molecule removed, such as sucrose, (which consists of one glucose unit and one fructose unit), and maltose, (which consists of two glucose units).

Detecting Glucose

Activity 1 Practical

Materials and Tools Used:

- Glucose solutions in different concentrations.
- Test tubes.
- Blue Benedict's solution.
- Hot water bath.

Steps:

1. Place 2 mL of glucose solutions in test tubes at different concentrations.
2. Add 2 mL of blue Benedict's solution to each tube.
3. Heat the test tubes in a water bath for 5 minutes.

What do you observe? .....

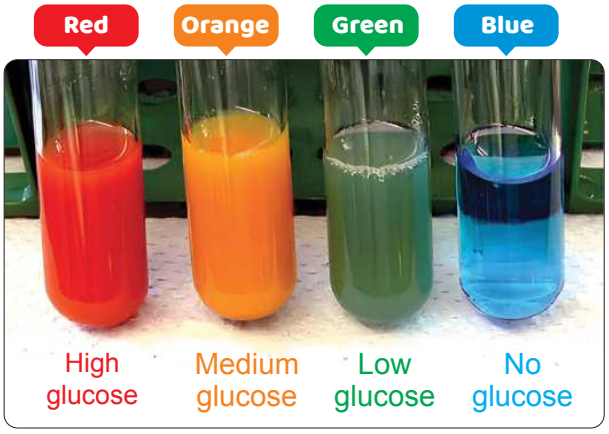


Figure (5)
Colours of Benedict's solution with different concentrations of glucose

Conclusion:

The colour of the glucose solution changes when Benedict's solution is added to it, depending on the concentration of sugar solution (Figure 5).

Integration with Biology

The accumulation of glucose in the blood as a result of insufficient secretion of insulin by the pancreas leads to diabetes, **whose symptoms** include significant weight loss, increased urination, and excessive thirst.

Critical Thinking

How can a person who suspects he has diabetes benefit from Activity (1)?

Detection of Starch

Activity 2 Practical

Materials and Tools Used:

- A potato.
- Iodine solution.
- Dropper.

Steps:

1. Cut the potato in half.
2. Put drops of the yellowish brown iodine solution on the inner part of the potato. **What do you observe?** .....

Figure (6)
Potato starch turns iodine solution into dark blue

Conclusion:

Potatoes contain starch, which converts the yellowish brown colour of iodine to dark blue (Figure 6).

The Importance of Carbohydrates

- **There are many ways in which living organisms benefit from carbohydrates, as follows:**
  1. They form a source of energy for the body.
  2. They support the brain functions.
  3. Plant cell walls are made of cellulose.
  4. They participate in forming the nectar of flowers.
- **Carbohydrates are used in many industries, such as making :**
  1. Paper from cellulose.
  2. Some cosmetics from sugars and starch.
  3. Medicine capsules (Figure 7).

Nutritional Awareness

▶ It is recommended to reduce carbohydrates found in white sugar and white flour in the meals and to rely on whole grains.

Figure (7)
Medicine capsules

Second Fats

- Fats are organic chemical compounds that contain the same elements as carbohydrates, but provide twice as much energy as carbohydrates.
  The most important sources of fats are butter, eggs, milk, meat, many types of nuts, and vegetable oils (Figure 8).
  When the body consumes more carbohydrates than its requirements, the excess is stored in the liver and muscles in form of glycogen or in the body's cells in form of fat, which is burned when needed, such as during periods of fasting or when following a diet.

Figure (8)
Foods rich in fats

Medical Awareness

- Cholesterol is a fatty substance found with body fats, and its deposition on the inside walls of the arteries leads to their blockage and increases the risk of heart diseases (Figure 9).
- Maintaining normal cholesterol levels in the blood **requires the following:**
  1. Reduce your intake of fats and fried foods.
  2. Exercise regularly.
  3. Drink plenty of water.

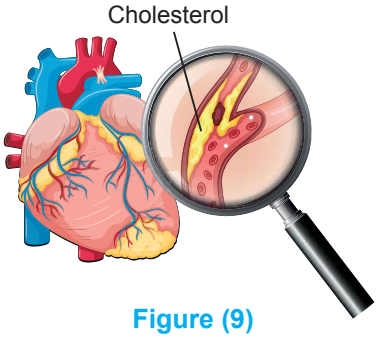


Figure (9)
Cholesterol causes blockage of the heart arteries

Detection of Fats

Activity 3 Practical

Materials and Tools Used:

- Egg yolk.
- Distilled water.
- Sudan (IV) solution.
- Test tube.

Cross-Cutting Concepts: Energy and Matter

Carbohydrates and fats are essential chemicals for transporting and storing energy in living organisms.

Steps:

1. Place a portion of egg yolk (rich in fat) in a test tube.
2. Add 10 mL of distilled water to make a mixture.
3. Add 10 mL of Sudan (IV) solution to the mixture, with shaking.

What do you observe? .....

Conclusion:

Sudan (IV) solution gives a red-orange colour on the surfaces of the mixtures containing fat (Figure 10).

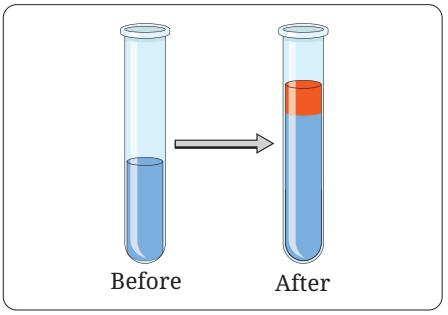


Figure (10)
Sudan (IV) solution with fat

Third Proteins

- Proteins are organic chemical compounds consisting of basic units soluble in water called amino acids (Figure 11). Amino acids are composed of the same elements as carbohydrates, in addition to nitrogen and, in most cases, phosphorus.

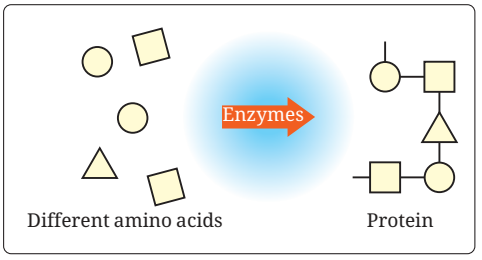


Figure (11)
Proteins are made up of amino acids

- **There are many sources of proteins in food (Figure 12) whether it is:**
  - Animal protein, such as red and white meat, fish, eggs, and milk and its derivatives.
  - Plant protein, such as legumes, nuts and soybeans.

Figure (12)
Foods rich in protein

Issue for Discussion

The adequacy of plant-based diets in providing the body with its protein requirements.

Medical Awareness

Irresponsible excessive use of dietary supplements containing amino acids (Figure 13) for rapid muscle building causes serious risks to the kidneys and liver.

Figure (13)
Dietary supplement

Protein detection

Activity 4 Practical

Materials and Tools Used:

- Egg whites.
- Biuret solution.
- Test tube.

Steps:

1. Put a portion of egg whites (rich in protein) in a test tube.
2. Add a few drops of Biuret solution with a gentle shake (Figure 14).

What do you observe? .....

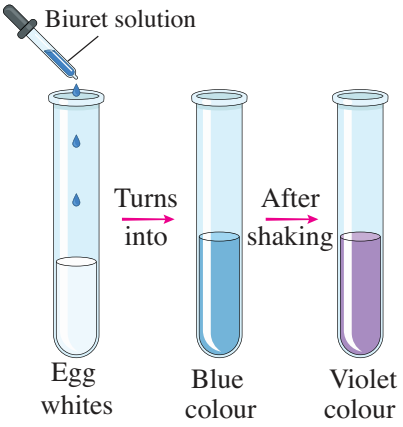


Figure (14)

Conclusion:

Biuret solution colour changes from blue to violet when added to proteins.

The Importance of Proteins

- **Living organisms benefit from proteins in many ways, such as:**
  1. They are involved in building muscles and repairing and growing damaged cells.
  2. They are used in the formation of enzymes that act as catalysts.
  3. They are used in the formation of antibodies that support the immune system against disease-causing microbes.
- **The benefits of proteins extend to many industries, such as :**
  1. Extraction of gelatin which is used in food industry from the proteins found in animal bones and skin.
  2. Production of insuline which is used in the treatment of diabetes through genetic engineering.
  3. Using the enzymes in the manufacture of laundry detergents to remove stains (Figure 15).

Research Activity

Search electronic and paper sources for data contained in the nutritional facts labels found on food product packaging, such as juices.

Figure (15)
Coloured granules in powder detergent contains enzymes

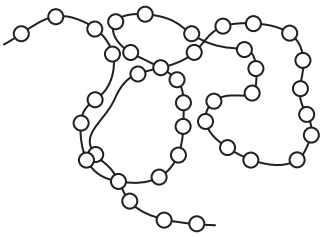
Evaluation Questions on Lesson Three

1 Choose the correct answer for questions (1) - (5)

(1) What type of food gives a violet colour when mixed with Biuret solution?

(a) Glucose. (b) Protein.
(c) Starch. (d) Fats.

(2) The following figure represents a protein molecule:



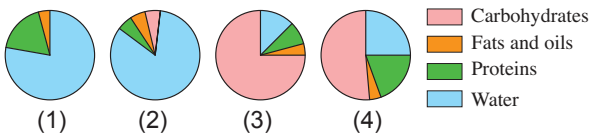
What do the balls in the figure represent?

(a) Amino acids.
(b) Monosaccharides.
(c) Starch molecules.
(d) Fatty acids.

(3) Which of the following describes enzymes?

(a) Energy-rich proteins.
(b) Proteins that work as catalysts.
(c) Energy-rich carbohydrates.
(d) Carbohydrates that work as catalysts.

(4) The following pie charts show the components of four different food samples, each weighing 100 g :



Which of these samples stores the greatest amount of energy?

(a) (1). (b) (2).
(c) (3). (d) (4).

(5) A food sample when reacts with iodine solution, it turns dark blue, and with a Biuret reagent it turns blue, while with Sudan (IV) solution it turns red-orange. What are the contents of this sample?

(a) Starch and fat.
(b) Starch and protein.
(c) Protein and fat.
(d) Starch, protein and fat.

2 A dough containing the following components:

- 100 g flour. - $\frac{1}{2}$ teaspoon salt.
- 250 mL milk. - 1 egg.

What organic chemical compounds are present in this dough?

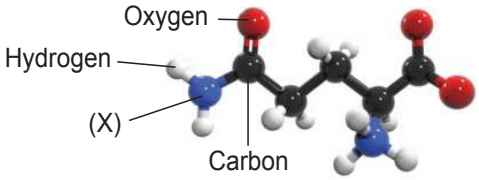
3 Compare between glucose and starch in terms of :

(1) Their constituent elements.
(2) Their classification as carbohydrates.
(3) Their effect on iodine solution.

4 From the following figure:

(1) What are the organic chemical compounds found in the food shown in the figure?
(2) Mention the benefits and harms of eating meat, poultry, and eggs in large quantities.

5 The following figure represents a chemical compound molecule of the basic unit of proteins:



(1) What is the type of this molecule?
(2) What is the name of the element (X)?

UNIT 3

Energy Flow in Photosynthesis and Cellular Respiration

Unit Lessons

Lesson one : Photosynthesis.

Lesson two : Cellular Respiration.

Learning Outcomes :

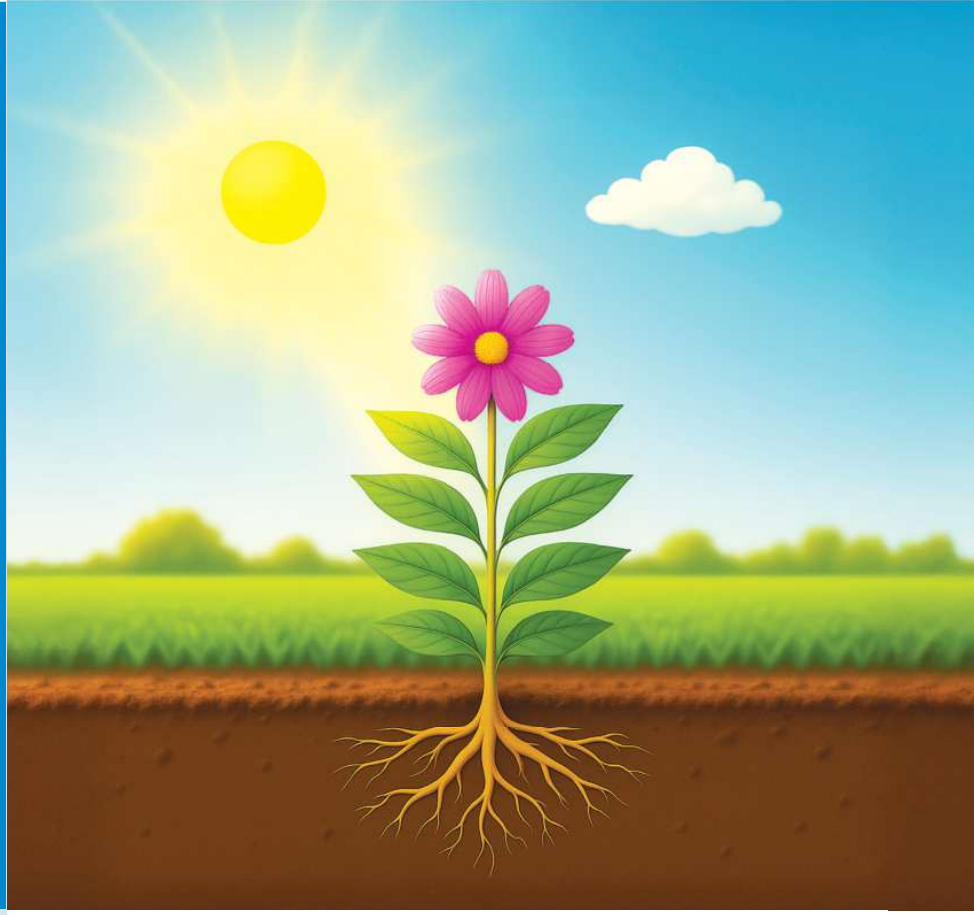
By the end of this unit, the student should be able to:

1. Design a model to describe how food molecules are rearranged through chemical reactions to form new molecules that support growth in plants through the processes of photosynthesis and respiration.

2. Explain the flow of energy during the processes of nutrition and respiration in living organisms. «Does not include: the biochemical mechanisms of photosynthesis or respiration».

Lesson One

Photosynthesis



Lesson Terminology

- Photosynthesis.
- Plastid.
- Organelles.
- Stroma.
- Enzymes.
- Light Independent Reactions.
- Granum (Grana).
- Thylakoids.
- Light Dependent Reactions.
- Chlorophyll.
- Vertical Farming.
- Quantum.

Included Skills, Values, and Issues :

- **Skills :** Practical practices - Model design.
- **Value :** Collaboration.
- **Issue :** Food security.

Cross-Cutting Concepts :

- Structure and Function.

Lesson Objectives :

By the end of the lesson, the student should be able to :

1. Identify the results of Van Helmont's experiment.
2. Identify the structure of the green plastids (chloroplasts).
3. Discover the role of chlorophyll in light absorption.
4. Recognize the mechanism of photosynthesis.
5. Distinguish between light dependent reactions and light independent reactions in photosynthesis.
6. Discover the formation of starch in photosynthesis.
7. Identify the factors that affect photosynthesis.

Lesson Preparation :

Here is a figure of solar panels.

This lesson explores ideas that will help you answer these questions :

- What are the organelles found in plant cells that perform the same role as solar cells in solar panels ?
- What is the difference between energy conversion in solar panels and photosynthesis ?
- What is the material in which energy absorbed in photosynthesis is stored ?

• Most scientists believed, till the 17th century, that plants get their nutrients from the soil, until the Belgian scientist Van Helmont conducted his experiment that was named after him.

Van Helmont's experiment

• He took a willow sapling weighing 2.2 kg and planted it in a pot containing 90 kg of dry soil.

• He watered the tree for five years without adding any other substances.

• He weighed both the tree (Figure 1) and the soil again after 5 years, so he found that the mass of the tree had become 75 kg and that the mass of the soil had decreased by only 55 g (almost the same).

Figure (1)
Willow tree

From his experiment, Helmont concluded that :

- The growth of the tree does not depend primarily on the absorption of nutrients from the soil.
- The slight decrease in the soil mass is attributed to that the plant absorbs small amounts of the soil elements.
- Water is the key element for tree growth.

Afterwards, researches showed that plants also use carbon dioxide and sunlight to make their food during photosynthesis.

Cumulative knowledge :

- ► Water and mineral salts are transported from the roots to the rest of the plant through the xylem tissue.
- ► Food is transported from the leaves to the rest of the plant through the phloem tissue.

• Photosynthesis takes place in green plastids found in the cells of the green parts of the plants, especially the leaves and the herbaceous stems, such as in Mallow (Molokhia) plant (Figure 2).

Figure (2)
Mallow (Molokhia) stem and leaves

Green Plastids (chloroplasts)

• Green plastids (chloroplasts) are cell organelles that resemble lentil grain and are found in the green parts of the plants, as well as in green algae :

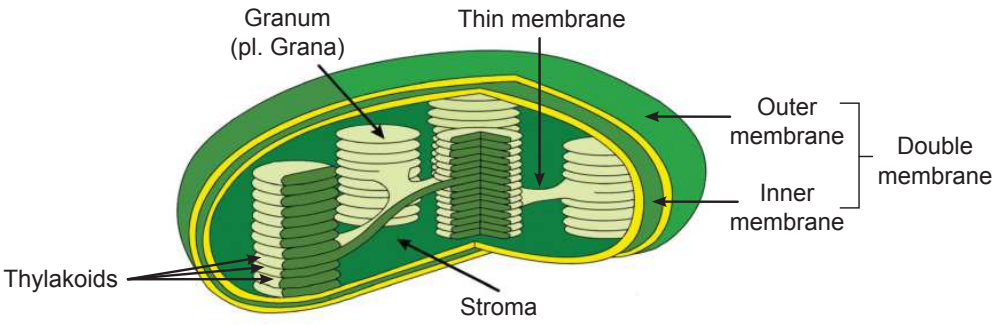


Figure (3)
Structure of a green plastid

Green plastid (Figure 3) structure comprises:

① A double membrane that allows substances to move in and out of the plastid.

② Stroma (fluid - filled space), which is the internal space of the plastid and contains most of the enzymes needed for the reactions that do not require light, called light independent reactions.

③ Granum (Plural : Grana), which consists of (a stack of) structural units called thylakoid membranes (thylakoids), their number reaches to 15 or more. The edge in some thylakoids extends to connect with another thylakoid in an adjacent granum through a thin membrane, which increases the surface area of the thylakoid membrane that is exposed to light.
The light dependent reactions take place in the grana.
The thylakoid membranes contain several types of pigments, including green chlorophyll.

Plastids are classified according to the pigments that they contain into green plastids (chloroplasts) and coloured plastids (chromoplasts), which are found in some fruits such as plums (Figure 4) and in the petals of the flowers (Figure 5), in addition to colourless plastids (leucoplasts) which are found in potatoes and sweet potatoes.

Figure (4)
Plums

Figure (5)
Flower petals containing coloured plastids (chromoplasts)

Absorption of light by Chlorophyll

Activity 1 Practical

Materials and Tools Used :

- Spinach leaves.
- Ethyl alcohol (ethanol).
- Filter papers.
- Test tube.
- Light bulb.
- Porcelain mortar and pestle (Figure 6).
- Coloured transparent sheets.

Figure (6)
Porcelain mortar and pestle

Steps :

1. Cut some spinach leaves and place them in the mortar.
2. Add enough alcohol to the spinach leaves to cover them.
3. Crush the leaves in the mortar using the pestle, till a green mixture is formed.
   Why does the mixture become green in colour ? .....
4. Use filter paper to separate the clear green solution in the test tube.
5. Place a red transparent sheet between the light bulb and the test tube containing the green solution (Figure 8) to allow only red light to pass through.
   Does the red light pass through the green solution ?
   .....
6. Repeat step 5 one time using a blue transparent sheet (Figure 9) and another time using a green transparent sheet (Figure 10).
   What do you observe ?
   .....

It is clear from the previous observations that the clear chlorophyll solution only transmits the green light from white light and absorbs both red light and blue light, whose energy is used in the photosynthetic reactions that take place in the grana to convert light energy into chemical energy that is stored in glucose.

Integration with Physics

Light is a form of energy, when white light falls on one of the faces of a glass prism, it splits into the seven colours of the visible spectrum (Figure 7), which are ordered according to their energy.

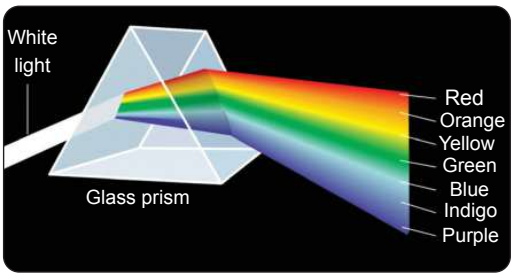
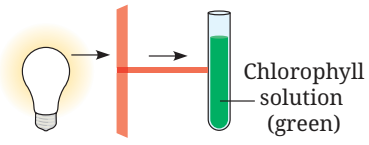
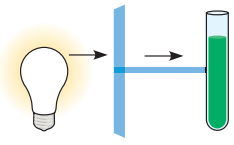


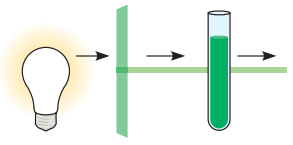
Figure (7)
White light is made up of seven colours



Red transparent sheet
Figure (8)



Blue transparent sheet
Figure (9)



Green transparent sheet
Figure (10)

Evaluate Your Understanding

Opaque object absorbs all colours of the visible spectrum but reflects its own colour. Based on your understanding of this statement, explain why plant leaves appear green.

.....

The mechanism of photosynthesis

Photosynthesis occurs in two stages, which are :

First Light dependent reactions

• A group of chemical reactions that depend on the presence of light, (known as Light dependent reactions) occur on the thylakoid membranes, as follows :

1. Chlorophyll absorbs blue and red light energies from the visible light, becoming active (excited) chlorophyll.
2. Part of the energy of the active chlorophyll is used to decompose water into oxygen and hydrogen.

The oxygen is transferred to the air as a by-product. The remaining part of the active chlorophyll energy is used to convert a molecule of compound called adenosine diphosphate ADP into the molecule of adenosine triphosphate ATP by adding a phosphate group P to it. The resulting ATP molecule is used in the light independent reactions.

Integration with Chemistry

When an electron in an atom gains a quantum (certain quantity) of energy, it moves from its energy level to a higher energy level. In this case, the atom becomes unstable, and is called excited atom, hence the electron quickly loses the energy it gained and returns to its original energy level, and the atom becomes stable once again.

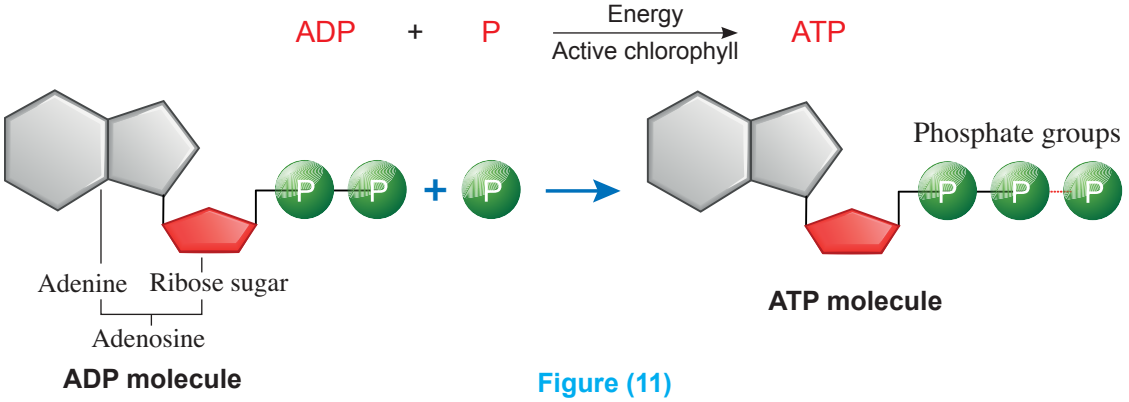


Figure (11)

Evaluate Your Understanding

Assisted by (Figure 11), **explain** the similarities and the differences between ADP molecule and ATP molecule.

.....

Second Light independent reactions

A group of chemical reactions that do not depend on the presence of light, (known as Light independent reactions) occur in the stroma, as follows :

1. Hydrogen, carried on one of the chemical compounds which are present on the thylakoid membranes, is transferred to the stroma.
2. Hydrogen combines with carbon dioxide that is absorbed from the air in the presence of each of ATP molecules resulting from the light dependent reactions and the enzymes present in the stroma to produce glucose $C_6H_{12}O_6$

Integration with Chemistry

Enzymes are protein molecules that work as catalysts, they increase the rate of light independent reactions without requiring the high temperatures used to carry out such reactions in research laboratories.

It is clear from the previous that :

- In the photosynthesis process, the plant rearranges the atoms obtained from simple molecules, which are water molecules absorbed from the soil and carbon dioxide molecules absorbed from the air, in the presence of sunlight to form its food (glucose), and release oxygen gas as a by-product, according to the following equation:

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2}$$

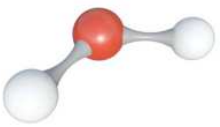
The glucose produced from the light independent reactions of photosynthesis dissolves in cold water. Therefore, if it remains in this form, it will dissolve in the plant sap. Hence, many of its molecules are linked together in long chains, forming starch granules that are sparingly soluble in cold water and are stored in the leaves, roots and stems. Storage efficiency is high in taro corms, sweet potato roots and potato stems.

Figure (12)
Components of the ball and stick model kit

Design models for photosynthesis substances

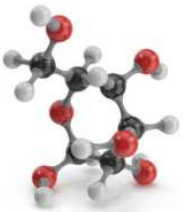
Collaborate with your classmates under the supervision of your teacher to use ball and stick models (Figure 12) to design models of the reactants and products of photosynthesis similar to the models shown in Figures (13) - (16).

$CO_{2(g)}$
Figure (13)



H_2O
Figure (14)

O_2
Figure (15)



$C_6H_{12}O_6$
Figure (16)

The models of the reactants and the products of the photosynthesis process

Starch Formation in Photosynthesis

Activity 2 Practical

Materials and Tools Used :

- Variegated leaf (Figure 17).
- Ethyl alcohol (ethanol).
- Tap water.
- Iodine solution.
- Beakers.
- Test tube.
- Heat source.
- Dropper.
- Tweezers (tongs).

Figure (17)
Variegated leaves

Steps :

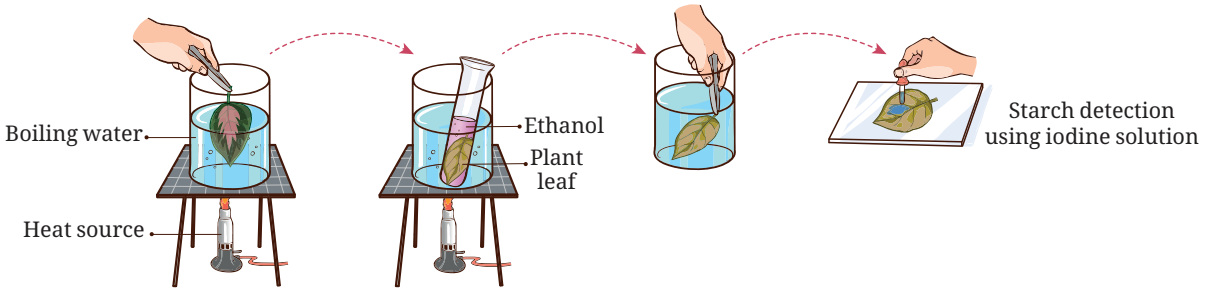


Figure (18) Figure (19) Figure (20) Figure (21)

1. Take a variegated leaf from a plant that has been exposed to light for a sufficient period of time, then place it in boiling water for two minutes to break the cell walls (figure 18).
2. Transfer the leaf to a test tube containing ethanol and heat the tube in a hot water bath (figure 19) till the green chlorophyll colour disappears, so that its colour does not interfere with the colour that will be formed in step (4).
3. Remove the leaf from the tube and wash it with water to make it soft once again (Figure 20).
4. Use the dropper to add drops of iodine solution to the leaf (Figure 21).

What do you observe ?

- Which areas undergo colour change ? What colour do they change into ?

.....

- Why doesn't the same colour appear in the other areas of the leaf ?

.....

- Could the presence of starch in a plant leaf be affected if part of it is covered with an opaque tape that blocks the light before the start of the experiment (Figure 22) ? **Explain**.

.....

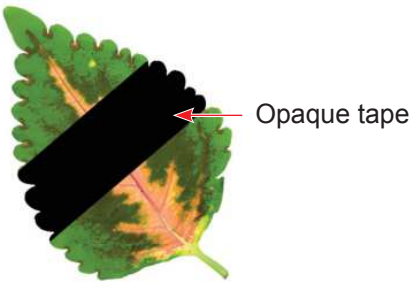


Figure (22)

It is clear from the previous :

The importance of each of :

- **Chlorophyll** in starch formation, as evidenced by the change in the colour of iodine in the green areas only of the variegated leaf to dark blue (Figure 23).
- **Light** in starch formation, as evidenced by the fact that the colour of iodine does not change in the areas covered by the tape.

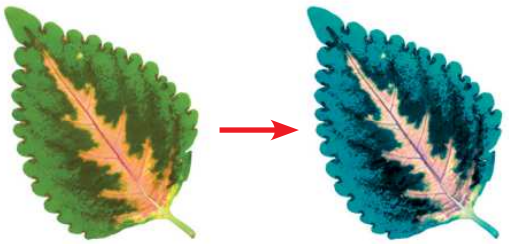


Figure (23)

Factors affecting the rate of photosynthesis

The rate of photosynthesis is affected by several factors, three of which are explained in (Activity 3).

Activity 3 Analyze

Team up with a classmate to analyze the data shown in figures (24) – (26) by answering the questions that follow.

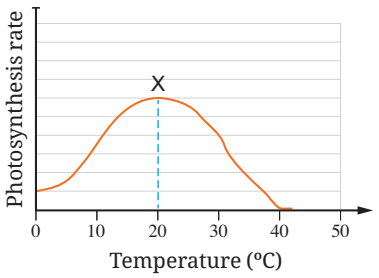


Figure (24)

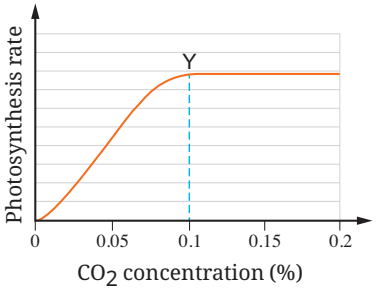


Figure (25)

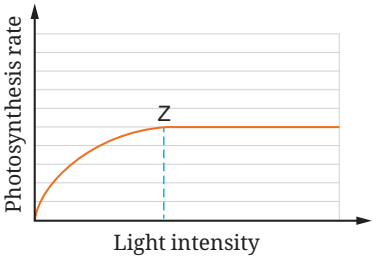


Figure (26)

1. What are the factors that affect the rate of photosynthesis ?

.....

2. What is the effect of increasing the temperature above 20°C on the rate of photosynthesis (when the intensity of light and CO_2 concentration are constant) ?

.....

3. **What is the effect of increasing each of the following on the rate of photosynthesis (when the other variables are constant):**

   - Concentration of carbon dioxide in the atmosphere.

   .....

   - Light intensity.

   .....

- The optimal rate of photosynthesis for each of the temperature, CO_2 concentration, and light intensity is at points (X), (Y), and (Z) shown in Figures (24 – 26).
  In addition to these mentioned factors, water, mineral salts and wind are also factors that affect the rate of photosynthesis.

Evaluate Your Understanding

How does the lack of light affect both the light dependent and light independent reactions in plants ? What is the effect of this on the plant growth in general ?

.....

Technological application :

Vertical farming (Figure 27) A technology developed in modern cities that mimics the conditions which are suitable for farming to perform photosynthesis process, to produce vegetables and fruits in multi-storey buildings (skyscrapers) using artificial lighting and hydroponics (water-based nutrients), to provide a sustainable solution to the problem of lack of arable land (Agricultural land suitable for farming).

Figure (27)
Vertical farming

Issue for Discussion

The role of vertical farming in addressing (facing) food security challenges.

Evaluation Questions on Lesson One

1 Choose the correct answer for the questions (1) - (5).

(1) Van Helmont's experiment demonstrated the importance of factor (X) in plant growth. What is factor (X) ?

(a) Soil. (b) Water.
(c) Carbon dioxide. (d) Sunlight.

(2) Which of the following indicates the factors that affect the rate of photosynthesis ?

Choices	Intensity of light	Temperature	Concentration of CO_2	Concentration of O_2
(a)	✓	✓	✓	✓
(b)	✓	✓	✗	✗
(c)	✗	✓	✓	✗
(d)	✓	✓	✓	✗

(3) Photosynthesis is represented by the following balanced equation : $X + 6CO_2 \longrightarrow Y + 6O_2$ Which of the following identifies (X) and (Y) ?

(a) (X) : $6H_2O$, (Y) : $6C_6H_{12}O_6$
(b) (X) : $6C_6H_{12}O_6$, (Y) : $6H_2O$
(c) (X) : $6H_2O$, (Y) : $C_6H_{12}O_6$
(d) (X) : $C_6H_{12}O_6$, (Y) : $6H_2O$

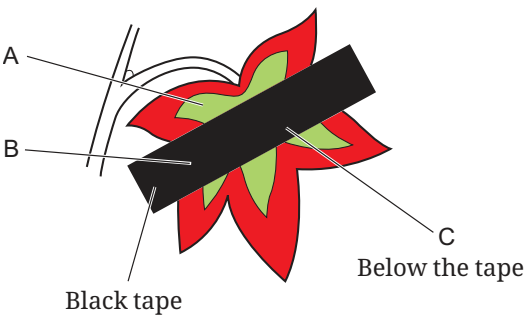
(4) Enzymes are .....

(a) proteins and fats only.
(b) proteins that act as catalysts.
(c) fats only.
(d) fats that act as catalysts.

(5) (X) is composed of the structural units (Y) which on their membranes, the reactions (Z) take place. Which of the following is correct ?

Choices	(X)	(Y)	(Z)
(a)	Granum	Thylakoids	Light dependent
(b)	Granum	Thylakoids	Light independent
(c)	Stroma	Stroma	Light dependent
(d)	Stroma	Stroma	Light independent

2 Part of a green and red coloured plant leaf on a plant branch was covered and the leaf exposed to light for a sufficient period of time, then the chlorophyll was removed, as shown in the following figure:



(1) What is the letter which indicates the part where the iodine solution turns dark blue? Explain.

(2) Why was chlorophyll removed from the leaf before adding drops of iodine solution?

3 Why is glucose stored in plant parts in the form of starch granules ?

Lesson **Two**

Cellular Respiration

Lesson Terminology

- Cellular Respiration.
- Mitochondria.
- Matrix.
- Pyruvate.
- Krebs Cycle.
- Metabolism.
- Anabolism.
- Catabolism.

Included Skills, Value and Issues :

- **Skills :** Predicting - Interpreting.
- **Value :** Appreciating the greatness of the Creator.
- **Issue :** The effect of strict diets on metabolic processes.

Cross-Cutting Concepts :

Cause and Effect.

Lesson Objectives :

By the end of the lesson, the student should be able to :

1. Distinguish between gas exchange and cellular respiration in living organisms.
2. Identify the structure of the mitocondria.
3. Recognize the mechanism of cellular respiration.
4. Distinguish between anabolic and catabolic processes in metabolism.

Lesson Preparation :

The figure shows an automated teller machine ATM
It works with electricity and gives you cash money when you have enough money in your bank account.
This lesson explores ideas that will help you answer these questions:
Which of the following in a living cell represents:

- The ATM
- The balance in the bank account.
- The electricity that powers the machine.
- Cash money.

• Gas exchange occurs in the process of respiration, where living organisms obtain oxygen from the air and release carbon dioxide. What is the difference between respiration (gas exchange) and cellular respiration, which produces energy?

Cumulative knowledge

▶ Plants do not have a specialized respiratory system, but they obtain oxygen necessary for respiration from the air through natural openings in the leaves called stomata.

First Gas exchange

• Gas exchange in plants is a biological process in which carbon dioxide gas and oxygen gas are exchanged with the surrounding environment to complete the photosynthesis process during the daytime and the respiration process during the day and the night.

Activity 1 Predict

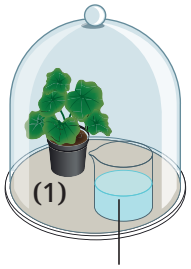
Materials and Tools Used:

• 3 pots of plants of the same type.
• 3 transparent glass bell jars.
• A beaker containing clear limewater.
• A beaker containing methylene blue solution.
• Petri dish containing soda lime (mixture of sodium hydroxide and calcium oxide).

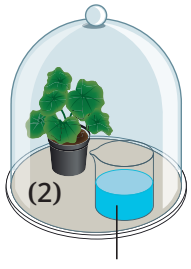
This activity should be performed once in the presence of light and another time in the absence of light.

Integration with Chemistry

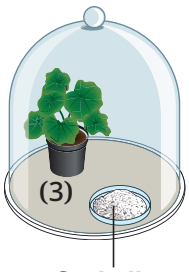
• The clear limewater solution turns milky when carbon dioxide gas is passed through it.
• The colour of the methylene blue solution disappears when oxygen is removed from the surrounding medium.
• Soda lime and sodium hydroxide solution are substances that absorb carbon dioxide gas from the surrounding medium.



Clear limewater solution
Figure (1)



Methylene blue solution
Figure (2)



Soda lime
Figure (3)

Steps

1. Place the beaker of clear limewater next to pot (1) and cover them with the first bell jar (Figure 1).
2. Place the beaker of methylene blue solution next to pot (2) and cover them with the second bell jar (Figure 2).
3. Place the petri dish which contains soda lime next to pot (3) and cover them with the third bell jar (Figure 3).

According to the previous:

(1) Predict what will happen after hours of conducting the experiment shown in each of the following:

Figure (1):

- Daytime : .....
- Night : .....

Figure (2):

- Daytime : .....
- Night : .....

(2) What change is likely to be observed when the oxygen gas percentage decreases and the carbon dioxide gas percentage increases?

.....

(3) How can we conclude that respiration occurs at night?

.....

(4) Predict the possibility of the occurrence of the photosynthesis in (Figure 3). Explain.

.....

It is clear from the above that:

- **Gas exchange occurs during:**
  - Day and night in the respiration process, when plants obtain oxygen gas and release carbon dioxide gas.
  - Daytime only in photosynthesis due to the availability of light.
- **It is obvious that:**
  - The consumption of oxygen in the respiration process is indicated by the disappearance of the blue colour of the methylene blue solution.
  - The formation of carbon dioxide in the respiration process is indicated by that the clear limewater turns milky.

Second Cellular Respiration

- The process of breaking down the large molecules of nutrients such as glucose inside the living cells in the presence of oxygen, where the atoms are rearranged to form smaller molecules of water and carbon dioxide gas, releasing a quantity of energy in the form of ATP molecules. This process is known as cellular respiration, most of which takes place inside the mitochondria.

Mitochondria

- Mitochondria (Singular : Mitochondrion) are specialized organelles that resemble beans (Figure 4) and are found in most cells. They work as power stations, producing energy from nutrients.
- **Mitochondrion structure comprises :**

(1) An outer membrane, whose function is to protect the components of the mitochondrion and regulate the entry and exit of substances.

(2) An inner membrane which forms folds called cristae, which increase the internal surface area of the mitochondrion, allowing more energy to be produced.

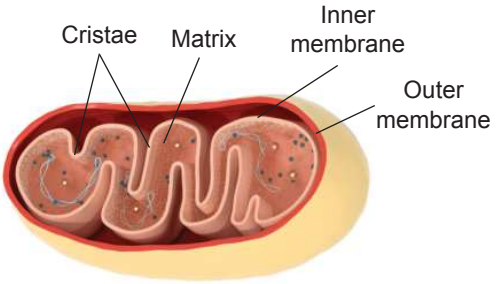


Figure (4)
Structure of a mitochondrion (in eukaryotes)

③ The matrix is a fluid found inside the inner membrane of the mitochondrion, containing the enzymes used to catalyze the reactions that take place inside the mitochondrion. The number of mitochondria increases in some cells, such as liver and muscle cells, which require a large amount of energy.

Cross-Cutting Concepts: Cause and Effect

The inner membrane of the mitochondrion forms folds that increase its surface area (Cause), which enhances energy production in cellular respiration with high efficiency (Effect).

Mechanism of Cellular Respiration

• Cellular respiration occurs in two stages (Figure 5):

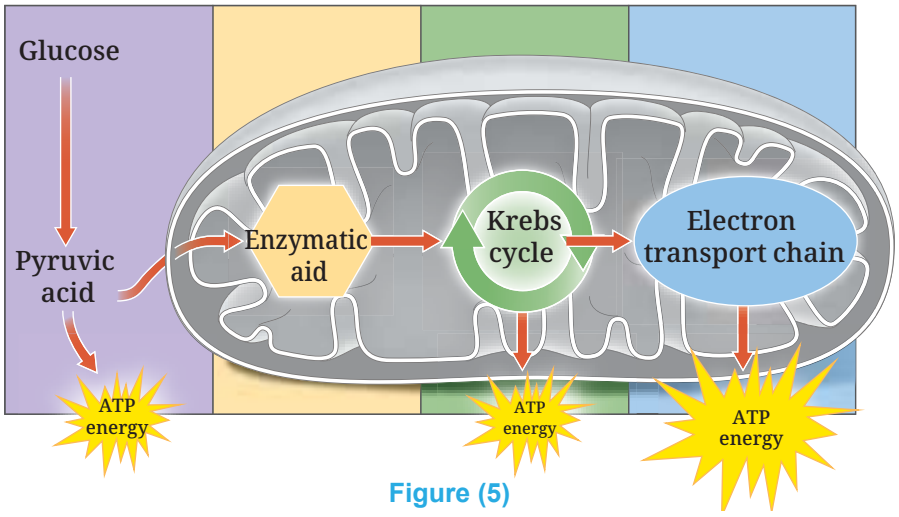


Figure (5)

Mechanism of cellular respiration

1 The first stage:

- It takes place in the cytoplasm in the absence of oxygen of the atmospheric air, where all glucose molecules are broken down in the presence of water (glycolysis) through a series of chemical reactions into two molecules of pyruvic acid (pyrovate), in addition to the formation of limited energy in the form of ATP molecules.
- Pyruvic acid is transferred to the mitochondria.

2 The second stage:

This takes place inside the mitochondria in the presence of oxygen, where two types of reactions occur :

- Krebs cycle reactions: A group of chemical reactions that occur in the matrix, in which pyruvic acid is broken down, to produce limited energy in the form of ATP molecules and carbon dioxide gas, which is transferred to the atmospheric air.
- Electron transport chain reactions: These occur on the inner membrane of the mitochondrion, involving the electrons which are produced from the Krebs cycle to form:
  - A large quantity of energy in the form of ATP molecules.
  - Water.

Evaluate Your Understanding

1 Compare between the light dependent reactions of photosynthesis **and** the reactions of cellular respiration regarding:

(1) Location.

.....

(2) The product that transferred to the atmospheric air.

.....

2 Complete the balanced symbolic equation that represents the cellular respiration process :

$C_6H_{12}O_6$ + ... ⟶ ..... + ... + ATP energy

Energy and Metabolism

Living organisms need energy to carry out all the vital processes necessary for survival, including growth and movement. This is achieved through a series of chemical reactions that take place in the body's cells.

These reactions include anabolism (building up) and catabolism (breaking down) processes, known as metabolism.

Anabolism (Building up processes)

Processes in which the energy of ATP molecules is consumed in building a large, complex molecule from many simple molecules (Figure 6), such as the formation of glycogen from glucose and the formation of proteins from amino acids in the cytoplasm and ATP molecules from ADP molecules.

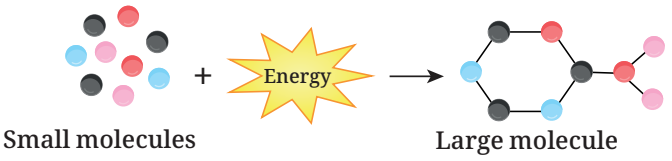


Figure (6)
Anabolic process

Catabolism (Breaking down processes)

Processes in which the energy of ATP molecules is released by breaking down a large molecule that has been built before into simpler molecules (Figure 7), such as breaking down of glucose molecules during cellular respiration and breaking down of protein molecules and glycogen molecules during digestion.

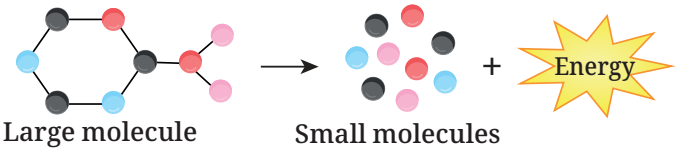


Figure (7)
Catabolic process

Issue for Discussion

The effect of strict diets on the metabolic processes.

Scientific Skills Interpretation

• Why is the process of breaking bonds in glucose molecules accompanied by energy absorption, while the process of breaking down glucose is accompanied by energy release?

.....

.....

Cross-Cutting Concepts: Cause and Effect

Breaking down the nutrients such as glucose involves breaking bonds and forming new bonds (Cause), consequently it is accompanied by the formation of new products and the release of energy (Effect).

Evaluate Your Understanding

Classify the following processes by placing the letter (A) next to the anabolic processes and the letter (C) next to the catabolic processes:

• Wound healing. (.....)

• Conversion of amino acids into proteins. (.....)

• Cellular respiration. (.....)

• Conversion of fats into energy. (.....)

Technological Application

Metabolic analyzer (Figure 8) provides accurate data about the resting metabolic rate (during rest), helping in effective planning of diet and exercise for more successful and sustainable weight management.

Figure (8)
Metabolic analyzer

Evaluation Questions on Lesson Two

1 Choose the correct answer for questions (1) - (5).

(1) Which of the following is correct about respiration?

(a) It occurs during the day and night in all cells.

(b) It occurs during the day and night in the cells of green parts.

(c) It occurs only at night in all cells.

(d) It occurs only at night in the cells of green parts.

(2) Mitochondria contain .....

(a) a folded outer membrane.

(b) a flat inner membrane.

(c) a fluid matrix called cristae.

(d) matrix containing enzymes.

(3) Green plastids are similar to mitochondria in the presence of .....

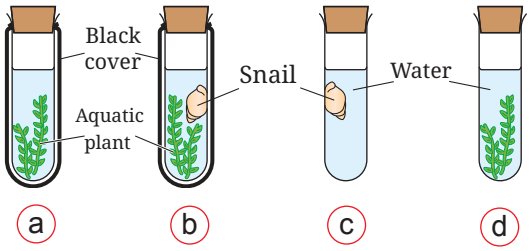
(a) enzymes in the stroma and matrix.

(b) cristae.

(c) thylakoids.

(d) grana.

(4) In which of these cases do photosynthesis and respiration occur at the same time?



(5) Photosynthesis represents process (X) and cellular respiration represents process (Y). Which of the following represents (X) and (Y)?

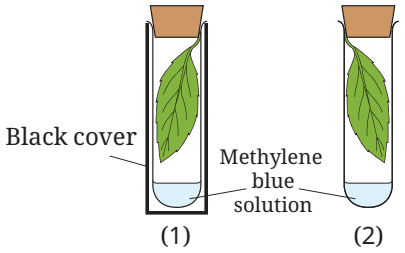
(a) (X): Catabolic process, (Y): Anabolic process.

(b) (X): Anabolic process, (Y): Anabolic process.

(c) (X): Anabolic process, (Y): Catabolic process.

(d) (X): Catabolic process, (Y): Catabolic process..

2 The following figure shows one of the scientific experiments conducted in an open place exposed to sunlight:



(1) What do you notice about the colour of the methylene blue solution in tubes (1) and (2) after several hours? Explain your answer.

(2) Identify each of the following:

1- The controlled variable.

2- The independent variable.

3 Explain the following:

(1) The presence of folds in the inner membrane of the mitochondria.

(2) Most cellular respiration processes take place in the mitochondria.

(3) The number of mitochondria in muscle cells increases.

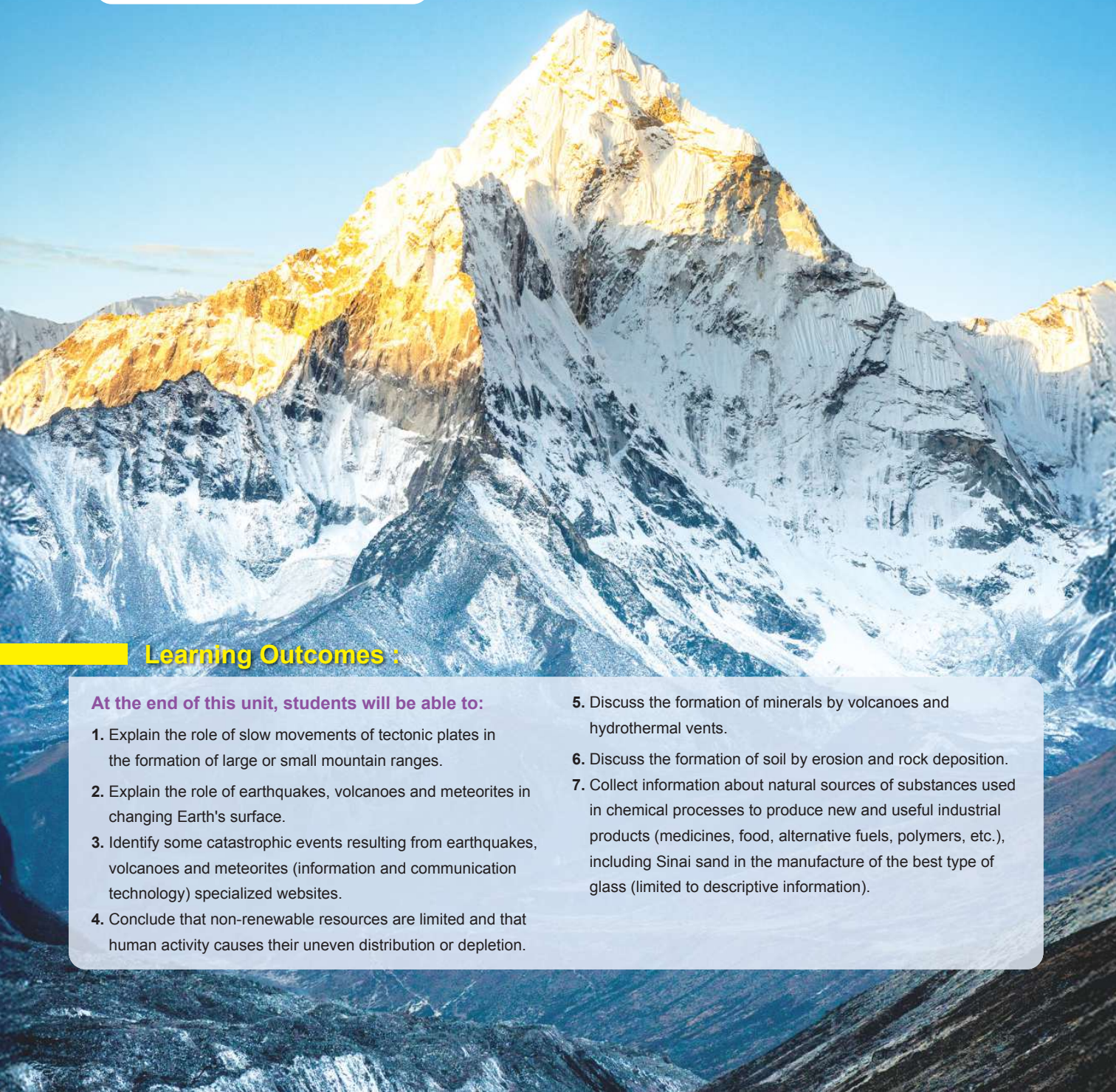
UNIT 4

Geological Processes

The lessons

Lesson one : Changes in Earth's surface.

Lesson two : Formation of minerals and soil.



Learning Outcomes :

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

1. Explain the role of slow movements of tectonic plates in the formation of large or small mountain ranges.
2. Explain the role of earthquakes, volcanoes and meteorites in changing Earth's surface.
3. Identify some catastrophic events resulting from earthquakes, volcanoes and meteorites (information and communication technology) specialized websites.
4. Conclude that non-renewable resources are limited and that human activity causes their uneven distribution or depletion.
5. Discuss the formation of minerals by volcanoes and hydrothermal vents.
6. Discuss the formation of soil by erosion and rock deposition.
7. Collect information about natural sources of substances used in chemical processes to produce new and useful industrial products (medicines, food, alternative fuels, polymers, etc.), including Sinai sand in the manufacture of the best type of glass (limited to descriptive information).

Lesson **one**

Changes in Earth's surface

Lesson Terminology :

- Continental Drift.
- Tectonic Plates.
- Oceanic Plates.
- Continental plates.
- Earth's crust.
- Mantle.
- Magma.
- Earthquake.
- Volcano.
- Meteorite.

Included Skills, Values and Issues :

- **Skill :** Conclusion.
- **Value :** Appreciating the greatness of the Creator.
- **Issue :** Social justice in addressing the natural disasters.

Cross-Cutting Concept :

- Patterns.

Lesson Objectives :

By the end of the lesson, students should be able to:

1. Identify Wegener's hypothesis of continental drift.
2. Understand the theory of tectonic plates.
3. Distinguish between the types of tectonic plates' movements.
4. Recognize the role of earthquakes, volcanoes and meteorites in changing Earth's surface.
5. Conclude the catastrophic risks of earthquakes and volcanoes.

Lesson Preparation :

The figure here shows a volcanic island.
This lesson explores ideas that will help you answer these questions:

- What is a volcano? What role does it play in changing Earth's surface?
- How are volcanic islands formed?
- Can a volcanic eruption cause an earthquake?

Earth's surface has changed over millions of years as a result of many geological processes, till it tooks its present shape. **How did scientists explain these changes?**

The Continental Drift Hypothesis

• With the evolution of the shape of the world map over time, scientist Alfred Wegener proposed a hypothesis called continental drift... What is it?

Activity 1 Conclude

Study (Figure 1), then answer the following questions:

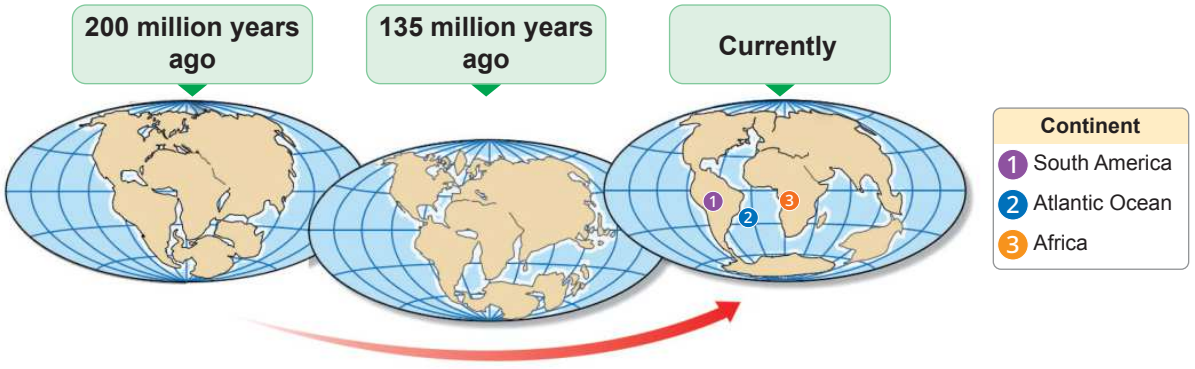


Figure (1)
The theory of continental drift

1. Has the shape of Earth changed over time?

.....

2. Did the currently existing continents exist 200 million years ago?

.....

3. What was the shape of the continents 1 and 3 200 million years ago?

.....

In 1912, German scientist Wegener presented his theory known as continental drift, in which he assumed that 200 million years ago, the land was a single large continent called Pangaea, which then began to drift apart over time.
135 million years ago, the continents of Africa and South America started to separate from each other, and over time, the continents took on the shape they are today.
However, Wegener was unable to explain how the continents moved as they separated from each other, till the theory of tectonic plates emerged, which is considered the modern development of the continental drift theory.

Information and Communication Technology

You can view the GPlates software and enjoy learning about what Earth's surface looked like millions of years ago.

The theory of tectonic plates

• The theory of tectonic plates is based on several assumptions, which are:

① The Earth's lithosphere (Figure 2), which includes the Earth's crust, in addition to the solid part of the upper mantle, is divided into the oceanic crust (covered by water) and the continental crust (covered by land).

② The oceanic crust and the continental crust are made up of solid plates of different shapes and sizes, known as tectonic plates.

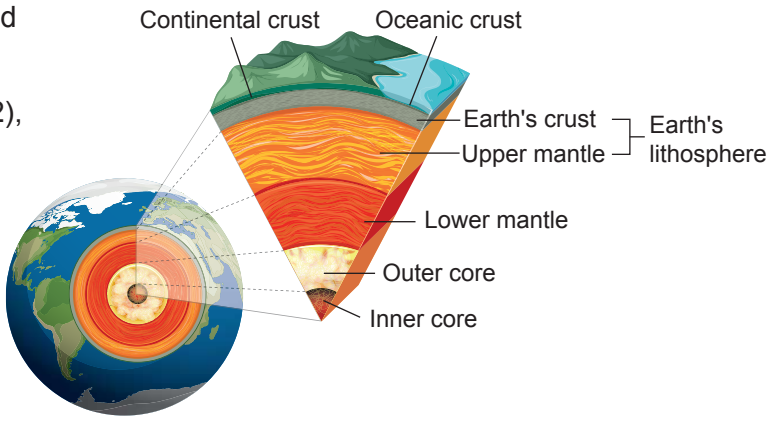


Figure (2)
Layers of Earth

③ **Tectonic plates are classified into:**

- Oceanic plates, which are composed of a thin, high-density oceanic crust and a part of the upper mantle.
- Continental plates which are composed of a thick continental crust and a part of the upper mantle.

④ Tectonic plates move in a slow and continuous movement, barely noticeable in relation to each other, above a layer of molten rock (or magma) called the asthenosphere as a result of the movement of the convection currents in the upper mantle.

Movement of tectonic plates

• The movement of tectonic plates affects the appearance of Earth's surface through the flow of magma beneath it. This movement is classified into three types:

1 Divergent movement. 2 Convergent movement. 3 Transform movement.

1 Divergent movement

• The movement of tectonic plates away from each other is known as divergent movement (Figure 3). The areas where the plates diverge are called divergent boundaries, and when two continental plates diverge due to **the upwards convection current**, the following are established :

- A new oceanic crust, such as the formation of the Red Sea in Africa.
- A new continental crust, such as the African Great Rift Valley.

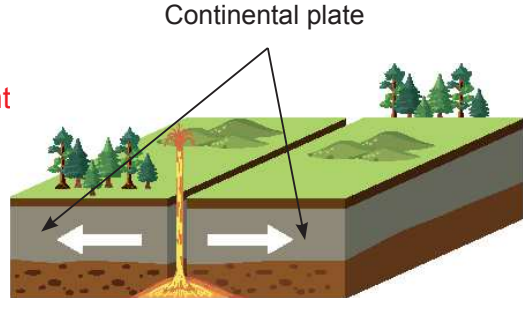


Figure (3)
Divergent movement of plates

Integration with Ecology

The Red Sea (Figure 4) was named as such for the abundance of the red algae in it and the reflection of the colour of the red mountains and rocks on its shores, especially in Sinai.

Figure (4)
Image of the Red Sea from space

2 Convergent movement

- The movement of tectonic plates towards each other is known as convergent movement (Figure 5) due to the downward convection current, where each two plates meet and one subducts (slides) under the other. The areas where the plates converge are called convergent boundaries.

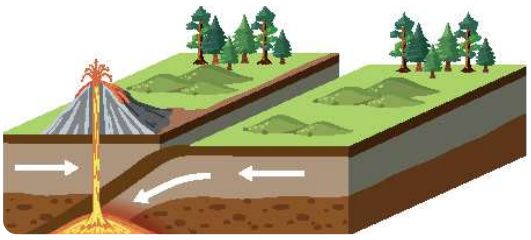


Figure (5)
Convergent movement of plates

Convergence occurs between:

- Two oceanic plates, which resulted in the formation of new arcs (chains) of volcanic islands, such as the Japanese islands.
- Two continental plates which resulted in the formation of the Himalayan mountain range (Himalayas) (Figure 6).
- An oceanic plate with a continental plate : The oceanic plate which is greater in density subducts under the continental plate, which has less density, this resulted in the formation of the Andes mountain range.

Figure (6)
Himalayan mountain range (Himalayas in Asia)

Integration with Geography

The Himalayas are higher than the Andes mountains because of their higher peak, while the Andes mountains are longer than the Himalayas because of their geographical extension.

3 Transform movement

- The horizontal movement of tectonic plates that are parallel to each other (side by side) is known as transform movement (Figure 7). and the areas where the plates move are called transform boundaries.

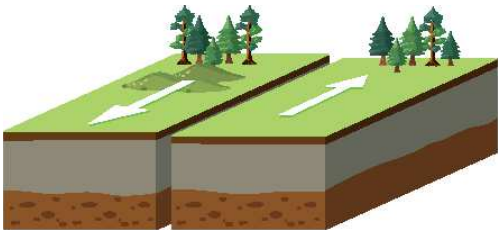


Figure (7)
Transform plates movement

The transform movement resulted in the formation of long faults (fault lines) such as San Andreas fault (Figure 8).

Geologists predict that new changes in Earth's land features will occur as the tectonic plates continue to move. **For example:** The Red Sea will be converted into an ocean in the future, and the Mediterranean Sea will become a mountainous continental region.

Figure (8)
San Andreas fault (in USA)

Evaluate your understanding

Study Figure (9), then answer the following questions:

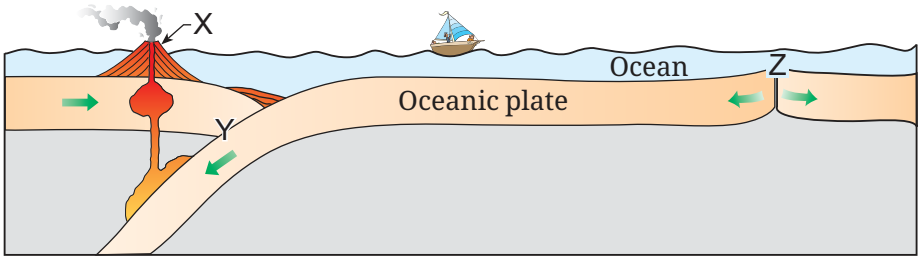


Figure (9)

1. What is the feature of Earth's surface at point (X)?

.....

2. What type of boundary is found at:

1. Area (Y). .....

2. Area (Z). .....

The role of earthquakes in changing Earth's surface

- Earthquakes are rapid, successive natural tremors that occur in Earth's crust. The theory of tectonic plates forms the scientific basis for understanding the origin of earthquakes. As the movement of tectonic plates leads to the storage of enormous amounts of energy in rocks. When the rocks break, this energy is released at the boundaries of the plates, forming what are known as tectonic earthquakes.This type of earthquakes is the most common type of earthquakes on Earth.

The role of strong earthquakes in changing Earth's surface is evident in:

1. The emergence or submergence of some islands and coasts.
2. Landslides or landslips.
3. The Earth cracks (Figure 10).
4. The tsunamis, which change the shape of coastlines.

- **Earthquakes vary in intensity, as they may be weak and not felt by human, or they may be strong and lead to:**
  - Human casualties, including deaths and injuries.
  - Material losses in the form of destruction of facilities and infrastructure, such as the collapse of buildings, roads, bridges, water, electricity and gas lines, and other else.

Figure (10)
Earth crack

Research Activity

Search multiple sources of knowledge, including the Internet for information on tsunamis.

Issue for Discussion

Social justice in addressing natural disasters.

The role of volcanoes in changing Earth's surface

- A volcano is a vent in Earth's crust that allows molten rock and trapped gases to escape to Earth's surface (Figure 11).
- The theory of tectonic plates forms the scientific basis for understanding the origin of volcanoes, as the divergent movement of tectonic plates creates a space between them into which magma rushes, and convergent movement leads to the melting of rocks, which rise to the surface through cracks, forming volcanoes at the boundaries of the plates.

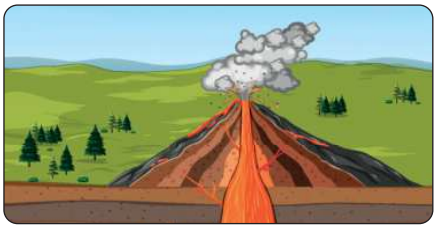


Figure (11)
Volcanoes

The role of volcanoes in changing Earth's surface is evident in:

1. The formation of volcanic mountains such as the Harrat Rahat in Saudi Arabia (Figure 12).
2. Formation of flat plains and plateaus.
3. Covering (disappearance) of valleys and rivers.
4. Change in the course of rivers.
5. Formation of volcanic islands such as the Hawaiian Islands.

Figure (12)
Crater of one of the Harrat Rahat mountains

Damages caused by volcanoes include:

- Human casualties due to inhalation of toxic gases and volcanic ash.
- Environmental losses, such as cities being covered in volcanic ash, which may lead to their disappearance, air and water pollution, and the formation of acid rains.

Cross-Cutting concept : Patterns

Earthquakes are similar to volcanoes in that they do not occur randomly, but are distributed in a clear pattern along the boundaries of tectonic plates.

The role of meteorites in changing Earth's surface

• Meteorites are rock masses that penetrate Earth's atmosphere and fall to the ground. Some of them cause huge circular craters, such as the Arizona crater in the United States and the Mount Kamel crater (Figure 13) in the Western Desert in the New Valley Governorate in Egypt. Scientists believe that meteorites caused the extinction of the dinosaurs long before human existence.

Figure (13)
Meteorite crater, Mount Kamel

Technological Application

NASA has developed an advanced radar system known as DART, whose function is to change the orbit of meteorites to protect Earth from meteorite collisions (Figure 14).

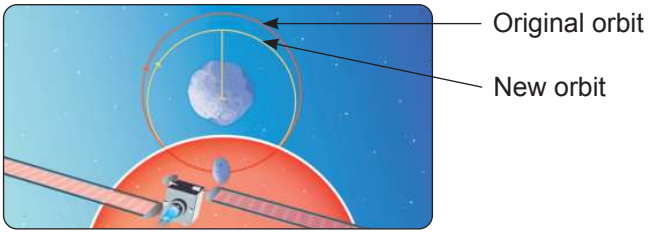


Figure (14)
DART system

Evaluation Questions on Lesson one

1 Choose the correct answer for the questions (1) – (5).

(1) Among the slow geological movements inside Earth are .....

(a) earthquakes.
(b) volcanic eruptions.
(c) convergence of tectonic plates.
(d) weathering of rocks.

(2) All the following are correct statements about the Red Sea, except .....

(a) it was formed by the convergence of two oceanic plates.
(b) it was formed by the divergence of two continental plates.
(c) it contains an abundance of red algae.
(d) it may turn into an ocean in the future.

(3) Some rocks on the west coast of Africa and the east coast of South America contain similar remains of ancient organisms, suggesting that they both were .....

(a) part of an ancient ocean.
(b) a single mass in ancient times.
(c) located near the North Pole.
(d) a forest area in ancient times.

(4) All the following are natural phenomena that cause changes in Earth's surface, except .....

(a) volcanic eruptions.
(b) the aurora borealis.
(c) meteorites.
(d) earthquakes.

(5) The dark line on the map shown in the following figure illustrates the San Andreas Fault in America:

What caused this fault?

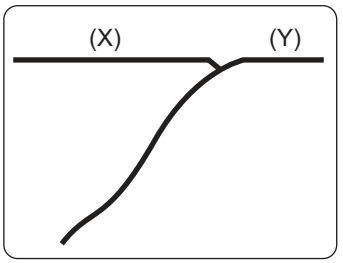
(a) Divergent plate movement.
(b) Convergence of two continental plates.
(c) Convergence of two oceanic plates.
(d) Transform movement of plates.

2 Explain the following:

(1) The formation of the Himalayan mountain range.

(2) The formation of the African Great Rift Valley.

3 The following figure shows a convergent boundary:



(1) Draw arrows on the figure to show the direction of movement of the two plates (X) and (Y).

(2) Classify the plates (X) and (Y) into continental plates and oceanic plates, with explanation.

Lesson **Two**

Formation of Minerals and Soil

Lesson Terminology:

- Minerals.
- Ores.
- Silicate.
- Crystallization.
- Hydrothermal Vents.
- Non-renewable Resources.
- Soil.
- Humus.
- Transported Soil.
- Sedentary Soil.

Included Skills, Value, and Issue :

- **Skills :** Practical practices - Conclusion.
- **Value :** Collaboration.
- **Issue :** Sustainability and resource protection.

Cross-Cutting Concepts :

- Cause and Effect.

Lesson Objectives :

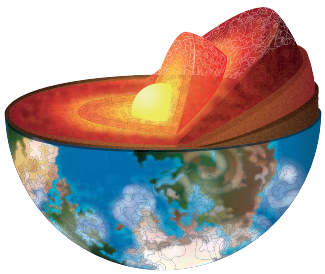
By the end of the lesson, student should be able to :

1. Identify the properties of minerals.
2. Understand how minerals are formed.
3. Understand how soil is formed.
4. Conclude that non-renewable resources are limited.
5. Identify the role of human activity in the unequal distribution or depletion of resources.

Lesson Preparation :

The figure shows the layers of Earth. This lesson explores ideas that will help you answer the following questions :

- In which layers of Earth is soil formed ?
- What is the relationship between Earth's interior and the formation of minerals?
- What is the relationship between soil and minerals ?



• Geological processes play a fundamental role in the formation of **minerals**, which in turn make up rocks. Weathering and erosion of rocks lead to the formation of **soil**.

First Minerals

• **A mineral** is a naturally occurring solid inorganic substance that has a crystalline structure and a specific chemical composition.
• Minerals exist in the form of elements, such as sulphur (Figure 1), or in the form of compounds, such as hematite (red iron oxide) (Figure 2), which is widespread in the Eastern Desert of Egypt.

Figure (1)
Sulphur mineral

Figure (2)
Hematite mineral

Research Activity

Write a report explaining the minerals found in Egypt in the northern coast, Sinai and eastern desert regions, using sources that are reliable in terms of accuracy of information.

Properties of the minerals :

The specific chemical composition of the mineral gives it a definite (specific) crystalline structure, which plays critical role in determining its properties, including :

1. The colour.
2. Luster (shining).
3. Transparency.

1 The colour :

Some minerals have definite colours, such as sulphur, which is yellow (Figure 1), while others change colour depending on the type of impurities they contain (Figures 3 and 4)

Figure (3)
Violet quartz

Figure (4)
Pink quartz

2 Luster (shining) :

Some minerals have luster similar to that of metals, such as galena, which was used by the ancient Egyptians to make eye makeup (kohl) (Figure 5).

Figure (5)
Galena used as eye makeup (kohl) by the ancient Egyptians

3 Transparency :

The minerals differ from each other in their ability to allow light to pass through them. For example the mineral talc is opaque in some forms (Figure 6), the mineral mica is translucent (Figure 7), while the pure quartz is transparent (Figure 8).

Figure (6)
Talc is opaque

Figure (7)
Mica is translucent

Figure (8)
Quartz is transparent

According to the previous, halite (table salt crystals) (Figure 9) is described as a mineral, while opal (Figure 10) is described as mineraloid, because even though opal has a specific chemical composition and luster, it is not crystalline, unlike halite.

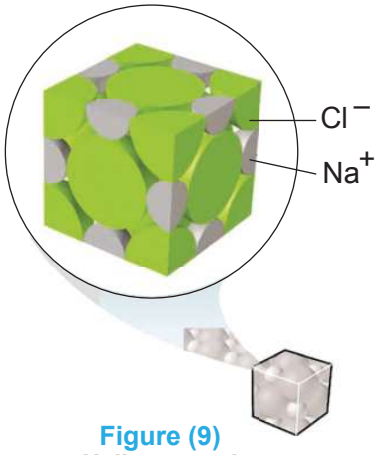


Figure (9)
Halite crystal

Figure (10)
Opal

Origin of minerals

- **Minerals originate in nature from several sources, including :**
  1. Magma solidification.
  2. Crystallization of solutions from hydrothermal vents.

1 The formation of minerals from magma solidification :

Most of the minerals that make up Earth's crust are formed by magma solidification. When silica-rich magma solidifies, it forms minerals such as **mica and quartz**. If the magma contains relatively high amounts of magnesium and iron, it solidifies to form minerals such as **olivine and pyroxene** (Figure 11).

Figure (11)
Pyroxene mineral

2 The formation of minerals from the crystallization of solutions from hydrothermal vents :

• The process of mineral formation from the crystallization of solutions can be explored by **performing the following activity :**

Cumulative knowledge :

► **The solution** is a homogeneous mixture of a solvent and a solute. The most common and important solvent is **water**.

Activity 1 Practical

Materials and Tools Used :

• Sodium acetate salt. • Water. • Beaker. • Heat source.

Steps :

1. Dissolve sodium acetate salt in a beaker containing water to form a saturated solution that cannot accept more salt.
2. Heat the saturated solution and add more salt to form a supersaturated solution.
3. Slowly pour the hot solution onto a quantity of cold solid sodium acetate salt (Figure 12).

What do you observe ?

.....

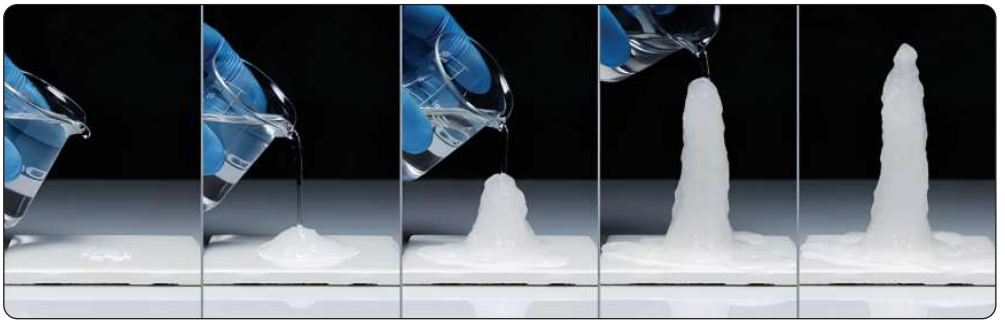


Figure (12)
Formation of a column of sodium acetate crystals

The excess salt in the supersaturated solution collects around the cold salt, in a process known as crystallization.

• Hydrothermal vents were formed near active volcanic areas, where ocean water seeps into cracks beneath Earth's surface. so water is heated by the heat of the magma and dissolves some of the minerals which compose the surrounding rock.

• The superheated water (400°C) loaded with minerals rises once again to the surface through porous rocks. When it comes into contact with the cold ocean water (2°C), many minerals such as apatite and calcite become crystallized (Figure 13).

Figure (13)
Crystallized minerals from the Yellowstone hot spring

Second The Soil

• The Soil is the surface layer of Earth's crust resulting from the fragmentation of rocks and the decomposition of organic matter, or both (Figure 14). Mature soil contains water, air, humus (decomposed organic matter), clay, silt, gravel, and sand.

Figure (14)
Agricultural soil

Soil is classified into several types, depending on the way it was formed, including :

1. Transported soil.
2. Sedentary soil.

1 Transported soil :

• Transported soil includes several types, including river soil, which is the soil that has been broken down in one place and then transported to another by rivers, **such as** the soil of the Nile Delta, where the Nile River transported rock fragments from the Ethiopian plateau to Egypt over millions of years. The chemical composition of this soil differs from the composition of the rock above it in its current location.

2 Sedentary soil :

• Sedentary soil (which remains in the same location) includes several types, including residual soil which is soil that has formed as a result of the slow weathering of rocks in the same place, and therefore resembles the original rock above it in chemical composition.
Examples of residual sedentary soil in Egypt include Mariout soil and Oasis soil, both of which were formed from the fragmentation of sandy and limestone rocks. It should be noted that most Egyptian soil is of the transported type.

Cumulative knowledge :

- **Weathering** is the process of breaking and fragmenting the rocks. It can be **mechanical**, caused by wind, running water, temperature differences, or the growth of plant roots inside rock cracks, or **chemical**.
- **Erosion** is the process of transporting rock fragments resulting from weathering process away from the areas where they were originally found.

Cross-Cutting Concepts : Cause and Effect

Weathering of rocks (Cause) leads to the formation of soil (Effect).

Limited non-renewable resources :

• With the start of the industrial revolution in the late 18th century, the consumption of non-renewable resources increased, especially with the growth of the population and the advancement of industry, which causes a threat of depletion, especially since it takes millions of years to be replenished.

• **Minerals and fossil fuels** are examples of non-renewable resources.

Cumulative knowledge :

- **Non-renewable resources** are natural resources that can be obtained from Earth's spheres, (excluding the biosphere), and cannot be replenished once consumed.

Activity 2 Conclude

Pair up with a classmate of yours to study (Figure 15) :

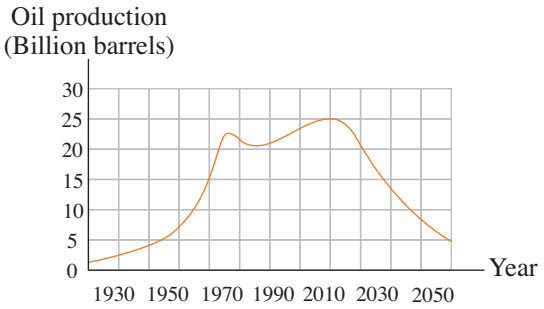


Figure (15)

1. What do you conclude from the rate of oil production over time ?

.....

2. Calculate the difference in oil production between 1970 and 2010 ?

.....

3. What is the effect of the oil production rate after 2010 on the price per barrel in the global market ?

.....

4. In which year do you expect oil to be depleted if production continues at the same rate as in 2010 ?

.....

It is clear from the above that :

- Non-renewable resources are limited so, there is an urgent need to reduce the rate of its consumption.
- Increased human activity in mining field, which is the extraction of the natural resources, such as fossil fuels and minerals, as well as the control of the non-renewable resources in developing countries by the major mining companies in the developed countries through the agreements, leads to the unfair distribution of natural wealth (resources) and possibly to its depletion.

Issue for Discussion

Sustainability and protection of non-renewable resources.

- **This requires working on** the sustainability of the non-renewable natural resources by preserving them from depletion and finding new alternatives for them, **through :**

1. Shifting to the use of renewable sources such as solar energy, wind energy and hydroelectric energy.
2. Recycling minerals instead of new mining.
3. Using technologies that consume less energy, such as electric cars and energy-efficient appliances.
4. Developing industrial alternatives to resources, such as rechargeable batteries.

Research Activity

Gather information from knowledge sources about the use of Sinai sand in the manufacture of the best types of glass.

Evaluation Questions on Lesson Two

1 Choose the correct answer for questions (1) – (5).

(1) The most widespread group of minerals in Earth's crust is the .....

(a) carbonates.
(b) oxides.
(c) phosphates.
(d) silicates.

(2) The mineral pyroxene contains relatively high proportions of the two elements .....

(a) magnesium and iron.
(b) magnesium and copper.
(c) copper and iron.
(d) potassium and sodium.

(3) What is the property which describes a mineral as opaque ?

(a) Colour.
(b) Luster.
(c) Transparency.
(d) Scratch.

(4) When silica-rich magma solidifies, it forms .....

(a) olivine.
(b) quartz.
(c) pyroxene.
(d) hematite.

(5) The type of Oasis soil is .....

(a) river-sedentary.
(b) river-transported.
(c) residual sedentary.
(d) residual transported.

2 The following two figures illustrate some of the physical properties of two minerals :

(A)

(B)

(1) What is the property distinguishing mineral (A) ?
(2) What causes the colour change in mineral (B) ?

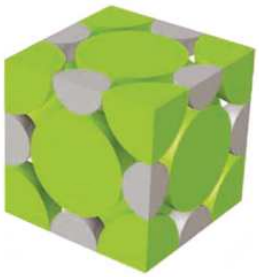
3 Why is oil not considered a mineral ?

4 What is the difference between the soil of the Nile Delta and the soil of Mariout ?

5 State :

(1) Two ways to ensure the sustainability of the non-renewable natural resources.
(2) The distinctive properties of minerals.
(3) Some sources of minerals origin in nature.

6 The following figure represents a crystal of one of the minerals :



(1) What is the name of this mineral ?
(2) Why is this crystal classified as a mineral, unlike opal ?

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