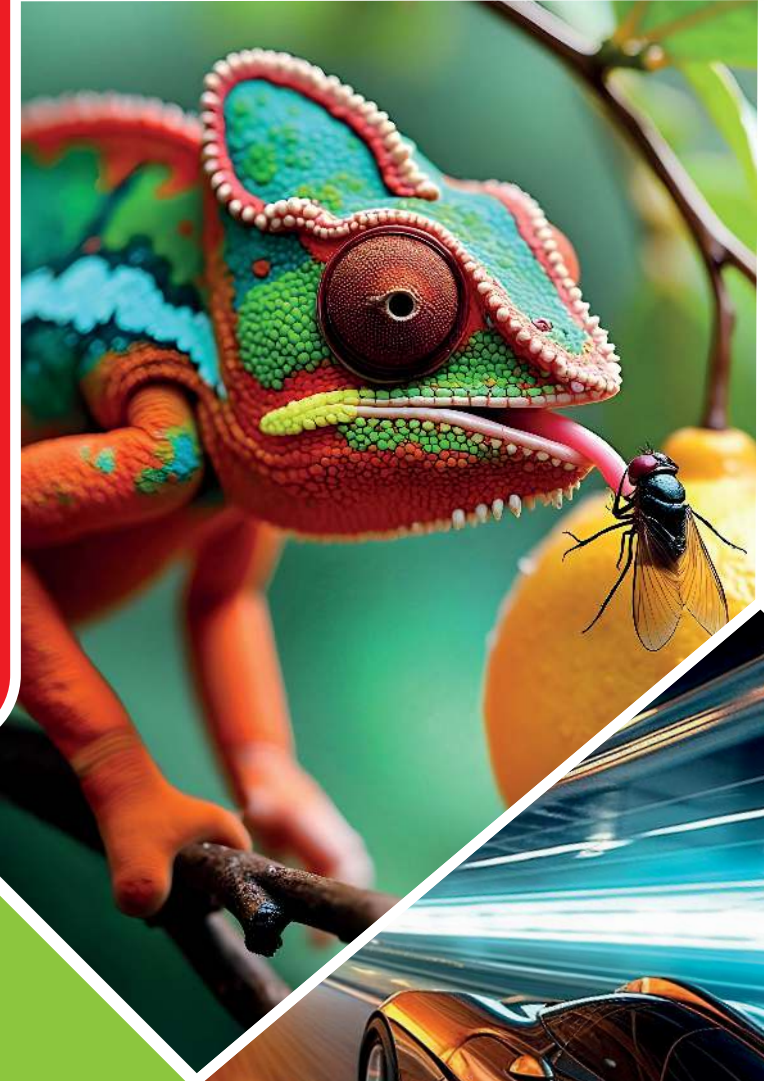

Student's Book

Discover and Learn

SCIENCE

First Preparatory - Second term

2024 -2025

GPS
للطبع والنشر والتوزيع

Discover and Learn

SCIENCE

First Preparatory - Second Term

2024 - 2025

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Introduction

Dear student,

We are delighted to present the science book to our first-year preparatory students. We want to emphasize the role of science in the development and advancement of society, and that science is not just a subject to study, but a way of thinking that helps you understand the world more deeply and make decisions based on precise knowledge. Learning science is an active process relied on discovery, research, experimentation, thinking, and practicing various scientific methods such as observation, interpretation, communication, prediction, experimentation, and drawing conclusions. The title of this curriculum reflects its philosophy, which is "Discover and Learn."

This book aims to foster students' love for exploration and experimentation, encourage critical thinking, collaboration, asking questions, and discovering answers through observation, experimentation, and a variety of activities that help them view scientific concepts practically and enjoyably. It also aims to help students develop a deep understanding of scientific concepts, apply scientific knowledge to new situations, solve problems, develop research and inquiry skills, encourage the ability to ask questions, design experiments, analyze data, develop innovative solutions, and enhance their understanding of the connections between science, technology, engineering, and mathematics. The book prepares students to be lifelong learners capable of facing future challenges.

To achieve these goals, this book covers various fields of science such as chemistry, physics, biology, and space sciences in the form of interconnected and combined study units, which are also linked with other subjects. This enhances students' comprehensive and integrated understanding of how these fields intersect in the real world. The topics included in this curriculum address key concepts in the areas of matter, energy, living organisms, and space, which helps in encouraging scientific inquiry.

The curriculum is based on active learning strategies in delivering its lessons, raising numerous scientific and social issues, and instilling many values. The lessons are enriched with sources of knowledge and communication technology, encouraging research skills, self-learning, and developing critical thinking skills to help students reflect and assess their understanding of what they study and learn.

We hope you find inspiration in this book that encourages you to continue your scientific curiosity. Always remember that scientists were once curious young men and women like you, searching for answers to their questions and discovering new wonders. You, too, may be the scientists who discover things that no one has found before!
As we introduce this book, we pray to God that it brings benefit to all.

Best wishes,
The Authors

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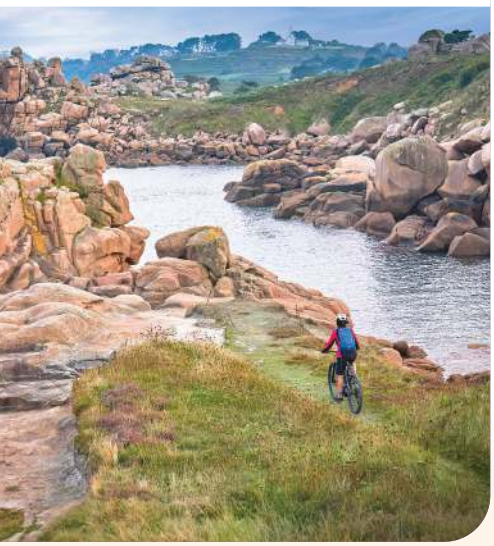


Natural Cycles

UNIT 1

Chemical Substances

The lessons

Lesson one : Metals and Nonmetals

Lesson two : Acids and Alkalis

Lesson three : Chemical indicators and Salts

Learning Outcomes :

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

1. Explain the metallic bond.
2. Differentiate between metals and nonmetals.
3. Describe bronze alloy.
4. Differentiate between the properties of each of the acids and the alkalis.
5. Recognize pH and its relation with acidity and basicity.
6. Describe the properties of the salts.
7. Distinguish between acids, alkalis and salt solutions by using chemical indicators.
8. Recognize a profile of the scientist Soren Sorensen.

Lesson **one**

Metals and Nonmetals

Lesson Terminology :

- Metal.
- Nonmetal.
- Metallic bond.
- Alloys.

Included Skills, Values and Issues :

- **Skills** : Discovery - Conclusion - Deduction.
- **Value** : Collaboration.
- **Issue** : The environmental effects of mining.

Lesson Objectives :

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

1. Differentiate between the properties of each of the metals and the nonmetals.
2. Identify the metallic bond.
3. Describe the formation of the alloys.
4. Identify the importance of metals recycling.

Lesson Preparation :

The figure shows a lion statue found at the entrance of Qasr El-Nile bridge. This lesson explores ideas that will help you answer these questions :

- What is the relation between bronze and copper ?
- Is copper a metal or a nonmetal ?
- Why are the statues not made of nonmetals ?

Metals and Nonmetals

In the first term, you have learned that :

– The last energy level in most Metals contains either 1, 2 or 3 electrons, while the last energy level in most Nonmetals contains either 5, 6 or 7 electrons.

– All metals are solids, **except** mercury which exists in the liquid form (Figure 1), while nonmetals are either solids or gases, **except** bromine which exists in the liquid form (Figure 2).

Figure (1) Mercury

Figure (2) Bromine

Activity 1 Discover

Collaborate with your classmates to discover the differences between the metals and the nonmetals through studying the figures from (3):(6), **and answering the questions of each of them :**

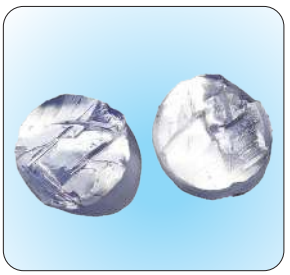


Figure (3) Sodium

Figure (4) Carbon (Graphite)

① **From the figures (3) and (4) :**

- **Which is the metallic element ? and which is the nonmetallic element ?**
  - The metallic element : .....
  - The nonmetallic element : .....
- **Which of the two elements has metallic luster ?**

.....

② **From figure (5) :**

- **Which is the metallic element ? and which is the nonmetallic element ?**
  - The metallic element : .....
  - The nonmetallic element : .....
- **Which of the two elements is ductile, malleable and formable, and which of them is brittle ?**

.....

.....

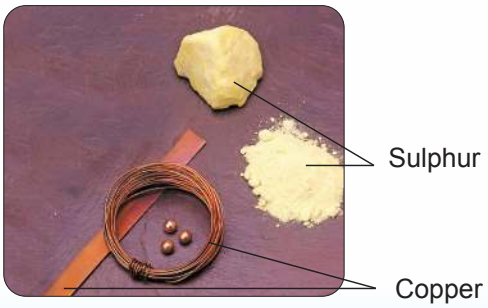


Figure (5)

③ **Construct an electrical circuit as shown in figure (6), then connect the two ends (X) and (Y) by using the following substances to test their electrical conductivity :**

- Sheets of (Zinc - Copper - Silver).

.....

- Pieces of (Sulphur - Graphite - Phosphorus).

.....

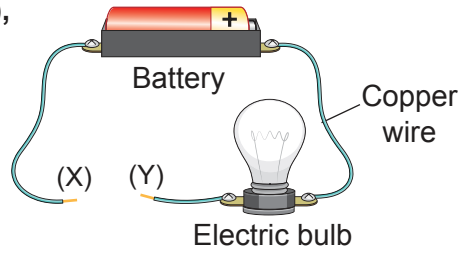


Figure (6)

It is concluded from the previous that :

– Metals such as sodium, copper, zinc and silver have metallic luster, and are ductile, malleable and formable, unlike the brittle nonmetals which don't have luster (opaque) such as carbon and sulphur.

– Metals are good electrical conductors, unlike nonmetals (except graphite) which is used in dry cells (Figure 7), furthermore, metals are distinguished from nonmetals by their high melting points, and their thermal conductivity (conduct heat).

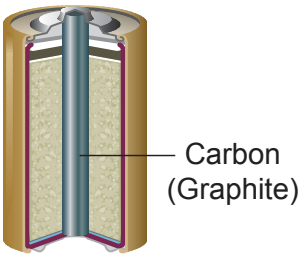


Figure (7)
Dry cell

Research Activity

Search in various knowledge sources, including the internet and the library in your school, about the most electrical conductive metals, and the most ductile and malleable metals.

Evaluate Your Understanding:

Table (1) shows the properties of four elements :

Element	Physical state	Electrical conductivity	Colour
(W)	Solid	Bad conductor	Coloured
(X)	Solid	Good conductor	Black
(Y)	Gas	Bad conductor	Colourless
(Z)	Liquid	Good conductor	Coloured

Table (1)

Which of the following are represent some of these elements ?

(a) (W) : Sulphur, (Y) : Hydrogen, (Z) : Bromine.

(b) (W) : Carbon, (Y) : Hydrogen, (Z) : Mercury.

(c) (X) : Carbon, (Y) : Oxygen, (Z) : Mercury.

(d) (X) : Sulphur, (Y) : Oxygen, (Z) : Bromine.

Metallic bonds

The atoms of the solid metals are gathered in an arrangement known as Metallic crystal lattice (Figure 8), they exist in the lattice as cations (Positive ions) surrounded by a cloud of the free-moving valence electrons (Figure 9), the attraction force between the positive metal ions and the negative valence electron cloud which surrounds them is called Metallic bond.

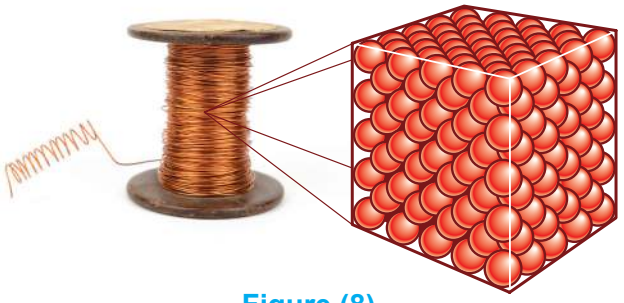


Figure (8)

Crystal lattice of copper metal

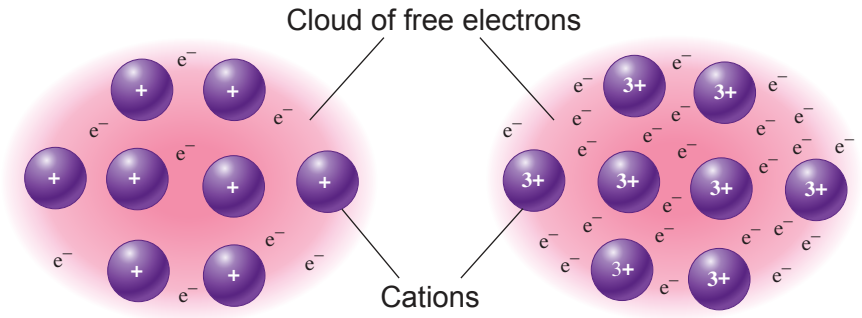


Figure (9)

Metallic bond of sodium $\cdot Na$ **Metallic bond of aluminum** $\cdot \dot{A}l \cdot$

- Some physical properties of the metals are due to the fact that their atoms bind together with metallic bonds, these metallic bonds are responsible for the metals hardness and their high melting points, where the hardness of metals increase by increasing the number of valence electrons.

Scientific Skills

Complete the table (2) with the suitable melting point of each metal from the following melting points **(650°C, 98°C, 660°C)**, **With explanation.**

Metal	Melting point
Sodium $\cdot Na$	.....
Magnesium $\cdot \dot{M}g$	.....
Aluminum $\cdot \dot{A}l \cdot$	.....

Table (2)

Explanation : .....

Alloys

- **Pure metals** are soft, almost unfit for the industrial uses, therefore one metal melt or more is added to another metal melt to form what is known as Alloy, where its properties are differ from the properties of the elements forming it.
- Alloys are mixtures, most of them are not expressed in molecular formulas.
- Bronze alloy is one of the well known alloys used in jewellery (Figure 10), medals (Figure 11) and statues (Figure 12), it is composed of copper (95%), tin (5%) and bronze alloy is characterized by being harder than copper, and it does not rust.

Figure (10)

Figure (11)

Figure (12)

Life Application

The process of the conversion of the wastes into new usable substances is known as Recycling (Figure 13).

Some metals as copper, aluminum and iron are recycled **for the following reasons** :

- Their percentage in the earth's crust decreases.
- It is difficult to extract them from their ores.
- Recycling metals is much cheaper than extracting them from their ores.

Figure (13)
Metal recycling

Issue for Discussion

The environmental effects of mining.

Evaluation Questions on Lesson one

1 **Choose the correct answer for the questions from (1) : (5).**

(1) All the following are properties of sodium element, except .....

(a) a metal.
(b) has metallic luster.
(c) bad electrical conductor.
(d) formable.

(2) Which of the following is the correct arrangement of the hardness of sodium $_{11}$Na, magnesium $_{12}$Mg and aluminum $_{13}$Al ?

(a) Na > Mg > Al (b) Al > Mg > Na
(c) Mg > Na > Al (d) Al > Na > Mg

(3) Element (X) its boiling point is 2807°C and its melting point is 1064°C Which of the following is a property of element (X) ?

(a) Bad electrical conductor.
(b) Brittle. (c) Ductile.
(d) Opaque.

(4) Which of the following questions helps in the classification of some elements to metals and nonmetals ?

(a) Is it solid ? (b) Is it liquid ?
(c) Is it coloured ? (d) Is it brittle ?

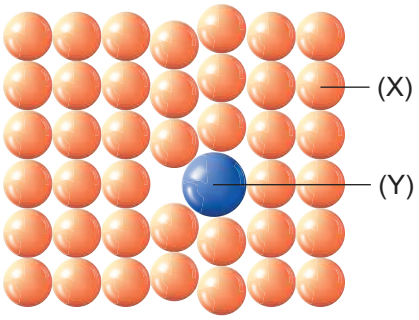
(5) What is the common property of both sodium and copper ?

(a) Colour.
(b) Density.
(c) Melting point.
(d) Physical state.

2 **Compare between metals and nonmetals, in terms of :**

- Electrical conductivity.
- Malleability, ductility and formability.
- Metallic luster.

3 **The following figure illustrates the composition of the bronze alloy :**



(1) What are the elements (X) and (Y) ?

(2) Why are alloys preferred to be used more than the pure metals ?

4 **The table below shows the properties of 3 elements (a metal, a nonmetal and a metalloid) without order :**

Element	Properties
(X)	• Solid at room temperature. • Shiny. • Brittle. • Heat conductor.
(Y)	• Solid at room temperature. • Shiny. • Soft. • Electrical conductor.
(Z)	• Solid at room temperature. • Opaque. • Brittle. • Bad electrical conductor.

Identify the metal and the nonmetal of these elements, with explanation.

Lesson **Two**

Acids and Alkalis

Lesson Terminology :

- Atomic group (Polyatomic).
- Acid.
- Alkali.
- Oxyacid.
- Acidic oxide.
- Base.
- Acid rain.

Included Skills, Values and Issues :

- **Skills** : Discovery - Prediction - Process.
- **Values** : Appreciation of scientists - Collaboration.
- **Issue** : Economic effect of acid rain.

Cross-Cutting Concept :

- Cause and Effect.

Lesson Objectives :

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

1. Identify Atomic (polyatomic) groups.
2. Conclude the molecular formulas of acids and alkalis.
3. Name the molecular formulas of the acids by knowing the names of their anions.
4. Distinguish between acids and alkalis by using two litmus strips.
5. Recognize the difference between acids and alkalis.
6. Recognize the relation between metal and nonmetal oxides and each of acids and alkalis.
7. Compare between the electrical conductivity of each of strong acids and weak acids.
8. Recognize the harmful impacts of the acid rain.

Lesson Preparation :

This figure shows some household cleaners. This lesson explores the ideas that will help you answer the following questions :

- Are these cleaners acidic substances or basic substances ?
- What is the relation between metals and alkalis, and between nonmetals and acids ?
- Can the rain be acidic ?

Acids and Alkalis

The scientist Arrhenius showed that acids are substances that dissolve in water and give positive hydrogen ions H^+, while alkalis are substances that dissolve in water and give negative hydroxide ions OH^-, this ion is composed of more than one atom of more than one element is known as polyatomic ion or Atomic Group.

Table (1) shows some atomic groups and their molecular formulas :

Atomic group	Formula
Hydroxide	OH^-
Nitrate	NO_3^-
Nitrite	NO_2^-
Carbonate	CO_3^{2-}
Bicarbonate	HCO_3^-
Sulphate	SO_4^{2-}
Sulphite	SO_3^{2-}
Phosphate	PO_4^{3-}
Ammonium	NH_4^+

Table (1)

Molecular formulas of acids and alkalis

The molecular formula of the acid begins with the symbol of hydrogen cation H^+, the name of the acid is related to the name of the anion which composes it, while the molecular formula of the alkali ends with the formula of hydroxide anion OH^- , and the name of the alkali is related to the name of the cation which composes it.

Activity 1 Analyze

Team up with one of your classmates to analyze the names of the acids and the anions which compose them in the tables (2) and (3) and the names of the alkalis and the cations which compose them in table (4).

Formula of acid molecule	Anion	Name of the compound in gaseous state	Name of the compound in solution form
HCl	Chloride Cl^-	Hydrogen chloride	Hydrochloric acid
HBr	Bromide Br^-	Hydrogen bromide	Hydrobromic acid
H_2S	Sulphide S^{2-}	Hydrogen sulphide	Hydrosulphuric acid

Table (2)

1 **Do the acids shown in table (2) contain oxygen element ?**

.....

2 **What is the suffix (letters added to the end) of each of the anion and the acid composed from it ?**

.....

3 **What is the section with which the name of the acid begins ?**

.....

Anion	Formula of acid molecule	Name of acid
Nitrate NO_3^-	HNO_3	Nitric acid
Nitrite NO_2^-	HNO_2	Nitrous acid
Sulphate SO_4^{2-}	H_2SO_4	Sulphuric acid
Sulphite SO_3^{2-}	H_2SO_3	Sulphurous acid
Phosphate PO_4^{3-}	H_3PO_4	Phosphoric acid

Table (3)

4 **Do the acids shown in table (3) contain oxygen element ?**

.....

5 **What is the suffix of the acid whose anion ends with :**

- The suffix (–ate) : .....
- The suffix (–ite) : .....

Cation	Formula of alkali molecule	Name of alkali
Sodium Na^+	NaOH	Sodium hydroxide
Magnesium Mg^{2+}	$Mg(OH)_2$	Magnesium hydroxide
Ammonium NH_4^+	NH_4OH	Ammonium hydroxide

Table (4)

6 **What is the section with which the name of the alkali ends in table (4) ?**

.....

It is clear from the previous that :

- The acids which do not contain oxygen element end with the word acid preceded by a section with the prefix (letters added at the beginning) Hydro followed by the name of the anion with replacing the suffix (–ide) with the suffix (–ic).
- The acids which contain oxygen element (oxyacids) whose anion suffix is :
  - (–ate) : Ends with the word acid, preceded by the name of the anion with replacing the suffix (–ate) with the suffix (–ic).
  - (–ite) : Ends with the word acid, preceded by the name of the anion with replacing the suffix (–ite) with the suffix (–ous).
- Number of hydrogen atoms in the acid molecule equals the magnitude of the charge of its anion.
- Number of hydroxide groups in the alkali molecule equals the magnitude of the charge of its cation.
- The total charge of a molecule of any compound is equal to zero.

Evaluate Your Understanding:

Write the formula and the name of the acid which contains the following anions :

(1) Iodide I^- : .....

(2) Carbonate CO_3^{2-} : .....

(3) Chlorite ClO_2^- : .....

Integration with Life Sciences

Acids play important roles in human body, **among them are** :

- Hydrochloric acid which is secreted by the stomach and participates in food digestion.
- Lactic acid which provides the muscles with energy during their lack of oxygen, but its accumulation in the muscles causes muscle cramps (Figure 1).

Figure (1)

Properties of acids and alkalis

In your house, you will find many acids and alkalis, for example, lemon, ketchup and grapes (Figure 2) are **acidic substances**, while cleaners, tooth paste and baking soda (Figure 3) are **alkaline substances**.

Figure (2)
Acidic substances

Figure (3)
Alkaline substances

What is the difference between the properties of acids and alkalis ?

Activity 2 Predict

Study Figure (4) which expresses the dissolution of hydrogen chloride gas HCl in water, and **figure (5)** which expresses the dissolution of solid sodium hydroxide NaOH in water,
Then answer the questions below them :

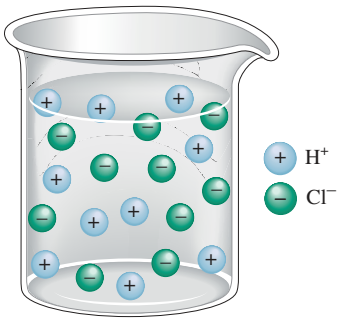


Figure (4)

- **What are the ions produced** from dissolving HCl gas in water ?

.....

- **Predict the ions produced** from dissolving sulphuric acid H_2SO_4 in water.

.....

- **What is the ion** which is common in the two solutions ?

.....

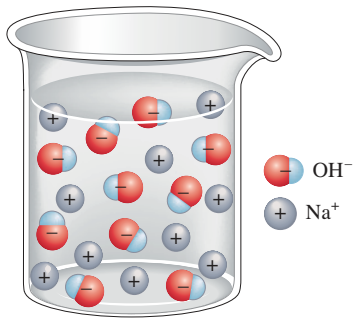


Figure (5)

- **What are the ions produced** from dissolving NaOH in water ?

.....

- **Predict the ions produced** from dissolving magnesium hydroxide $Mg(OH)_2$ in water.

.....

- **What is the ion** which is common in the two solutions ?

.....

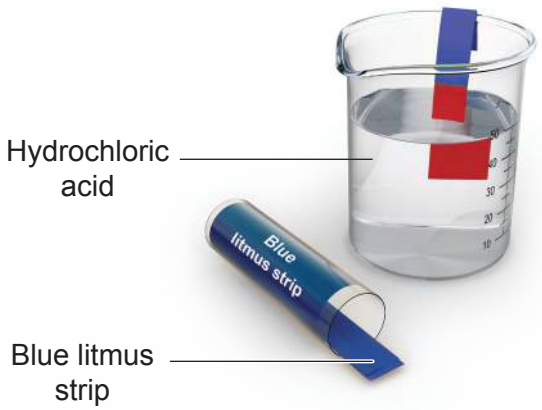


Figure (6)

What is the effect of hydrochloric acid solution on the blue litmus strip (Figure 6) ?
What is the ion responsible for this ?

.....

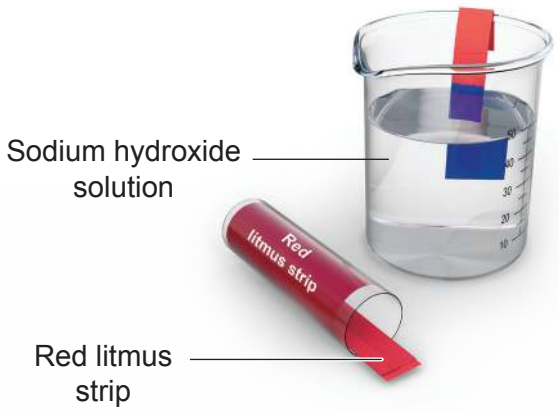


Figure (7)

What is the effect of sodium hydroxide solution on the red litmus strip (Figure 7) ?
What is the ion responsible for this ?

.....

Cross-Cutting Concepts : Cause and Effect

- **Acid** is a substance that when dissolves in water, the percentage of **H^+ cations** in the solution increases, which are responsible for all the properties of the acids.
- **Alkali** is a substance that when dissolves in water, the percentage of **OH^- anions** in the solution increases, which are responsible for all the properties of the alkalis.
- Acids **react** with alkalis **forming** salts and water, such as the reaction of hydrochloric acid HCl with sodium hydroxide solution NaOH forming sodium chloride salt NaCl and water H_2O, but acids do not react with each other, neither are the alkalis.

Medical Application

Milk of magnesia (Figure 8) is used as a temporary treatment for neutralize the gastric acidity, as it contains magnesium hydroxide $Mg(OH)_2$

Figure (8)
Milk of magnesia

- **Acids and alkalis conduct electricity to variant degrees, according to their strength.**

Activity 3 Compare

Test the electrical conductivity of each of hydrochloric acid and the acetic acid (used in making vinegar), both with the same concentration (Figure 9) :

1. **Which acid conducts electricity more (to a higher degree) ? How can this be indicated ?**

.....

.....

2. **Compare between the strength of hydrochloric acid and that of acetic acid, according to their ability to conduct electricity.**

.....

.....

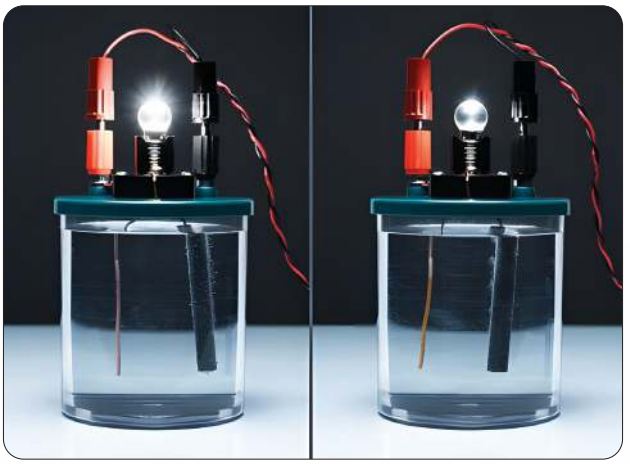


Figure (9)
Hydrochloric acid **Acetic acid**

It is clear from the previous that :

Strong acids, as hydrochloric acid, nitric acid and sulphuric acid, are good electrical conductors, while the weak acids as vinegar (dilute acetic acid), sulphurous acid and nitrous acid are bad electrical conductors.

By the same way ...

The electrical conductivity of sodium hydroxide solution (strong alkali) differs from the electrical conductivity of ammonium hydroxide solution (weak alkali).

You may wonder ... ?

Is there any relation between metals and alkalis, or between nonmetals and acids ?!

- Metals burn in the presence of oxygen forming **metal oxides**, most of them known as **basic oxides**, what can dissolve in water from them forms **alkalis**.

  Such as magnesium burning forms magnesium oxide MgO (Figure 10), which dissolves in water forming magnesium hydroxide solution $Mg(OH)_2$

- Nonmetals burn in the presence of oxygen forming **nonmetal oxides**, most of them known as **acidic oxides**, which dissolve in water forming **acids**.

  Such as sulphur burning forms sulphur trioxide SO_3 (Figure 11), which dissolves in water forming sulphuric acid solution H_2SO_4

- **Metal oxides** can react with acids, but they do not react with alkalis, while **nonmetal oxides** can react with alkalis, but they do not react with acids.

Figure (10)
Magnesium burning

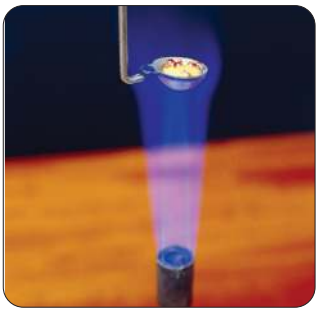


Figure (11)
Sulphur burning

Integration with Environmental Sciences

Burning of fossil fuels (such as petrol and coal) in cars, power stations (power plants) and factories causes the evolution of acidic oxides as nitrogen dioxide NO_2 and sulphur dioxide SO_2, which dissolve in the water vapour of the atmospheric air, their accumulation in the clouds leads to what is called acid rains (Figure 12), which have very harmful impacts, where they cause destruction of forests, and harm the living organisms which live in water, in addition to the corrosion of buildings, and health problems in the human respiratory system.

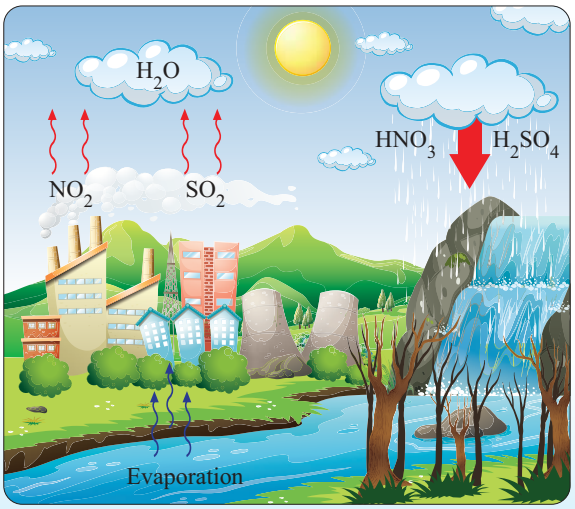


Figure (12) **Acid rains**

Evaluation Questions on Lesson Two

1 Choose the correct answer for the questions from (1) : (5).

(1) If the anion which composes the acid HClO is called hypochlorite, then the acid is called .....

(a) hypochlorous acid.
(b) hypochloric acid.
(c) perchloric acid.
(d) chlorous acid.

(2) What is the ion whose percentage in the solution increases when an acidic oxide dissolves in water ?

(a) H^+ (b) OH^- (c) Cl^- (d) Na^+

(3) Element (X) forms the oxide XO which reacts with acids. Which of the following represents (X) and XO ?

(a) (X): Metal , XO: Acidic oxide.
(b) (X): Nonmetal, XO: Acidic oxide.
(c) (X): Metal , XO: Basic oxide.
(d) (X): Nonmetal, XO: Basic oxide.

(4) On dissolving calcium oxide in water, and placing two litmus strips in the solution, the colour of one of them changes into .....

(a) red. (b) purple. (c) blue. (d) yellow.

(5) Which of the following are properties of solid sodium hydroxide ?

(a) It dissolves in water, and reacts with HCl acid.
(b) It dissolves in water, and does not react with HCl acid.
(c) It does not dissolve in water, and does not react with HCl acid.
(d) It does not dissolve in water, and reacts with HCl acid.

2 Write the names of the following acids and alkalis :

(1) H_2CO_3 **(2)** HF
(3) $Mg(OH)_2$ **(4)** LiOH

3 Write the chemical formula of each of the following compounds :

(1) Sulphuric acid.
(2) Sodium hydroxide.

4 Can the type of potassium hydroxide solution be identified by using the blue litmus strip ? Explain.

5 Element (X) oxide has the following properties :

- It can react with acids.
- It does not react with alkalis.

Is element (X) sulphur or copper ? Explain.

6 The following two figures show the same statue left in open air for nearly 100 years :


Why did the details of the statue disappear according to what you have studied ?

Lesson **Three**

Chemical Indicators and salts

Lesson Terminology :

- Indicator.
- Litmus.
- Universal indicator.
- pH scale.
- Salts.

Included Skills, Values, and Issues :

- **Skill** : Practicality.
- **Values** : Collaboration - Appreciation of scientists.
- **Issue** : Commercial fraud.

Cross - Cutting Concepts :

- Cause and Effect.

Lesson Objectives :

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

1. Recognize the concept of the indicators.
2. Compare between the effect of gases on the indicators.
3. Recognize pH
4. Differentiate between the different types of solutions in terms of the pH value.
5. Describe the properties of salts.
6. Differentiate between the different types of solutions by using the indicators.

Lesson Preparation :

This figure shows the change of the colour of a strip when it is placed in water or in a solution. this lesson explores the ideas that will help you answer these questions :

- What is the scientific name of these strips ?
- How do these strips differentiate between the different types of salt solutions ?
- What is the difference between water and aqueous solution ?
- What are the properties of salts ?

Chemical Indicators

Adding concentrated sulphuric acid to the table sugar causes it to be charred (becomes black) (Figure 1), this indicates that it is dangerous, so it is completely forbidden to taste, smell or touch any chemical substance in laboratory without teacher's permission, because some acids are burning and some alkalis are caustic.

Figure (1)

• **As we cannot identify** chemicals like acids and alkalis solutions by tasting or smelling, So.

How can we differentiate between acidic substances, alkaline substances and neutral substances ?

Activity 1 Practical

Used substances :

- Strong acid such as hydrochloric acid.
- Weak acid such as acetic acid.
- Strong alkali such as sodium hydroxide solution.
- Distilled water.
- Blue and red litmus strips.

Figure (2)

Litmus strip in hydrochloric acid

Figure (3)

Litmus strip in acetic acid

Figure (4)

Litmus strip in sodium hydroxide solution

Figure (5)

Litmus strips in distilled water

1 **What is the change occurring** in the colour of the litmus strip when it is dipped in the used solutions :

- In hydrochloric acid : .....
- In sodium hydroxide solution : .....
- In acetic acid : .....

(2) **Does** the colour of the red or the blue litmus strip change in distilled water ?

.....

(3) **Why** can't litmus strip be used to differentiate between strong acid and weak acid ?

.....

It is concluded from the previous that :

- Differentiation between acids, alkalis and neutral substances as distilled water is accomplished by using chemicals known as Indicators , they are substances whose colour differs in acidic medium from that in alkaline medium, such as litmus indicator which is used in the composition of the litmus strips.
- Distilled water is neutral, it does not change the colour of litmus strip, as number of H^+ ions in it equals number of OH^- ions.
- Litmus indicator cannot be used to differentiate between strong acids and weak acid **as** it gives the same colour with both of them.

There are many other indicators, the most famous is the universal indicator which is found in form of strips or dyes (Figure 6), it can differentiate between acids and alkalis, or between different acids, or the different alkalis, according to their strength.

Figure (6)

Strips and dye of the universal indicator

Evaluate Your Understanding

Some dyes are extracted from some plants to be used as indicators, from table (1) :

Plant	Colour of the dye	Colour of dye in acid	Colour of dye in alkali
(W)	Crimson	Purple	Green
(X)	Green	Yellow	Yellow
(Y)	Purple	Purple	Yellow
(Z)	Orange	Red	Green

Table (1)

Which of the following plants its dye cannot be used as indicator ?

(a) (W). (b) (X). (c) (Y). (d) (Z).

Testing the acidity and the basicity of the gases

1. The indicator strips must be wet with water during testing the acidic gases like carbon dioxide gas CO_2 , or the basic gases like ammonia gas NH_3 to dissolve them, where the indicators act only in aqueous medium.
2. Gaseous elements as H_2, O_2 and N_2 do not change the colour of the indicator, except chlorine gas Cl_2 which removes the colour of the two litmus strips (Figure 7).

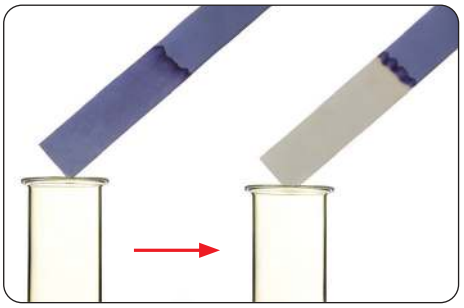


Figure (7)
Chlorine gas removes the colour of litmus strip

Integration with Agriculture Sciences

The colour of the flowers of Hydrangea plant (Figure 8) differs according to the type of the soil, where the flowers acquire red colour when they grow in acidic soil, while they acquire blue colour when they grow in basic soil.

Figure (8)
Hydrangea flowers acquire different colours according to the type of the soil

Life Application

Acidic soil is treated by adding basic substances to it, such as calcium hydroxide $Ca(OH)_2$

Cross-Cutting Concepts : Cause and Effect

The colours of most of the chemical indicators are changed by changing the type of the used solution.

Activity 2 Practical

Prepare a chemical indicator from red cabbage plant (Figure 9) by following these steps :

Figure (9) **Red cabbage**

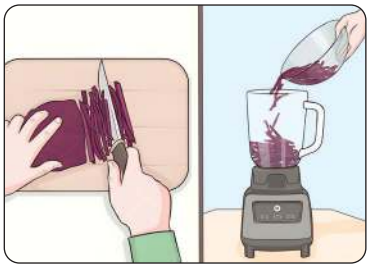


Figure (10)

1 Slice $\frac{1}{4}$ of a red cabbage plant and chop the slices using a blender.

Figure (11)

2 Add 500 mL ($\frac{1}{2}$ of a liter) of boiled water to the contents in the blender.

Figure (12)

3 Filter the mixture using a sieve.

Figure (13)

4 Add 50 mL of ethyl alcohol to the filtrate.

Figure (14)

5 Immerse a piece of paper in the filtrate until it colours, then leave it to dry.

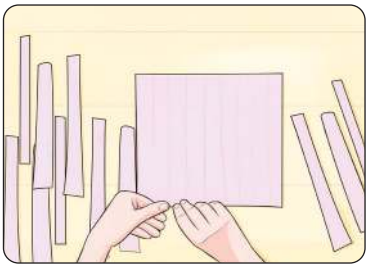


Figure (15)

6 Cut the piece of coloured paper to make the indicator strips.

7 Use the strips of the red cabbage indicator to identify the acidity, the basicity or neutralization of some liquids in your house, such as : Orange juice, water and baking soda solution

... What do you observe ?

.....

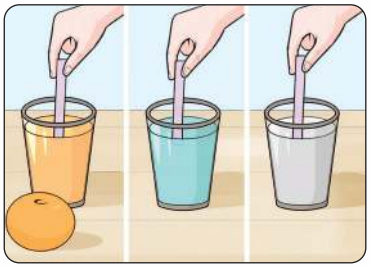


Figure (16)

Potential of Hydrogen pH

- Acidity of tomatoes differs from that of lemon, So how can the acidity be accurately identified ?
- The acidity or the basicity of the solution can be identified by what is known as pH which stands for potential of Hydrogen (Figure 18), it is a scale ranges between the values 0 to 14

A profile of the scientist

Soren Sorensen

He was a Danish chemist, he developed pH scale in 1909 to differentiate between acidic,basic and neutral solutions

Figure (17)

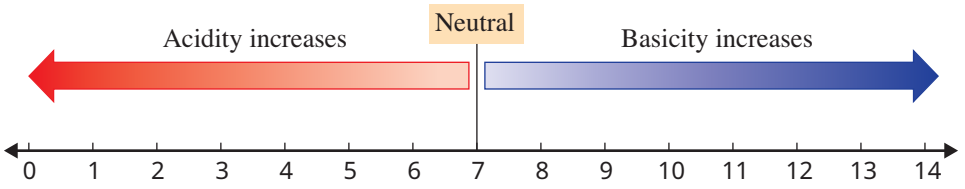


Figure (18)
pH scale

pH value of the neutral solutions and distilled water is 7 , its value decreases than 7 for the acids, and increases than 7 for the alkalis, the strength of the acidic solution increases as its pH value approaches 0, while the strength of the alkaline solution increases as its pH value approaches 14,
pH value of any solution can be measured directly and accurately by pH meter device (Figures 19, 20).

Figure (19)
Reading of pH meter for HCl acid

Figure (20)
Reading of pH meter for NaOH solution

Or, it can be measured in approximate way by using the universal indicator strips (Figure 21), by comparing the colour of the strip (after being dipped in the solution whose pH is required to be measured) with the indicator scale provided with the box, where each colour in this scale represents a definite pH value.

Figure (21)

Evaluate Your Understanding:

Figure (22) shows some pH values of some substances :

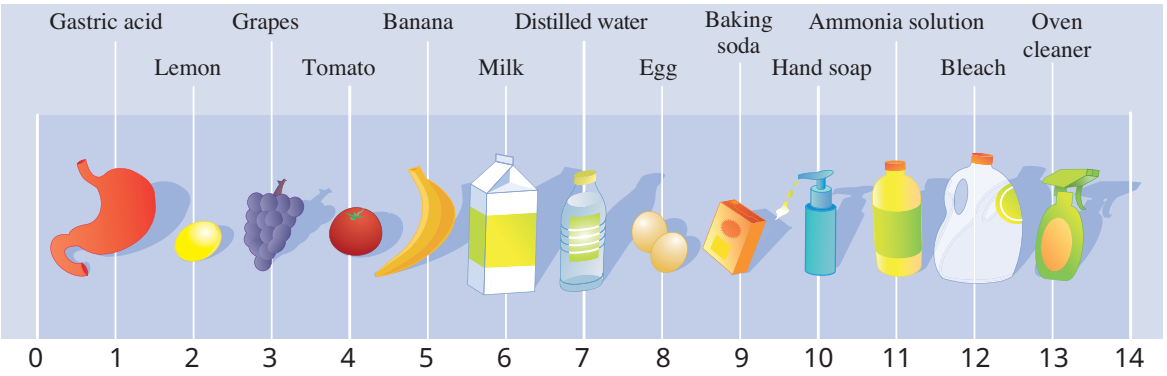


Figure (22)

(pH values are for illustration only)

1. **What is the strongest alkaline substance ? What is its pH ?**

.....

2. **What is the strongest acidic substance ? What is its pH ?**

.....

3. **Compare between the acidity of grapes and tomatoes, with explanation.**

.....

4. **Compare between the alkalinity of baking soda and ammonia solution, with explanation.**

.....

Life Application

pH values of hair and skin care products varies (Figure 23), for example, pH of a dry hair shampoo differs from that of oily hair shampoo.

Find out the pH values of the cosmetic products in your house.

Figure (23)

Hair and skin care products

Issue for Discussion

Controlling the commercial fraud in cosmetics and cleaners.

Salts

Previously, you knew some types of chemical compounds like oxides, acids and alkalis, there is another type of compounds known as salts, most of them are ionic compounds produced from the reaction of the acids with the alkalis, it is formed by the combination of a cation of an alkali with an anion of an acid.

Activity 3 Conclude

Study the figures (24) : (27), to fill in the shown spaces by :

1 The name of each ion.

2 The molecular formula of the formed salt.

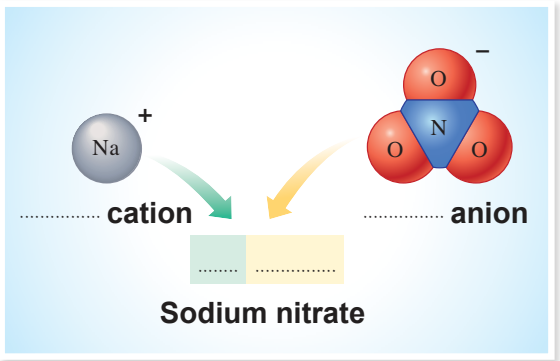


Figure (24)

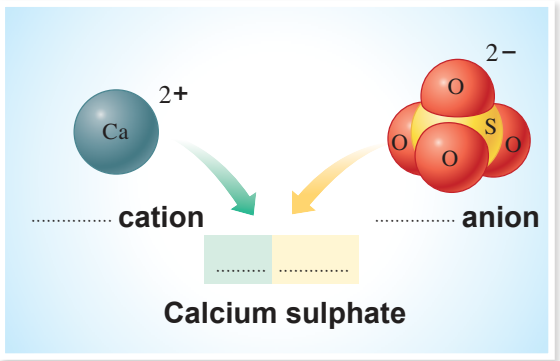


Figure (25)

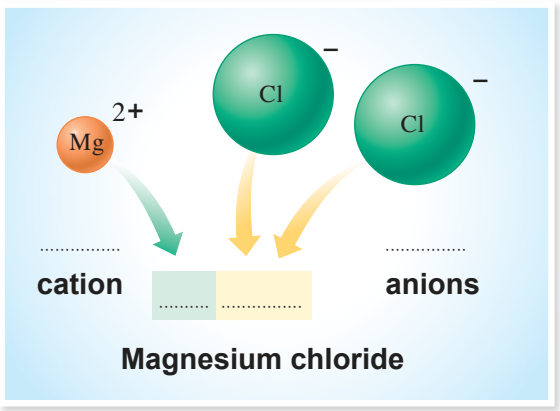


Figure (26)

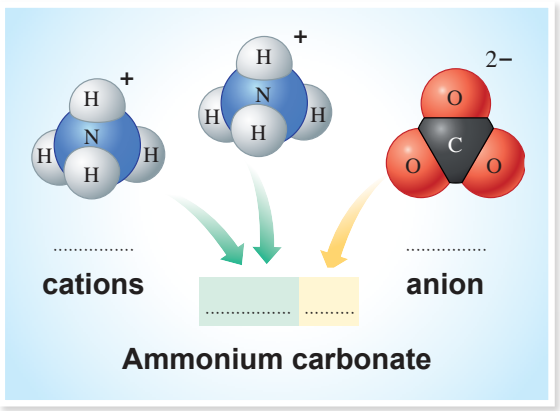


Figure (27)

It is concluded from the previous that :

- The molecule of the salt can be formed by the combination of :

- Metal ion and nonmetal ion, **except** negative oxygen ion (O^{2-} oxide).
- Ion of one element with ion of one atomic group, **except** hydroxide group (OH^-).
- Ions of two atomic groups.

- When the same atomic group is repeated in the molecular formula of the compound, it is written between brackets, and the number of its repetitions below it.
- Naming of the salt begins with the name of the cation followed by the name of the anion.

Properties of Salts

- Salts are differ from each other in their colours, solubility in water and the pH of their solutions.
- Salts are solid substances, some of them are white in colour, such as zinc sulphate salt $ZnSO_4$, sodium carbonate salt Na_2CO_3, and some are coloured, such as the blue copper sulphate salt $CuSO_4$, and the green nickel chloride salt $NiCl_2$ (Figure 28).

Figure (28)
Solid salts

- Some salts are soluble in water, they form solutions, such as copper sulphate, nickel chloride and all sodium, potassium, ammonium and nitrate salts.
- Some of them are insoluble or sparingly soluble in water, such as silver chloride AgCl, calcium sulphate $CaSO_4$, and all carbonate salts (except sodium, potassium and ammonium carbonate salts) (Figure 29).

Figure (29)
Sodium carbonate dissolves in water, while calcium carbonate does not dissolve in water

Integration with Physics science

Salinity of the Dead Sea is the highest in the world, it is almost 10 times saltier than the Red sea, so it is not possible to drown in it (Figure 30), where the high percentage of salts found in water leads to increasing the density of this water.

Figure (30)
High salinity and density of Dead Sea water

Information and Communication Technology

Watch educational videos that demonstrate how to make soap which is considered a salt.

Activity 4 Practical

Participate with a classmate of yours under teacher's supervision to investigate the approximate pH values of three different salts solutions, and their ability to conduct electricity.

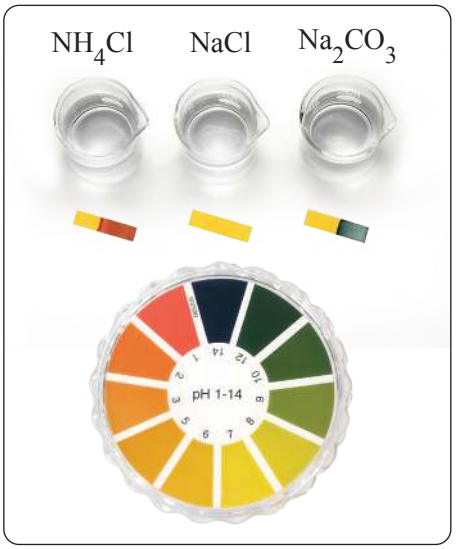


Figure (31)

1. Prepare three solutions of these salts :
   - Ammonium chloride.
   - Sodium chloride.
   - Sodium carbonate.
2. Dip universal indicator strips in these solutions to identify the approximate pH value of each of them.
3. Conclude the type of each solution in terms of acidity and basicity by the indication of pH value of it, and complete the table (2).

Solution	Ammonium chloride	Sodium chloride	Sodium carbonate
pH of solution	.....	.....	.....
Type of solution	.....	.....	.....

Table (2)

4. Test the electrical conductivity of each of the three solutions and of the distilled water as in figure (32) ...

What do you observe ?

.....

.....

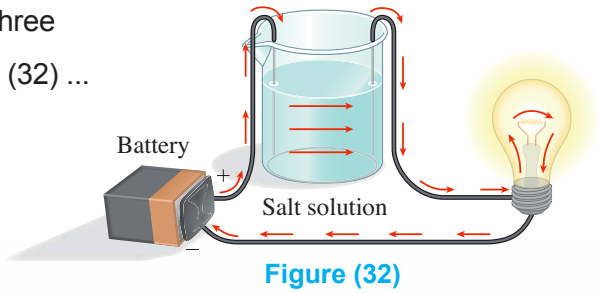


Figure (32)

It is clear from the previous that :

- Solutions of salts can be acidic as ammonium chloride solution (pH < 7), or neutral as sodium chloride solution (pH = 7), or alkaline as sodium carbonate solution (pH > 7).
- Solutions of the acids and the alkalis are similar to the solutions of the salts (mixtures of salts dissolved in water) and their melts (molten salts) in conducting electricity.

It's noticed that, solid salts do not conduct electricity, neither do the distilled water.

Evaluation Questions on Lesson Three

1 Choose the correct answer for the questions from (1) : (6).

(1) A red litmus strip is placed in solution (1), so no change in colour occurs, when it is placed in solution (2), it becomes blue. Which of the following is correct ?

(a) Solution (1) : Neutral, Solution (2) : Acidic.
(b) Solution (1) : Acidic, Solution (2) : Neutral.
(c) Solution (1) : Acidic, Solution (2) : Alkaline.
(d) Solution (1) : Alkaline, Solution (2) : Acidic.

(2) The colour of the universal indicator is the same in both .....

(a) tomato juice and hydrochloric acid.
(b) distilled water and sodium chloride solution.
(c) tomato juice and sodium hydroxide solution.
(d) distilled water and hydrochloric acid.

(3) All the following from ions that form salts, except .....

(a) OH^- (b) Cl^-
(c) NH_4^+ (d) NO_3^-

(4) All the following are properties of solid sodium carbonate salt, except .....

(a) it dissolves in water.
(b) pH of its solution is higher than 7
(c) its colour is white.
(d) it conducts electricity.

(5) pH value of a solution is changed from 8 to 5, that means it was .....

(a) acidic and becomes alkaline.
(b) acidic and becomes neutral.
(c) alkaline and becomes neutral.
(d) alkaline and becomes acidic.

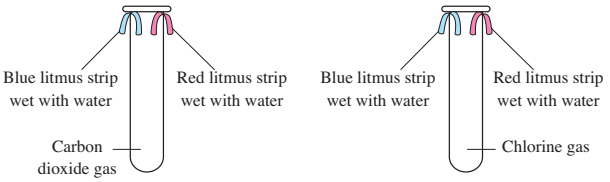
(6) From the table :

Indicator	Colour change	pH at which colour change
(X)	Red ⟶ Yellow	4
(Y)	Yellow ⟶ Blue	6.4

What is the pH value of the solution which acquires yellow colour when drops of both (X) and (Y) are added to it ?

(a) 3 (b) 5
(c) 7 (d) 10

2 What happens to the colours of the litmus strips in the following cases ?



3 Acidity of the soil varies from one place to another :

(1) How can acidic soil be treated ?

(2) What is the colour of Hydrangea flowers which grow in acidic soil ?

4 Write the molecular formulas of the salts composed from the following cations and anions :

(1) K^+ , PO_4^{3-}

(2) Al^{3+} , SO_4^{2-}

(3) NH_4^+, NO_3^-

(4) Mg^{2+}, CO_3^{2-}

UNIT 2

Energy and Its Applications

The lessons

Lesson one : Potential Energy

Lesson two : Kinetic Energy

Learning Outcomes :

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

1. Recognize the concept of potential energy.
2. Recognize the concept of kinetic energy.
3. Represented graphically the relation between kinetic energy and mass.
4. Represented graphically the relation between kinetic energy and the square of speed.
5. Differentiate between kinetic energy and potential energy mathematically.
6. Recognize the concept of mechanical energy.
7. Provide real-life examples of the transformation of potential energy into kinetic energy and vice versa.

Lesson **one**

Potential Energy

Lesson Terminology :

- Distance.
- Displacement.
- Work.
- Force.
- Energy.
- Mass.
- Independent Variable.
- Dependent Variable.
- Controlled Variables.
- Potential Energy.
- Gravitational Field Intensity.

Included Skills, Values and Issues :

- **Skills:** Calculation - Conclusion - Discovery and Data analysis.
- **Value:** Collaboration.
- **Issue:** Road Accidents.

Cross-cutting Concepts :

- Measurement - Ratio and Proportion.
- Cause and Effect.

Lesson Objectives :

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

1. Differentiate between distance and displacement.
2. Calculate the speed of an object in terms of distance and time.
3. Recognize the concept of work.
4. Explain the relation between energy and work.
5. Recognize the concept of potential energy.
6. Discover the relation between the height of an object above the ground and its potential energy.
7. Determine the potential energy of an object mathematically.
8. Differentiate between the independent variable, the dependent variable, and the controlled variables when conducting scientific experiments.

Lesson Preparation :

The opposite figure shows a bow and arrow game. This lesson explores the ideas that assist you in answering the following questions:

- What term describes the total length of the path taken by the arrow after it is released ?
- Why is it said that work has been done when pulling the arrow back ?
- Does the arrow possess energy when it is stationary (at rest) while the bowstring is drawn (pulled back)?
- Why does the arrow travel a greater distance when the force of the bowstring is increased ?

Distance (d), Displacement (s) and Speed (v)

• When a camel strays in the desert, its owner tracks its footprints in the sand (Figure 1) to ascertain its path of movement. The path of any moving object is defined as the set of points it passes through during its motion (Figure 2).

Figure (1)

Footprints of a camel in the sand

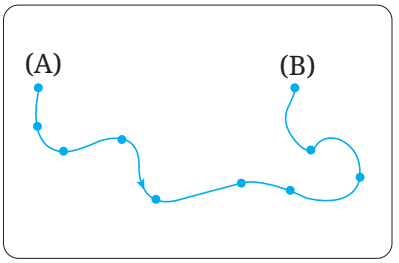


Figure (2)

The set of points defining the path

From Figure (3), it is shown that :

• The total length of any path taken by the object during its moving from the starting point to the end point is referred to as distance (d).

• The shortest straight path connecting between the starting point and the end point in a constant direction referred to as displacement (s).

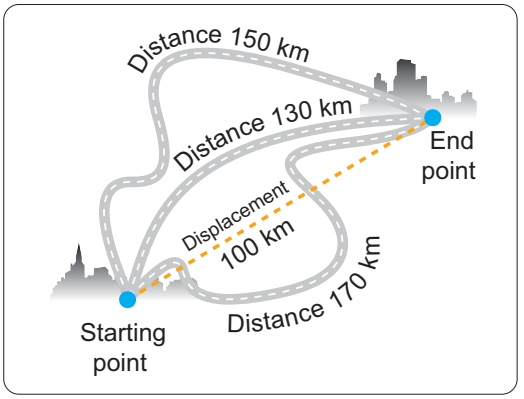


Figure (3)

Cross-cutting Concepts : Measurement, Ratio and Proportion

Both distance and displacement are measured in the same unit, which is the metre (m) or its multiples such as kilometre (km), or subdivisions such as centimetre (cm).

1 km = 1000 m, , 1 m = 100 cm

• The distance covered per unit of time is known as **speed (v)**, which is determined by the following mathematical relation:

$$\textbf{Speed (v)} = \frac{\text{Distance (d)}}{\text{Time (t)}}$$

Speed is measured in several units, including:

- Metre per second (m/s)
- Kilometre per hour (km/h)

Mathematical Understanding

Calculate the speed of an object that covers a distance of 8 m in a time of 2 s

$$v = \frac{d}{t} = \frac{8}{2} = 4 \text{ m/s}$$

Information and Communication Technology

Conversions of the measuring units of the physical quantities can be carried out directly by visiting the website: www.unitconverters.net

Issue for Discussion

The impact of vehicles exceeding the permitted speed limits on road accidents (Figure 4).

Figure (4)

Evaluate Your Understanding:

Figure (5) illustrates the path of an object from point (A) to point (B) over a time of 24 s:

Calculate each of the following:

(1) The distance.

.....

(2) The speed.

.....

(3) The displacement.

.....

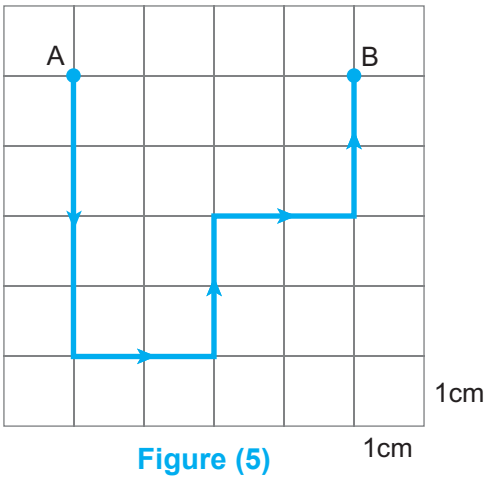


Figure (5)

Work (W)

It is said about the weightlifter that :

- Does he not do any work while he is in standing position (Figure 6)?
- Does he work while he gets up (Figure 7)?

Figure (6)

Figure (7)

Activity 1 Conclude

Study Table (1), then conclude the following:

- When does a force do work?

When .....

- When does a force not do work?

When the direction of its effect is ..... to the direction of motion.

Or when the object is .....

The case	Direction of the acting force	Direction of the object's motion	Possibility of doing work
	→	→	✓
	↓	–	✗
	↑	↑	✓
	↓	→	✗

Table (1)

It is concluded from the above that:

- A force does work when it acts on an object, causing it to be displaced in the same direction of its effect, and the greater the magnitude of the acting force is, the greater the work done.

Work (W) is defined as the amount of energy required to move an object through a certain displacement in the same direction of the force which acts on it.

Work is measured in joule (J), force in newton (N), and displacement in metre (m).

- Work is determined by the following mathematical relation:

Work (W) = Force (F) × Displacement (s)

Mathematical Understanding

- A person pushes an object with a force of 20 N, causing it to move in a straight line over a distance equals 50 m in the same direction of the force.

Calculate the amount of work done.

$$W = F \times s$$

$$= 20 \times 50 = 1000 \text{ J}$$

Analytical Thinking

Each robot in Figures (8) : (11) performs work by lifting a number of bricks to different heights.

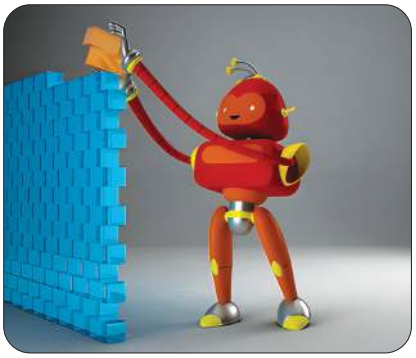


Figure (8)
Robot (1) exerts a force equals 20 N on 2 bricks to lift them vertically for 3 m

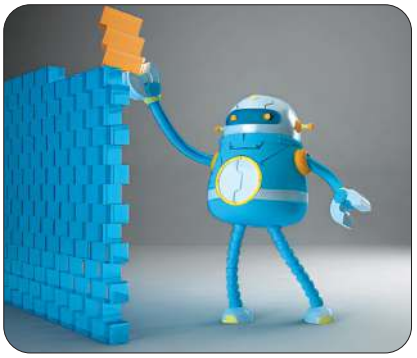


Figure (9)
Robot (2) exerts a force equals 30 N on 3 bricks to lift them vertically for 3 m

Figure (10)
Robot (3) exerts a force equals 10 N on 1 brick to lift it vertically for 2 m

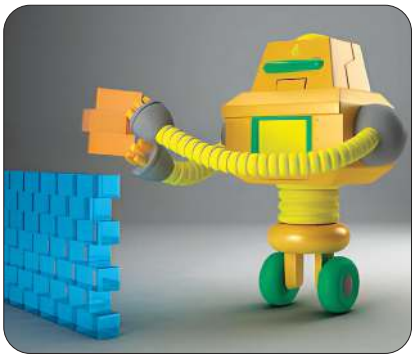


Figure (11)
Robot (4) exerts a force equals 30 N on 3 bricks to lift them vertically for 2 m

Show by mathematical calculations the numbers of the two robots which do the same work.

Energy (E)

- **Energy** is the ability to do work, it is measured like work in joule (J).
- **Forms of energy include :**
  - **Potential energy.**
  - **Kinetic energy.**

Potential Energy (PE)

When a person lifts a book from the floor to a higher shelf (Figure 12), he does work, this work is converted into stored energy in the book (Figure 13).

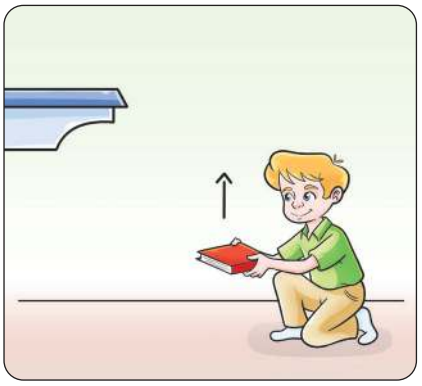


Figure (12)

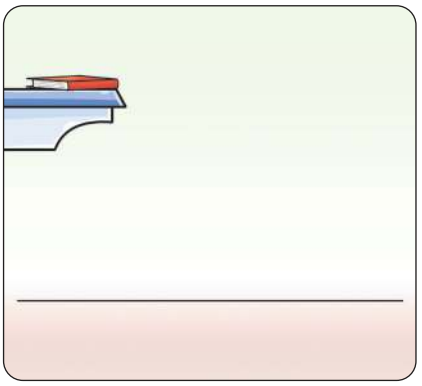


Figure (13)

This stored energy in the object, as a result of the work done on it, is referred to as potential energy.

Scientific Processes: Controlling Variables

Controlling variables is one of the skills in scientific research and the design of scientific comparative experiments. It is essential for studying causes and their resultant effects.

The three main variables are:

- Independent Variable (Cause): The variable that is changed during the experiment.
- Dependent Variable (Effect): The variable to be tested, which changes in response to changing the independent variable.
- Controlled Variables: The variables that are controlled to remain constant throughout the experiment.

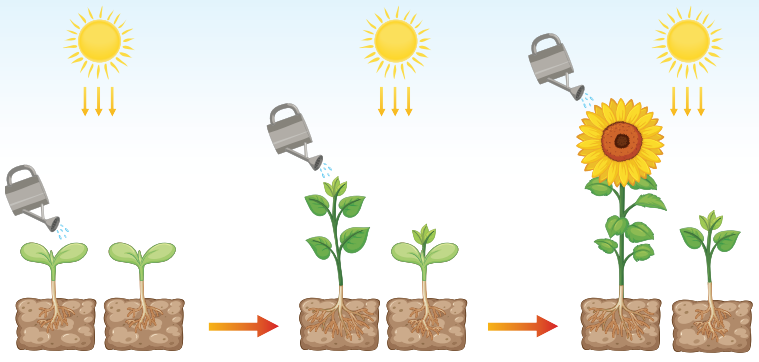
Application

Dependent Variable

The growth of the plant that is watered daily.

Independent Variable

The amount of water used to irrigate one of these two plants daily.



Controlled Variables

- The number and type of seeds used.
- The type and amount of soil.
- The amount of light.

Figure (14)

What are the factors affecting the potential energy of the objects?

Activity 2 Discover

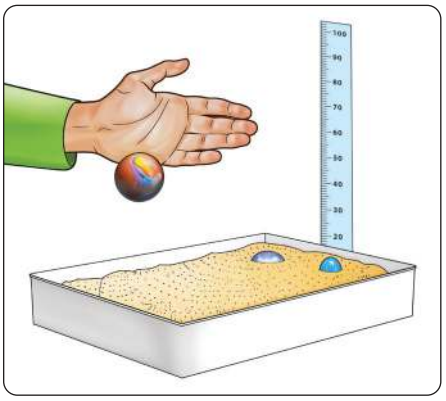


Figure (15)

Used tools:

- A basin filled with fine sand.
- 3 glass marbles of different weights.
- A metric ruler.

Steps:

- **Team up with your classmates to carry out the following steps:**

1. **Drop** the small marble from a height of 50 cm above the surface of the sand.
2. Repeat the previous step with the other two marbles from the same height (Figure 15).

Classify each of the following as (Dependent – Independent – Controlled) variable :

- Weight of the marbles :

.....

- Height of the marbles above the ground surface and the amount of sand :

.....

- Depth of the crater (hole) formed by each marble :

.....

3. **Level** the surface of the sand back, then allow the large marble to fall from a height of 75 cm once, then from a height of 100 cm once again.

What do you observe?

.....

What is the independent variable? What is the controlled variable? What is the dependent variable?

Independent variable: .....

Controlled variable: .....

Dependent variable: .....

Note that:

As the weight of the marble or its height above the surface of the ground surface (or both) increases, the depth of the crater formed by the marble in the sand also increases.

It is clear from the previous that:

• Objects which are higher than the surface (level) of the ground possess **potential energy (PE)**,

The amount of this energy depends on:

- The weight of the object (w) measured in Newton (N).
- The height of the object above the surface of the ground level (h) measured in metre (m).

• **The potential energy is determined by the following relation:**

Potential energy (PE) = Weight of the object (w) × Height (h)

Potential energy is measured in joule (J).

∵ Weight of the object (w) = Mass of the object (m) × Gravitational field intensity (g)

Potential energy (PE) = Mass of the object (m) × Gravitational field intensity (g) × Height (h)

It is noted that the gravitational field intensity is approximately equal10 N/kg

Mathematical Understanding

A work equals 150 kJ is done to raise an object with a mass of 50 kg from the surface of the ground level to a height (h) above the ground.

"Given that the gravitational field intensity is 10 N/kg, 1 kJ = 1000 J"

Calculate:

(1) The potential energy of the object.

∵ The potential energy of the object represents the amount of work done on the object.

∴ Potential energy of the object = 150 kJ

(2) The height (h) :

$$\because PE = mgh$$

$$\therefore 150 \times 1000 = 50 \times 10 \times h$$

$$\therefore h = \frac{150 \times 1000}{50 \times 10} = 300 \text{ m}$$

Evaluate Your Understanding:

Figure (16) illustrates the path of a football that has been kicked, the letters (X), (Y) and (Z) indicate three positions along the ball path.
Which of the following represents the potential energy of the ball at the positions X, Y and Z?

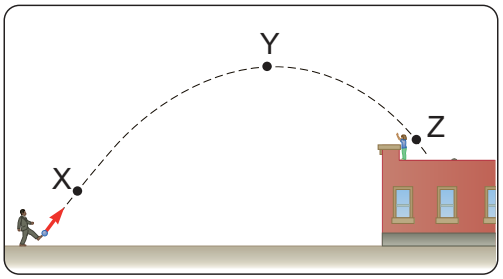
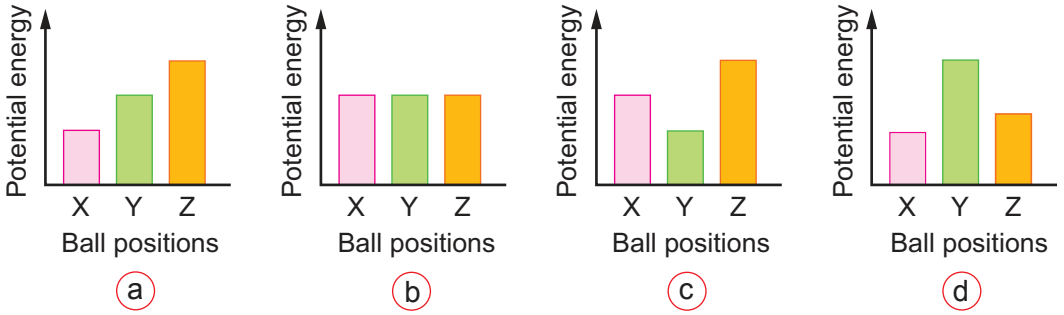


Figure (16)



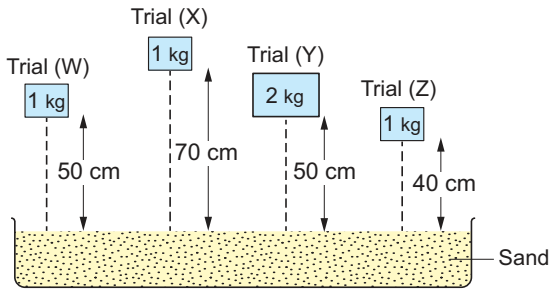
Integration with Chemistry Sciences

The chemical energy found in food and fuel is potential energy stored in chemical bonds, it is released and converted into kinetic energy during a chemical reaction occur.

Evaluation Questions on Lesson one

1 Choose the correct answer for the questions from (1) : (4).

(1) The following figure represents an experiment that includes four trials (W), (X), (Y) and (Z):



Which of the following shows the controlled variable and the independent variable?

Choices	Trials	Controlled variable	Independent variable
a	(W), (X)	Height	Mass
b	(W), (Y)	Height	Mass
c	(X), (Y)	Mass	Height
d	(X), (Z)	Height	Mass

(2) Which of the following cases involve doing work?

a Lifting a bag from the floor, pushing a shopping cart.

b Carrying a backpack while walking, pushing a shopping cart.

c Lifting a bag from the floor, pushing a tree.

d Carrying a backpack while walking, pushing a tree.

(3) The potential energy of an object depends on .....

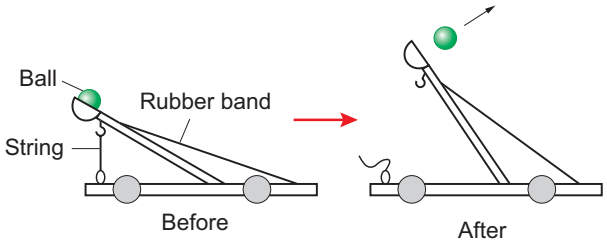
a its weight and speed.

b its weight and mass.

c its speed and height above the ground.

d its weight and height above the ground.

(4) The following figure illustrates the motion of a ball after the slingshot string is cut :



Which of the following leads the ball to cover the maximum possible distance?

Choices	Change	As the stored potential energy in the rubber band is
a	Using a ball with a greater mass	Less before cutting the string
b	Using a longer rubber band	Greater before cutting the string
c	Using a shorter rubber band	Less before cutting the string
d	Using a shorter string	Greater before cutting the string

2 Calculate the time taken by a car moving at a speed of 40 m/s to cover a distance of 200 m

3 Calculate the height of an object of mass is 6 kg above the ground when its potential energy is 180 J, knowing that the gravitational field intensity is 10 N/kg

4 What is meant by that the speed of an object is 100 m/s?

Lesson **two**

Kinetic Energy

Lesson Terminology :

- Kinetic Energy.
- Mechanical Energy.

Included Skills, Values and Issues :

- **Skills:** Discovery - Comparison.
- **Value:** Collaboration.
- **Issues:** Safety and Security.

Cross-cutting Concepts :

- Cause and Effect.

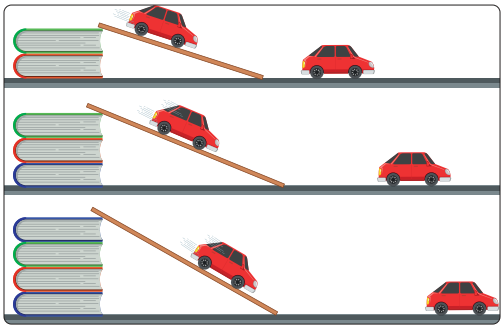
Lesson Objectives :

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

1. Recognize the concept of kinetic energy.
2. Determine the kinetic energy of an object mathematically.
3. Analyze from given data the relation between kinetic energy and the mass of the moving object.
4. Analyze from given data the relation between kinetic energy and the square of the speed of a moving object.
5. Compare between potential energy and kinetic energy.
6. Deduce the relation between potential energy and kinetic energy.
7. Provide real-life examples of the transformation of potential energy into kinetic energy.

Lesson Preparation :

The following figure represents a physical experiment :



This lesson explores ideas that will assist you in answering the following questions:

- What is the energy transformation illustrated by this experiment ?
- What is the difference between potential energy and kinetic energy ?
- Why does the speed of the car vary in the three cases ?

Kinetic Energy (KE)

The work done by the blue car is greater than the work done by the red car, even though they both have equal masses (Figure 1).

Why?

Figure (1)

The work done by the truck is greater than the work done by the car, even though they both have equal speeds (Figure 2).

Why?

Figure (2)

The acquired energy by an object as a result of its motion is known as kinetic energy, and it is estimated by the work done during the motion of an object.

What are the factors which affect the kinetic energy of the objects?

Activity 1 Discover

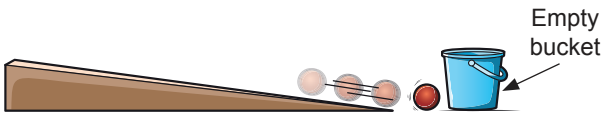


Figure (3)
Ramp (1)

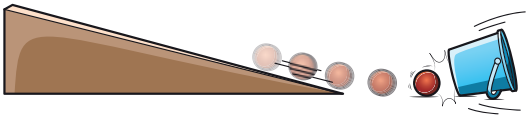


Figure (4)
Ramp (2)

1. **Release** a ball with a small mass to roll down the ramp (1) (Figure 3), then to roll down the ramp (2) (Figure 4).
   Does the effect of the ball on the empty bucket differ with the increase in the ball speed ?
   .....

2. **Release** another ball with a greater mass to roll down the ramp (2) (Figure 4).
   What do you observe? .....
   What is the independent variable? .....
   What is the dependent variable? .....

It is clear from the previous that:

The kinetic energy (KE) of any object **depends on both** :

- The mass of the object (m) measured in kilogram (kg).
- The speed of the object (v) measured in metre per second (m/s).

• The kinetic energy is estimated by the following mathematical relation :

$$\textbf{Kinetic energy (KE)} = \frac{1}{2}\ \textbf{Mass (m)} \times \textbf{Square of the speed (v)}^2$$

Kinetic energy is measured in Joule (J).

Mathematical Understanding

Calculate the kinetic energy of a metal ball of mass 2 kg and moves with a speed of 3 m/s

$\because$ KE = $\frac{1}{2}$ mv^2

= $\frac{1}{2} \times 2 \times (3)^2$

$\therefore$ KE = 9 J

Critical Thinking

Two objects (X) and (Y), the mass of object (X) is double that of object (Y), and the speed of object (X) is half that of object (Y).

Is the kinetic energy of object (X) **equal to** the kinetic energy of object (Y)? **With explanation**.

Activity 2 Discover

1 **Use the data illustrated** in Table (1) to plot the graph which represents the relation between kinetic energy and mass for different objects at constant speed (Figure 5).

Mass (kg)	Kinetic energy (J)
2	1
4	2
6	3

Table (1)

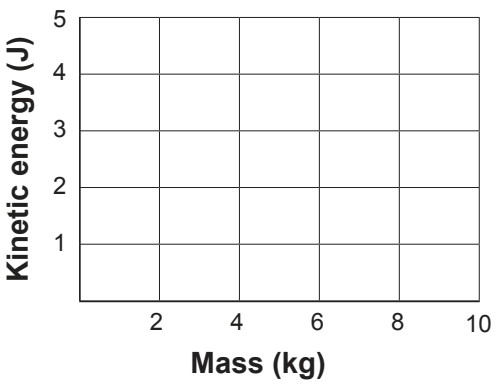


Figure (5)

What is the relation between kinetic energy and mass at constant speed?

2 **Use the data illustrated** in Table (2) to plot the graph which represents the relation between kinetic energy and the square of the speed of an object at constant mass (Figure 6).

Speed (m/s)	Square of speed $(m/s)^2$	Kinetic energy (J)
1	1	0.5
2	4	2
3	9	4.5

Table (2)

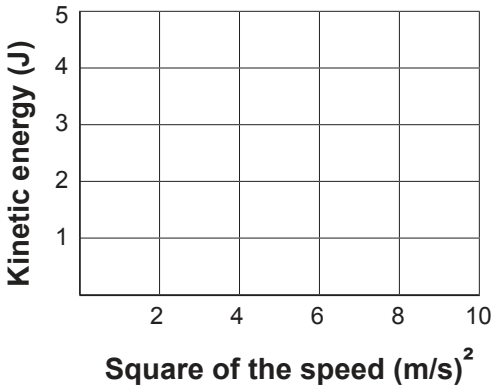


Figure (6)

What is the relation between kinetic energy and the square of the speed at constant mass?

Cross-cutting Concepts : Cause and Effect

- Increasing the mass of a moving object leads to an increase in kinetic energy, and vice versa.
- Increasing the speed of a moving object leads to an increase in kinetic energy, and vice versa.

Scientific skills: Comparison

Compare between potential energy (PE) and kinetic energy (KE) by completing Table (3):

	Potential energy (PE)	Kinetic energy (KE)
Definition	....	....
Affecting factors	....	....
Mathematical relation used in calculation	.....	.....
Measuring unit	.....	.....

Table (3)

The Relation Between Potential Energy and Kinetic Energy

When the ball is pulled up from its original position A to position B, potential energy is stored in the ball, and when it is released to roll down, the potential energy is converted to kinetic energy (Figure 7).

What is the relation between the potential energy and the kinetic energy of an object?

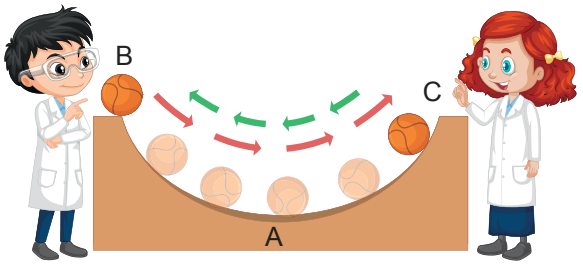


Figure (7)

Activity 3 Discover

1. Pull the pendulum ball from its original position (A) to position (B).
2. Release the ball to move freely (Figure 8) .. What do you observe?
   - What is the speed of the ball at positions (B) and (C)?

     .....
   - Identify the position(s) where:
     - Kinetic energy is at its maximum .....
     - Kinetic energy equals zero ..... , ...
     - Potential energy is at its maximum ..... , ...
     - Potential energy equals zero .....

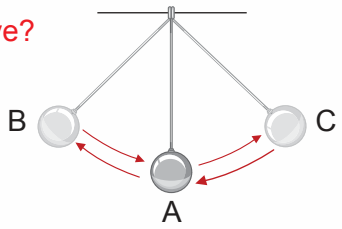


Figure (8)

- Complete Table (4) with what happens to both potential energy and kinetic energy of the pendulum ball during its motion:

During the movement from	Potential energy	Kinetic energy
(B) ⟶ (A)	Decreases	Increases
(A) ⟶ (C)	.....	.....
(C) ⟶ (A)	.....	.....
(A) ⟶ (B)	.....	.....

Table (4)

It is clear from the previous that :

- The object has the maximum potential energy at its highest point above its original position, while its kinetic energy becomes at its maximum when passing through its original position.
- The decrease in potential energy is followed by an increase in kinetic energy, The amount of decreasing in potential energy equals that of increasing in kinetic energy.
- The summation of potential energy and kinetic energy of any moving object is known as Mechanical Energy (ME), the mechanical energy of any object is constant value, **estimated by the mathematical relation:**

Mechanical energy (ME) = Potential energy (PE) + Kinetic energy (KE)

- The mechanical energy of a freely falling object **equals:**
  - Potential energy at its maximum height.
  - Kinetic energy at the moment it reaches the ground.

Evaluate Your Understanding:

A car starting from rest position (A) moves down a slope until it reaches the ground at point (C) (Figure 9). If the mechanical energy of the car is 600 kJ at position (B) :

1. Determine the amount of each of the following for the car :
   1- Potential energy at position (A).
   .....
   2- Kinetic energy at position (C).
   .....
2. Calculate each of the following for the car:
   1- Potential energy at the midpoint of the vertical distance between positions (A) and (C).
   .....
   2- Kinetic energy at position (B), if the potential energy at that point equals 400 kJ
   .....

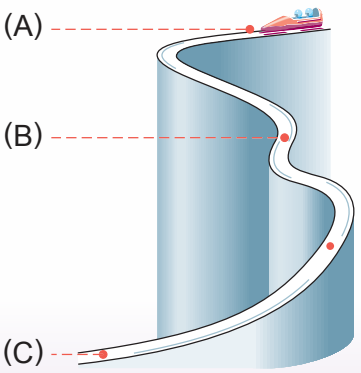


Figure (9)

Cross-cutting Concepts : Cause and Effect

The increase in potential energy of an object moving upwards vertically results in a decrease in kinetic energy by the same amount, and vice versa.

Medical Application

Avoid lifting heavy objects above ground level in a manner that harms your spine,
the load should be on the leg muscles rather than the back (Figure 10) to ensure balanced weight distribution.

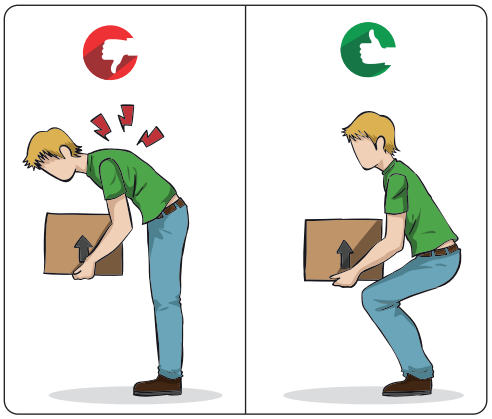


Figure (10)

Life Applications

(1) Generation of Electricity from the High Dam:

The High Dam in Aswan is one of the most important engineering projects in Egypt in the last century in using water energy, as the potential energy of water held behind the dam is converted into kinetic energy when it rushes downwards.
This kinetic energy of water drives turbines which generate electricity in a sustainable way (Figure 11).

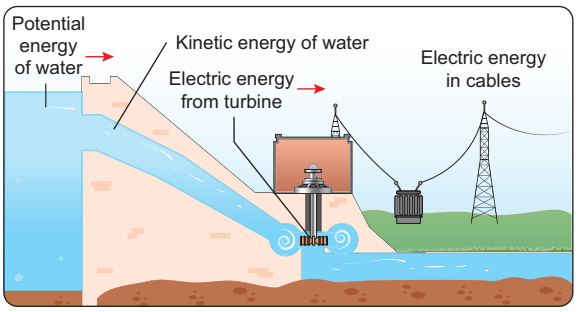


Figure (11)

(2) Demolition Ball:

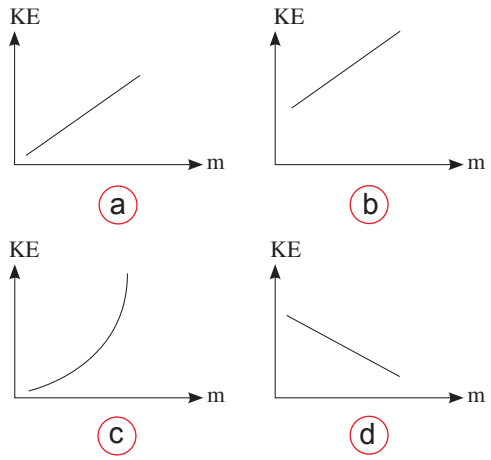
The demolition ball is used for demolishing old buildings (Figure 12) as a result of the conversion of the potential energy stored in the heavy ball (which is suspended at a height) into kinetic energy upon its release.
This energy is transferred to the building upon the ball impact, **causing its demolition**.

Figure (12)

Evaluation Questions on Lesson two

1 Choose the correct answer for the questions (1) , (2).

(1) The relation between the kinetic energy and the mass for several objects at constant speed is expressed graphically by .....



(2) Which of the following expresses the change occurring in the potential and kinetic energies of an object falling from a height ?

Choices	Potential energy	Kinetic energy
a	Decreases	Decreases
b	Increases	Decreases
c	Increases	Increases
d	Decreases	Increases

2 What is meant by that the mechanical energy of an object equals 200 J ?

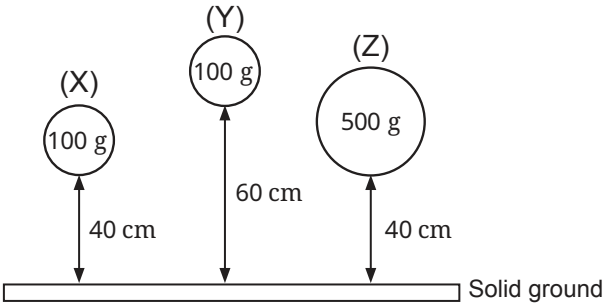
3 What happens to the kinetic energy of an object in the following cases, when:

(1) The mass of the moving object is decreased to half, while its speed remains constant.

(2) The speed of the moving object is doubled, while its mass remains constant.

4 The following figure illustrates falling of three objects to the ground from different heights:

[Given that : The intensity of the gravitational field is : 10 N/kg]



Mark (✔) or (✘) next to the following :

(1) The potential energy of ball (X) is greater than the potential energy of ball (Z). ( )

(2) The potential energy of ball (Y) is greater than the potential energy of ball (X). ( )

(3) Balls (X), (Y) and (Z) gain kinetic energy upon falling. ( )

(4) The impact of ball (Y) with the ground produces a louder sound than the impact of ball (Z). ( )

5 Calculate the kinetic energy of an object of mass12 kg moving with a speed of 1 m/s

6 An object its mass is 10 kg is released to fall from a height of 4 m above the ground level.

[Given that: Gravitational field intensity = 10 N/kg]

(1) Calculate the kinetic energy of the object in the following cases:

1- Just before falling.

2- At the moment it reaches the ground.

(2) Calculate the mechanical energy of the object at the midpoint between the falling position and the ground.

7 An object its mass is 600 g is thrown upwards vertically at a speed of 20 m/s, Calculate: **(Given that : 1000 g = 1 kg)**

(1) The kinetic energy of the object at the moment of being thrown upwards.

(2) The mechanical energy of the object at the maximum height it reaches.

UNIT 3

Environment and Genetics

The lessons

Lesson one : Nutritional Relationships in Biological Communities

Lesson two : Genetic Traits and Mutations

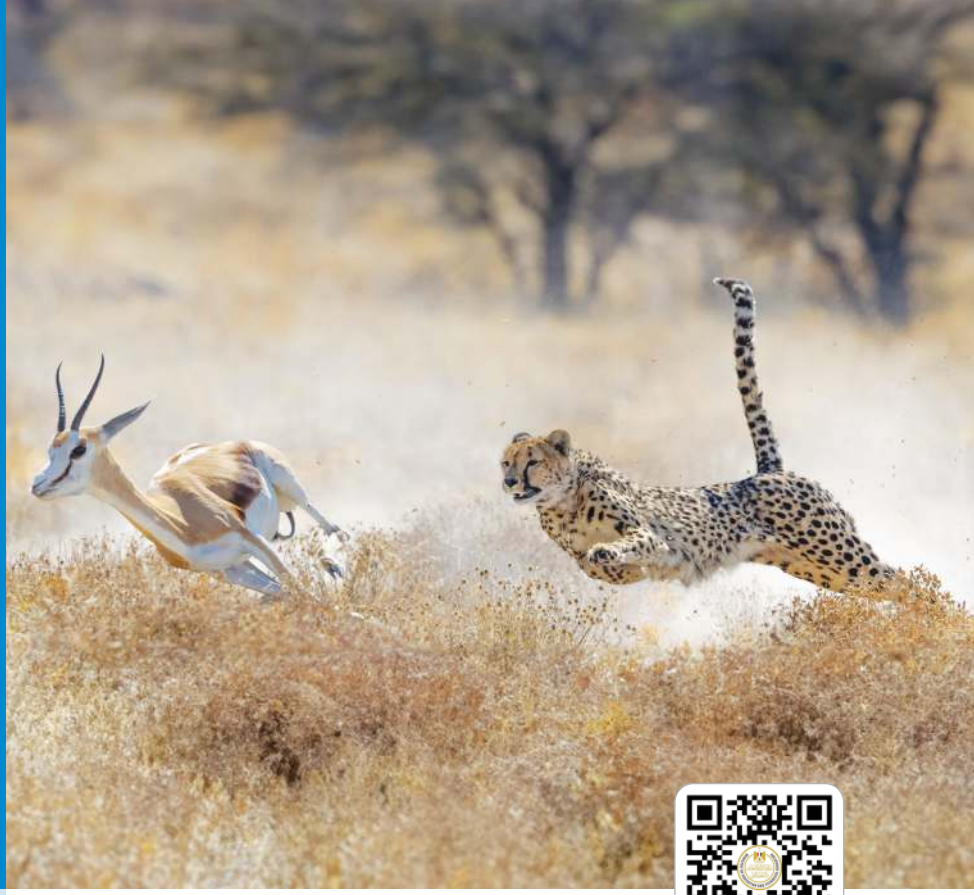
Learning Outcomes :

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

1. Distinguish between the concept of biotic population and that of biological community.
2. Explain the patterns of nutritional interactions in biotic populations.
3. List examples of nutritional relationships among living organisms.
4. Recognize food chain.
5. Illustrate the nutritional relationships in food webs.
6. Recognize the concept of the energy pyramid.
7. Differentiate between inherited traits and acquired traits.
8. Design a model of chromosome structure.
9. Describe the structure of chromosomes and the locations of genes on them.
10. Identify the steps involved in the expression of genetic traits.
11. Present a profile of the scientist Gregor Mendel.
12. Recognize the concept of mutation.
13. Describe the relation between mutation, protein production, and changes in genetic traits.
14. Write a report on the impact of genetic changes on the production of different proteins.

Lesson **one**

Nutritional Relationships in Biological Communities



Lesson Terminology :

- Ecosystem
- Nutritional Relationships
- Commensalism
- Mutualism
- Competition
- Predation
- Food Chain
- Food Web

Included Skills, Values and Issues :

- **Skills** : Observation - Conclusion.
- **Value** : Appreciation of Researchers' Efforts.
- **Issues** : Protection of Ecosystems - Collaboration.

Cross-cutting Concepts :

- Cause and Effect.

Lesson Objectives :

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

1. Distinguish between the concept of biotic population and that of biological community.
2. Illustrate patterns of nutritional interactions in biological communities.
3. List examples of nutritional relationships among living organisms.
4. Recognize the food chain.
5. Illustrate nutritional relationships in food webs.
6. Compare the patterns of nutritional relationships among living organisms across various biological systems.
7. Recognize the concept of the energy pyramid.

Lesson Preparation :

The following figure shows the meerkat, which lives in groups. This lesson explores the ideas that help you answer the following questions:

- Do the meerkat individuals together form a biotic population or a biological community?
- What type of nutritional relationship exists between the meerkat and the snakes it preys upon?
- What is the difference between the nutritional relationship between bees and flowers and that between meerkats and snakes?
- What is the impact of the disappearance of all individuals of this animal on the ecological balance in its habitat?

The Ecosystem

The ecosystem consists of living organisms and non-living (abiotic) components such as water, air and soil. The ecosystem includes several levels of organization (Figure 1).

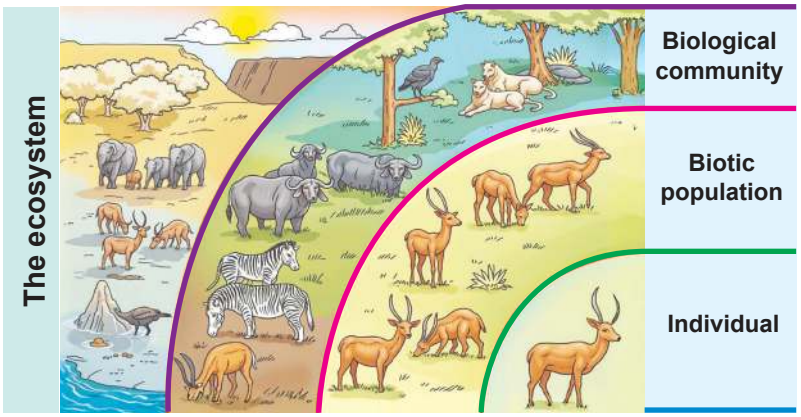


Figure (1) Levels of the ecosystem

Organization begins at the individual level, which is the single living organism belonging to a specific species. The species is the fundamental unit in the classification of living organisms. A group of individuals of the same species that live in a particular place at the same time is known as a biotic population. The various populations of different species that inhabit the same environment form a biological community.

Patterns of Nutritional Interactions Among Individuals of Biological Communities

The patterns of nutritional (food) relationships vary with the variation of the methods by which the living organisms obtain their food. There are relationships that result in harm to one individual, such as predation, or both individuals such as competition, and other relationships in which one individual benefits such as commensalism, or both individuals benefit without causing harm to either of them such as mutualism.

1 Predation

Activity 1 Observe and Conclude

Observe the figures (2) : (4) which show predation of certain living organisms by other living organisms, and then answer the following questions :

Figure (2)
Predation of a zebra by a lion

Figure (3)
Predation of an insect by a panther chameleon

Figure (4)
Predation of an insect by a Dionaea (Venus flytrap) plant

① Identify in each nutritional relationship:

The predators ..... , ... , ...

The preys ..... , ... , ...

② State the beneficiary and the harmed organisms in these nutritional relationships.

Beneficiary organism ..... , ... , ...

Harmed organism ..... , ... , ...

- The relationship of the predator that benefits from the nutritional relationship with the prey that is harmed or loses its life is referred to as predation.

2 Competition

- Competition is a nutritional relationship that can take various forms and types.

Among these types is the competitive relationship between two individuals of the same species for a food source that is found in limited quantities (Figure 5), which negatively impacts their growth or survival.

Figure (5)

3 Mutualism

Mutualism is a nutritional relationship between two individuals where they benefit from each other without causing harm to either of them.

Examples of mutualistic relationships include:

The nutritional relationship between bees and plant flowers :

Bees benefit by extracting nectar from the flowers, while the plant benefits from the transfer of its pollen grains on the bodies of the bees from one flower to another, which promotes the floral reproduction (Figure 6).

Figure (6)

4 Commensalism

Commensalism is a nutritional relationship that benefits one organism, known as the commensal, while the other organism, known as the host, neither benefits nor is harmed.

Examples of commensal relationships include:

The nutritional relationship between the Egyptian plover birds and Nile crocodiles:

The Egyptian plover bird benefits by feeding on leftover food trapped in the crocodile's teeth, while the crocodile neither benefits nor is harmed (Figure 7).

Figure (7)

Evaluate your understanding :

According to your understanding of the patterns of nutritional relationships,

Explain the nutritional relationship illustrated in each of the figures (8) and (9) :

Figure (8)

Figure (9)

- Figure (8) represents the ..... relationship.
- Figure (9) represents the ..... relationship.

Energy Flow Among Living Organisms

All living organisms require energy to survive. Producers obtain their energy from the sun, which is the main source of energy on the surface of the Earth. A portion of this energy is then transferred to other living organisms through various pathways that involve several levels across food chains and food webs.

The Food Chain

Activity 2 Observe and Conclude

Study Figure (10), then answer the following questions :

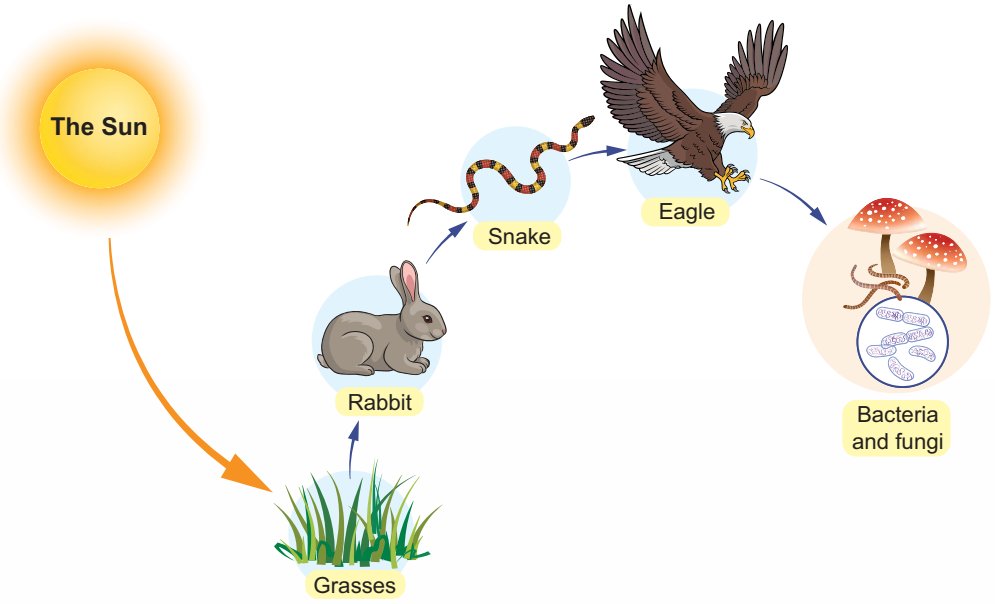


Figure (10)

(1) Illustrate the path of energy flow by completing Diagram (1).

Grasses → Consumed by ..... → Consumed by ..... → Consumed by ..... → Consumed by .....

Diagram (1)

2 What is the producer ? And why is it described as autotrophic organism?

.....

3 Why are the rabbit, snake, and eagle classified as consumers?

- The rabbit is a consumer because it obtains energy by feeding on .....
- The snake is a consumer because it obtains ..... by feeding on .....
- The eagle is a consumer because it obtains ..... by feeding on .....

4 Which is (are) the consumer(s) that feed(s) on plants (herbivorous organisms or herbivores) and which feed(s) on meat (carnivorous organisms or carnivores)?

- Herbivorous organisms : .....
- Carnivorous organisms : .....

5 What are the (primary, secondary and tertiary) consumer organisms?

- ..... is a primary (or first level) consumer, as it feeds on .....
- ..... is a ..... consumer, as it feeds on .....
- ..... is a ..... consumer, as it feeds on .....

6 Why are bacteria and fungi called decomposers?

.....

It is clear from the previous that:

- The path of energy transfer (flow) in the form of food as it moves from one organism to another within the ecosystem is known as a food chain.
- Each stage in which energy is transferred in the food chain is referred to as a trophic level.
- The food chain, whether terresterial, aquatic or desert, are formed of many trophic levels, the first level is occupied by a producer, while the consumers occupy the higher levels (the second, the third ...), and end with a decomposer.
- The organisms which obtain their food from the dead bodies are known as the decomposers, as they break down (decompose) the organic substances found in the bodies of the other organisms after being dead to simpler substances which mix with the soil and become part of its components.

Life Application

Sustainable agriculture

The study of food chains is used in designing food systems that utilise living organisms to eliminate agricultural pests instead of using pesticides, a method known as biological control, such as the use of the dotted beetles (ladybugs) to feed on aphids insects, which are agricultural pests that harm vegetables and fruits (Figure 11).

Figure (11)

• Most herbivorous animals, such as the horse, are characterised by the presence of incisors for cutting plants (Figure 12), whereas most carnivorous animals, such as the lion, are distinguished by sharp canines for tearing prey (Figure 13).

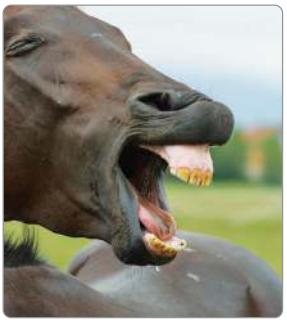


Figure (12)
Herbivore

Figure (13)
Carnivore

Organisms that feed on :

- Both plants and animals are known as omnivores, such as the bear (Figures 14, 15), the raven, the mouse and the hedgehog.
- The remains of dead organisms are known as scavengers, such as hyenas (Figure 16), eagles (Figure 17), and cockroaches.

Figure (14)

Figure (15)

The bear is an omnivore

Figure (16)
Hyena is a scavenger

Figure (17)
Eagle is a scavenger

What is the difference between a decomposers and a scavengers ?

.....

.....

Evaluate Your Understanding:

Figure (18) illustrates some living organisms in an aquatic environment at the North Pole:

(1) Construct a food chain from these living organisms.

..... → ..... → ..... → ..... → .....

(2) Which organism represents a secondary consumer ?

.....

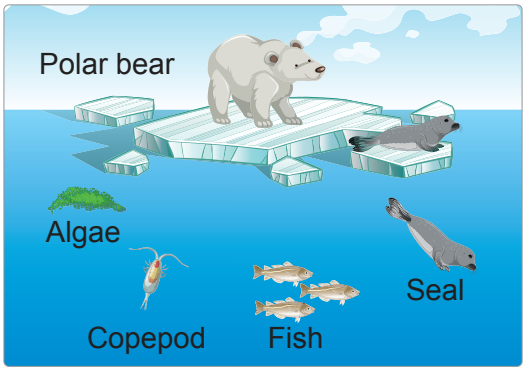


Figure (18)

Food Web

It is rare to find isolated food chains in ecosystems, as each single organism can feed on multiple sources, whilst this organism itself is a food source for several other organisms at higher trophic levels. The interconnection and overlapping of multiple food chains lead to the formation of what is known as a food web (Figure 19).

Activity 3 Discover

Team up with one of your classmates to study the food web illustrated in figure (19) to answer the following questions :

1. What are the producers?

.....

2. What are the primary consumers?

.....

3. Which living organism is considered a predator as well as a prey?

.....

4. What are the predators which occupy the top of the food chains?

.....

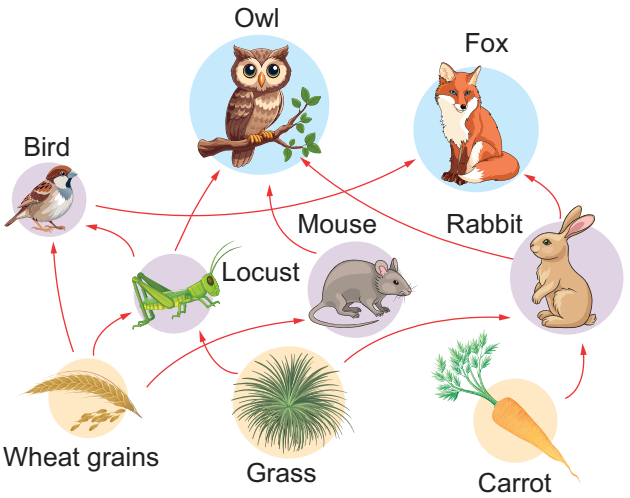


Figure (19)
Food web

5. Identify four energy paths that end at the owl.
   - ..... → ..... → Owl.
   - ..... → ..... → Owl.
   - ..... → ..... → Owl.
   - ..... → ..... → Owl.

6. What is the effect of bird migration on the increase or the decrease of the numbers of each of locusts and foxes?
   - Numbers of ..... are ..... , due to the decrease in the number of their predators.
   - Numbers of ..... are ..... , due to the decrease in the number of their preys.

Cross-cutting Concepts : Cause and Effect

- Lack of food sources leads to increased competition among living organisms, which affects the number of individuals in the biotic populations.
- The absence of any living organism from a balanced ecosystem affects the remaining individuals of the food chain or food web, resulting in a disruption of this ecological balance or even its destruction.
- An increase in the number of primary consumers leads to a decrease in the number of producers as well as an increase in the number of secondary consumers.
- A decrease in the number of secondary consumers results in a decrease in the number of tertiary consumers and an increase in the number of primary consumers.

Research Activity

Investigate through various knowledge sources, including the internet and the Egyptian Knowledge Bank, the role of nature reserves in preserving the ecological balance.

Issue for discussion

The effect of pesticides on the food webs in the ecosystems.

Energy Pyramid

- The energy pyramid represents the flow of energy and its amounts between the different trophic levels in any food chain (Figure 20).
- The base of the pyramid is occupied by producers, while its apex is occupied by the last consumer (the top predators) in the food chain.
  It is shown in (Figure 20) that only $\frac{1}{10}$ of energy is transferred from the living organisms at any level to the living organisms which occupy the next level in the energy pyramid.
- This means that 90% of the energy is lost when moving from any level to the next level.

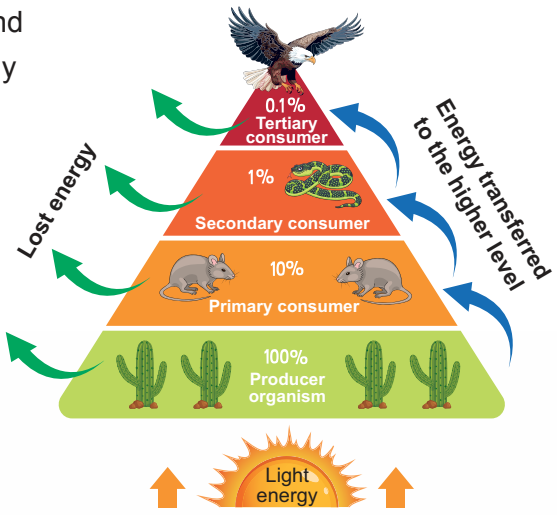


Figure (20)
Energy pyramid

Evaluate Your Understanding:

What is the amount of energy which reaches the third level in a food chain if the energy at the first level is equal to 1000 energy units?

.....

Evaluation Questions on Lesson one

1 Choose the correct answer for the questions from (1) : (5).

(1) Which of the following nutritional relationships causes harm to one of the organisms?

(a) Predation and competition.
(b) Mutualism and commensalism.
(c) Mutualism and predation.
(d) Predation and commensalism.

(2) In a food chain that includes insect, fish, plant and swan.
Which of these living organisms is considered as a predator and a prey at the same time?

(a) The insect. (b) The fish.
(c) The plant. (d) The swan.

(3) The following table shows 5 living organisms and their food:

Organism	It's food
(1)	Insects, dead animals
(2)	Scorpions, reptiles, snakes, mice
(3)	Grasses, seeds, berries
(4)	Dead animals
(5)	Rabbit, mice, birds, squirrels

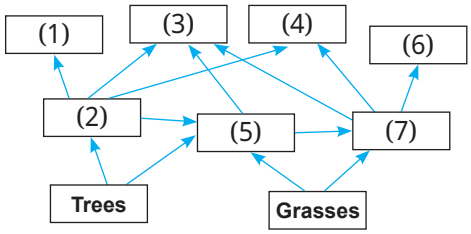
Which of the following represents a correct food chain?

(a) Berries ⟶ (1) ⟶ (2) ⟶ (3).
(b) Grasses ⟶ (3) ⟶ (2).
(c) Cactus ⟶ (1) ⟶ (4).
(d) Seeds ⟶ (4) ⟶ (2) ⟶ (5).

(4) Rabbits were introduced to Australia approximately one hundred years ago, and shortly thereafter their numbers increased significantly due to .....

(a) the decrease in the vegetation.
(b) increasing the biodiversity.
(c) presence of a few number of predators.
(d) presence of a large number of predators.

(5) In the following food web:



Which of the following feeds on only one producer and is eaten by 3 different predators?

(a) (5) , (7) (b) (5) , (2)
(c) (2) , (7) (d) (2) , (3) , (7)

2 Give reasons for the following:

(1) The nutritional relationship between bees and flowers of plants is a mutualistic relationship.

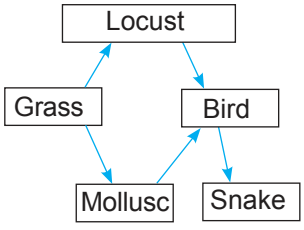
(2) The nutritional relationship between the Nile crocodile and the Egyptian plover bird is not a mutualistic relationship.

3 What is the effect of killing hawks on the number of earthworms in a food chain consisting of grasses, hawks, earthworms, and snakes?

4 What is the type of the nutritional relationship between each of the following:

(1) The wolf and the rabbit.
(2) The fly and the Dionaea plant.
(3) The polar bear and the seal.

5 In the following food web:

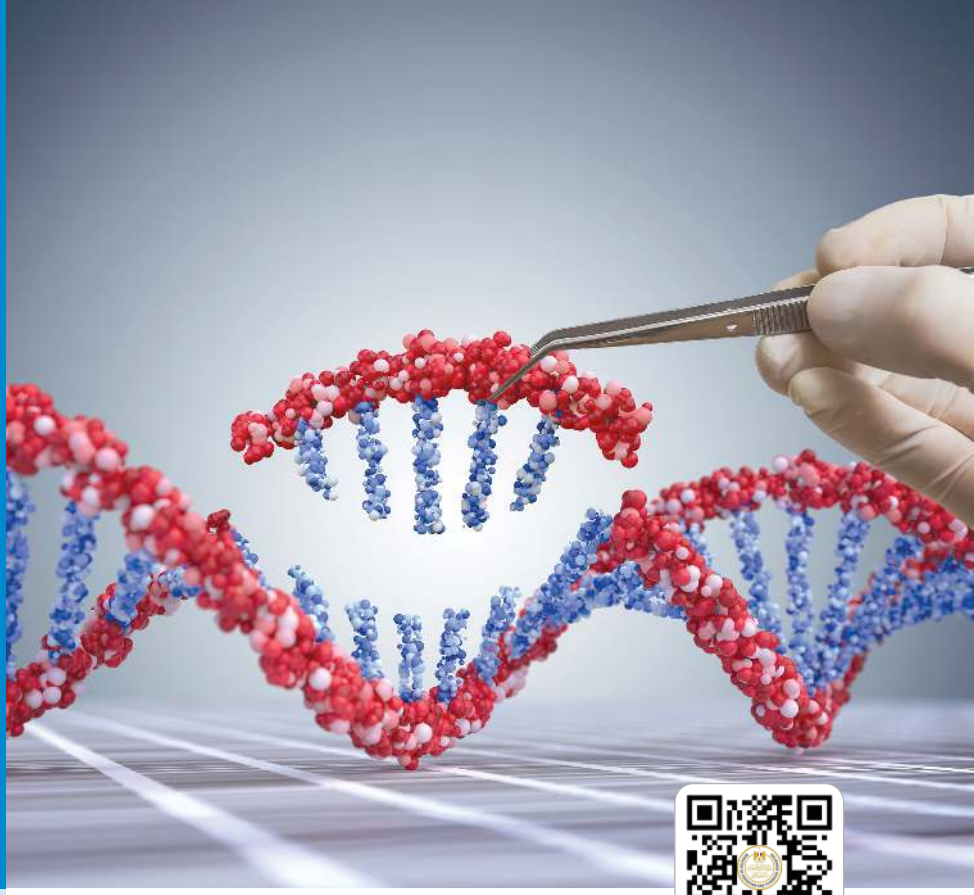


(1) How many food chains do make up this web?

(2) Complete: To reduce the number of molluscs, it is necessary to increase the number of ..... and reduce the number of .....

Lesson **Two**

Genetic Traits and Mutations



Lesson Terminology :

- Reproduction
- Genetics
- Hereditary Traits
- Acquired Traits
- Instinct
- Chromosome
- Genes
- Mutation

Included Skills, Values and Issues :

- **Skills:** Conclusion - Model Designing - Practicality.
- **Value:** Appreciation of Scientists.
- **Issue:** Ethics of Genetic Modification.

Cross-cutting Concepts :

- Structure and Function.

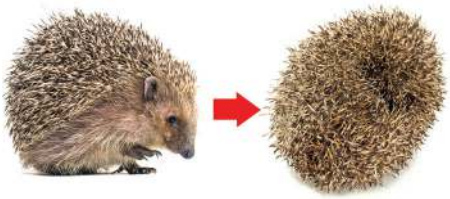
Lesson Objectives :

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

1. Differentiate between hereditary traits and acquired traits.
2. Practically extract chromosomes from strawberry fruit cells.
3. Design a structural model of a chromosome.
4. Describe the structure of a chromosome and the location of genes.
5. Identify the steps for demonstrating genetic traits.
6. Appreciate the role of scientists in the development of genetics.
7. Describe the relation between mutation, protein production and changes in genetic traits.
8. Recognize the concept of mutations.
9. Write a report on the effect of genetic changes on the production of different proteins.

Lesson Preparation :

The opposite figure : A hedgehog covered in spines that curls up when it senses danger.



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

- Are the spines of the hedgehog considered a hereditary trait or an acquired trait?
- Is the hedgehog curling up when it senses danger considered an acquired trait or an instinctive behaviour?
- What is the substance responsible for transferring hereditary traits from hedgehog parents to their offspring?
- Can scientists produce hedgehogs without spines?

Genetic (Hereditary) Traits and Acquired Traits

In the first term, you have learned that all living organisms perform a series of vital processes, including reproduction. All of them reproduce to produce new individuals (offspring) resembling their parents (Figure 1). The science that studies the transmission of genetic traits from parents to offspring is called genetics (Heredity).

Figure (1)

Activity 1 Conclude

Investigate the figures (2) : (7), then clarify the trait or behaviour expressed by each figure by writing:

- The letter (H) below the figures that represent traits that are likely to be transmitted from parents to offspring without learning.
- The letter (I) below the figures that represent behaviours and skills that are likely to be transmitted from parents to offspring without learning.
- The letter (A) below the figures that represent traits that one individual may acquire more than other individuals through learning or training.

Figure (2)

A squirrel breaks hazelnut shell

(.....)

Figure (3)

Coloured eyes

(.....)

Figure (4)

Strong muscles

(.....)

Figure (5)

The length of giraffe's neck

(.....)

Figure (6)

A dolphin plays with a ball

(.....)

Figure (7)

A bat sleeps upside down

(.....)

It is clear from the previous that there are :

- Traits that are transmitted from parents to offspring without learning and are inherited from one generation to the next, such as the human hair colour, the short legs of the Arctic fox (Figure 8), and the presence of a hard skeleton covering the body of the turtle. Such traits are known as genetic (or hereditary) traits.

Figure (8)

- Behaviours and skills that are transmitted from parents to offspring without learning, such as the spider weaving its web to catch insects (Figure 9), and a chicken incubating its eggs. Such behaviours are known as instinctive behaviours (instinct).

Figure (9)

- Traits that are not inherited from parents but are acquired from the surrounding environment through learning or training and do not pass from one generation to another. Such traits are known as acquired traits.
  Examples include a child learning to walk (Figure 10) and learning languages.

Figure (10)

Evaluate Your Understanding :

Classify the following into genetic traits, acquired traits, and instinctive behaviours:

1. Reading and writing .....
2. Facial freckles .....
3. Curly hair .....
4. The bird building its nest .....
5. Breastfeeding .....
6. The horse jumping over obstacles .....

Chromosomes and the Transmission of Genetic Traits

- Genetic material exists in the cytoplasm of prokaryotic organisms and in the nuclei of eukaryotic organisms, in the form of thread-like bodies known as chromosomes, which are responsible for the transmission of genetic traits from parents to offspring.
- Can the chromosomes in the cells of living organisms be separated?

Activity 2 Practical

Used materials and tools :

- Strawberries.
- Self-sealing plastic bags.
- Plastic cup.
- $\frac{1}{2}$ cup of water.
- 2 spoonful of dishwashing liquid.
- 1 spoonful of table salt.
- Coffee filter paper.
- Ethyl alcohol.
- Toothpick.

Steps: Follow the steps illustrated in figures (11) : (18), with taking care when handling the used chemicals.

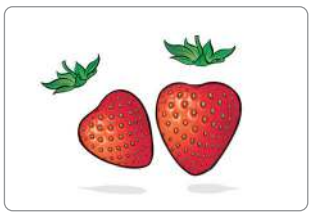


Figure (11)

1 Separate the green leaves from the strawberries.

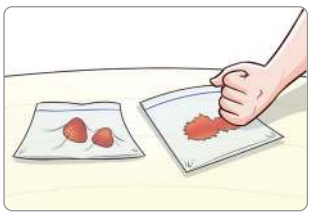


Figure (12)

2 Put the fruits inside the plastic bag and mash them by hand.

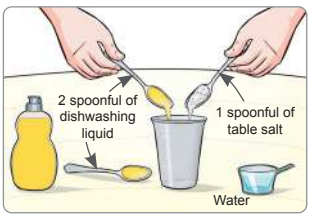


Figure (13)

3 Prepare a mixture for separating the chromosomes using dishwashing liquid and table salt with water in the plastic cup.

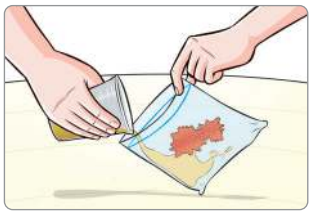


Figure (14)

4 Add the previously prepared mixture to the mashed strawberries.

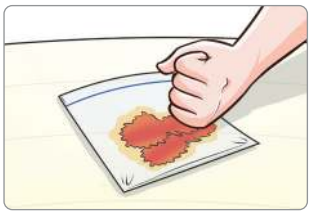


Figure (15)

5 Repeat the mashing process slowly to avoid the formation of bubbles inside the bag.

Figure (16)

6 Filter the mixture in the bag using the coffee filter paper.

Figure (17)

7 Add an equal volume of ethyl alcohol to the resulting filtrate on the inner wall of the cup without shaking or stirring.

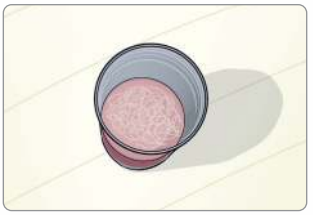


Figure (18)

8 Wait a few seconds...
What do you observe?
What is the substance which can be separated using the toothpick?

It is clear from the previous that :

- The white threads that are separated on the surface of the filtrate are the chromosomes of strawberry cells (Figure 19).

Figure (19)

Chromosome Structure

- Each chromosome consists of two threads, each called a chromatid, the two chromatids are connected at a central point known as the centromere (Figure 20).
- Individuals of the same species have the same number of chromosomes in each of their somatic cells, such as liver and skin cells, and their number varies from one living organism to another, as illustrated in Table (1).

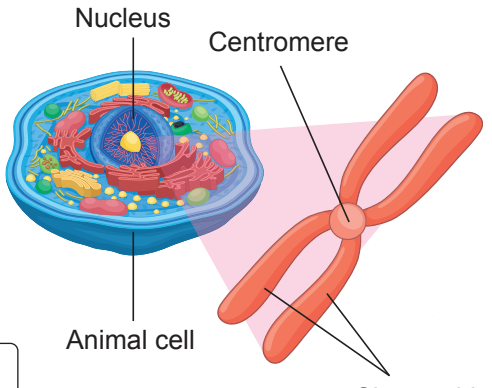


Figure (20)
Chromosome

Living organism	Human	Bee	Corn plant
Number of chromosomes	46	32	20

Table (1)

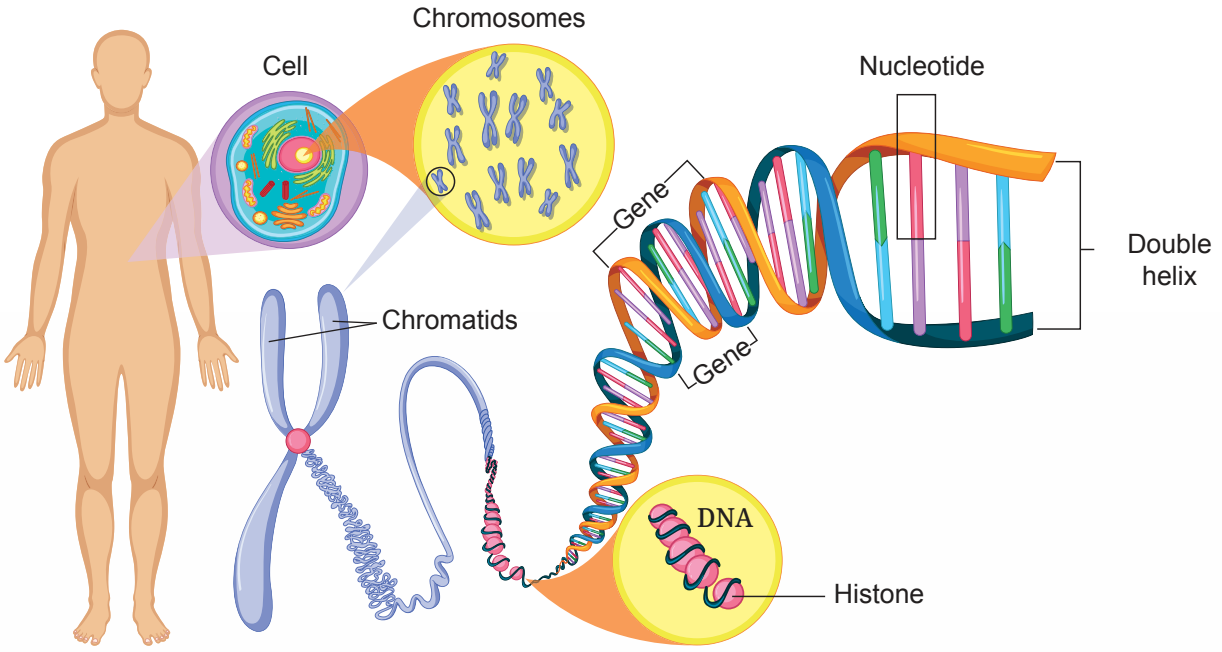


Figure (21) **Chemical structure of the chromosome**

- The chromosome is chemically composed of a nucleic acid abbreviated as DNA, wrapped around a type of protein known as histones.
- The nucleic acid DNA is made up of small segments called genes, each gene consists of a sequence of smaller building units known as nucleotides, arranged in the form of two strands twisted around each other, forming what is known as the double helix (Figure 21).
  The genes are responsible for the appearance of the hereditary traits in the living organism.
- A single chromosome carries thousands or millions of genes, the number of which differ from one chromosome to another within the cells of the same individual.

Designing a Model of the Chromosome

Use the available materials in your environment to design a structural model of chromosome, you can use the steps illustrated in Figures (22) : (27).

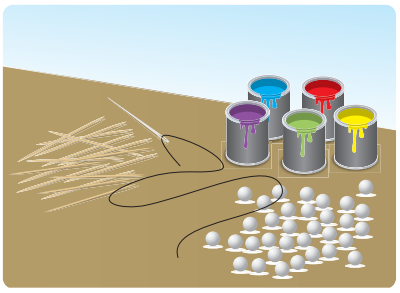


Figure (22)

1 Prepare small foam balls, coloured paint containers, thread, a needle and toothpicks.

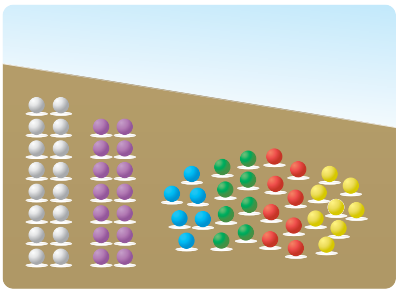


Figure (23)

2 Paint a number of the balls in (yellow, red, green, blue, purple) colours, and keep 16 of them unpainted.

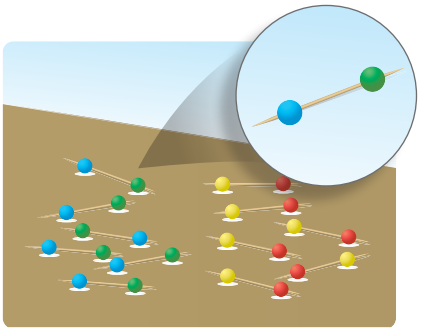


Figure (24)

3 Insert a red ball with a yellow ball on 8 toothpicks, and on another 8 toothpicks, insert a green ball with a blue ball, with leaving a distance at each end of each toothpick.

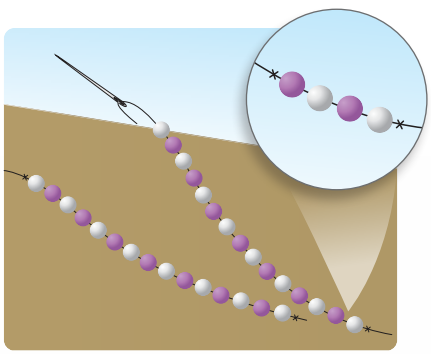


Figure (25)

4 Use the thread and the needle to create two branches, each consists of 8 white balls alternating with 7 purple balls, and tie the ends to prevent the balls from slipping.

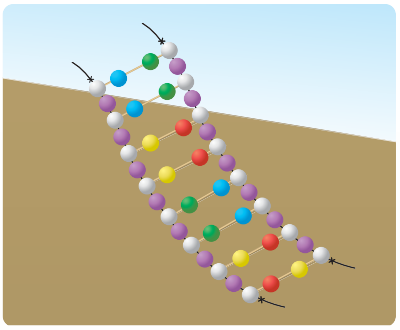


Figure (26)

5 Insert the ends of each toothpick into the white foam balls in the two branches.

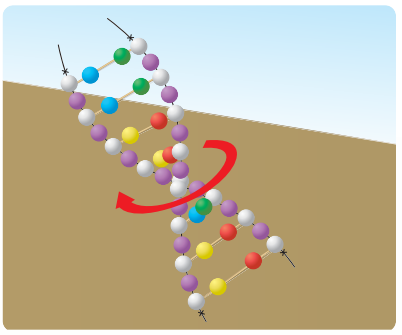


Figure (27)

6 Twist the two branches anticlockwise to create a double helix similar to the structure of DNA that forms the chromosome.

A profile of the scientist

Gregor Mendel

An Austrian scientist born in 1822, he is considered the founder of the science of genetics. He conducted experiments over approximately eight years on 24,000 pea plants, after which he concluded that each hereditary trait is controlled by a pair of genetic factors, which were later became known as genes. Had it not been for Mendel's efforts, scientific research today would not have achieved such remarkable advancements in the field of genetic engineering.

Figure (28)

The Role of Genes in Expression of Hereditary Traits

- Hereditary traits are passed from parents to offspring through genes, with an individual inheriting half of their genetic material from the father and the other half from the mother. Scientists Beadle and Tatum, through their experiments, affirmed the one gene - one enzyme hypothesis, which states that each gene produces a specific enzyme, and this enzyme is responsible for occurrence of a chemical reaction that leads to the formation of a protein that expresses a specific hereditary trait.

Cross-cutting Concepts : Structure and Function

The difference in the arrangement of the nucleotides on DNA results in the difference of the genes present on a single chromosome, which in turn leads to the difference in the hereditary trait that each gene is responsible for expressing.

Mutations

Why do some cows appear huge compared to other cows (Figure 29)?

What are the reasons for a person being born with six fingers on one hand (Figure 30)?

Figure (29)

Figure (30)

• A change may occur in the nature of a gene, such as a change in the arrangement of the nucleotides that form it, which leading to a change in the hereditary trait for which this gene is responsible, and consequently the emergence of a new trait that did not previously exist; this is known as a mutation.

Mutations may occur naturally, as in the case of a dark-skinned mother giving birth to an albino child (Figure 31), and such mutations are referred to as spontaneous mutation.

They may also occur through human intervention, as in the production of featherless chickens (Figure 32) to reduce the electrical energy used in air conditioning farms in hot regions, and such mutations are known as induced mutations.

Figure (31)

Figure (32)

Research Activity

Write a report explaining the impact of genetic changes on the production of the different proteins, assisted by a reliable source of knowledge for the accuracy of its information.

Issue for discussion

Ethics of using genetic modification techniques in embryos.

Impact of Mutations

• Mutations may be harmful, some of them lead to death, while others may be beneficial. Among the harmful mutations is spinal deformity (curved spine) (Figure 33), and among the lethal mutations is the severe muscular dystrophy (wasting and weakness) in certain newborns.

Mutations may also be beneficial, whether occurring naturally or through human intervention. An example of a beneficial natural mutation is the change in skin colour to adapt to the environment, such as the light skin colour in individuals living in cold countries which helps them to absorb Vitamin D better.

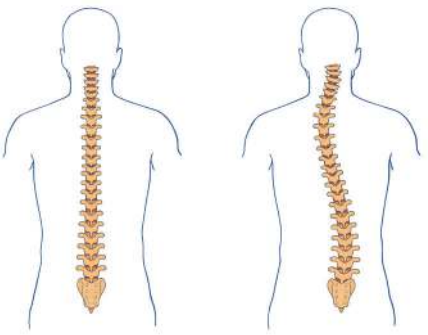


Figure (33)

Normal spine **Deformed (curved) spine**

The mutations resulting in seedless fruits (Figure 34) or wheat plants resistant to wheat rust disease (Figure 35) they are all beneficial mutations induced by human.

Figure (34)
Seedless lemon

Figure (35)
Leaves of wheat plants infected with wheat rust

Integration with Agricultural Science

The production of cubic-shaped watermelons (Figure 36) to facilitate their transport is not resulting from a mutation, rather, it is an agricultural technique whereby watermelons are placed in square molds during their growth, causing them to take the shape of the mold.

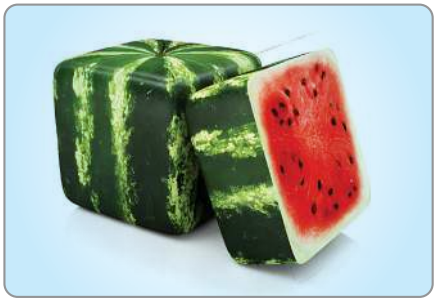


Figure (36)
Cubic-shaped watermelon

Life Application

- The mutation of lactose tolerance, which allows lactose sugar found in milk and dairy products such as cheese and yogurt to be converted into simpler sugars that are easier for the body to absorb, is a natural mutation.
- Individuals who suffer from lactose intolerance feel crampy, nausea and other painful symptoms when drinking milk or eating dairy products. They can avoid milk and dairy products by using dairy alternatives, as illustrated in Figure (37), which do not cause these symptoms.

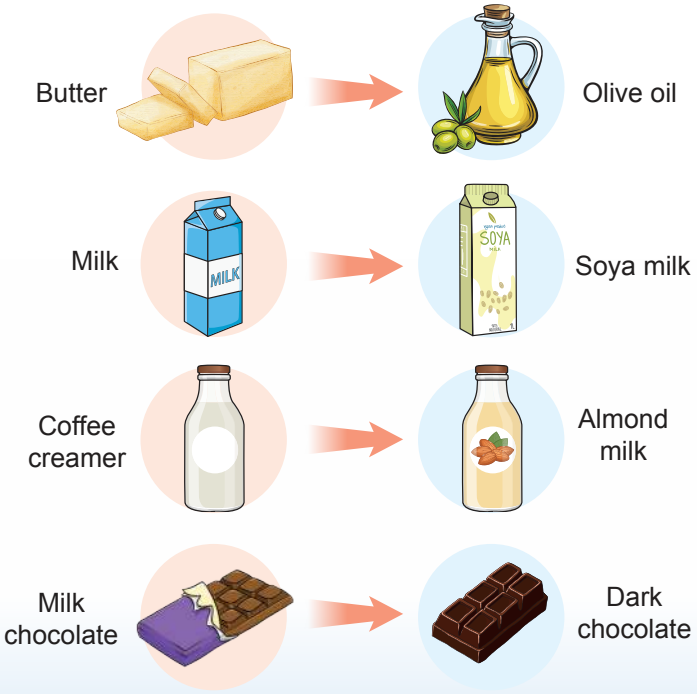


Figure (37) Dairy products alternatives

Evaluation Questions on Lesson two

1 Complete the blanks in the statements from (1) : (3) with what is suitable.

(1) The short legs of Arctic fox is a ..... trait, while the taming lions is a ..... trait.

(2) DNA is composed of small segments called ..... , each of them consists of a sequence of .....

(3) The scientists Beadle and Tatum concluded that each gene is responsible for producing ..... which is responsible for the formation of .....

2 Choose the correct answer for the questions from (1) : (3).

(1) Millions of nucleotides come together directly, forming .....

(a) chromosomes.
(b) chromatids.
(c) genes.
(d) histones.

(2) Which of the following represents lethal natural mutations, and which represents beneficial spontaneous mutations, respectively?

(a) Muscular dystrophy in children, seedless grapes.
(b) Muscular dystrophy in children, lactose tolerance.
(c) Six fingered hand, lactose tolerance.
(d) Six fingered hand, cubic-shaped oranges.

(3) What is the composition of the mixture which is used to separate strawberry chromosomes?

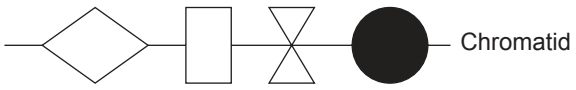
(a) Salt, dishwashing liquid, and water only.
(b) Salt, ethyl alcohol and water only.
(c) Dishwashing liquid and ethyl alcohol only.
(d) Salt, dishwashing liquid and ethyl alcohol.

3 From the following figure:

(1) What is the term used to describe people who look like this child?

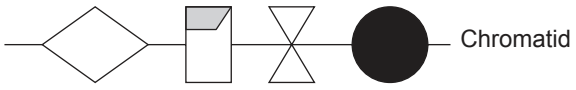
(2) What is the scientific explanation for the birth of this child from a dark-skinned mother?

4 The illustrative figure (1) represents a part of a chromosome in the body of a woman, and the illustrative figure (2) represents the same chromosome in another cell in the body of the same woman:



(X)

Figure (1)



(X)

Figure (2)

(1) What is the term used for part (X) of the chromatid?

(2) What is the term used to describe the change occurring in part (X) in figure (2)?

5 What is the hypothesis which the two scientists Beadle and Tatum affirmed ? What does it mean ?

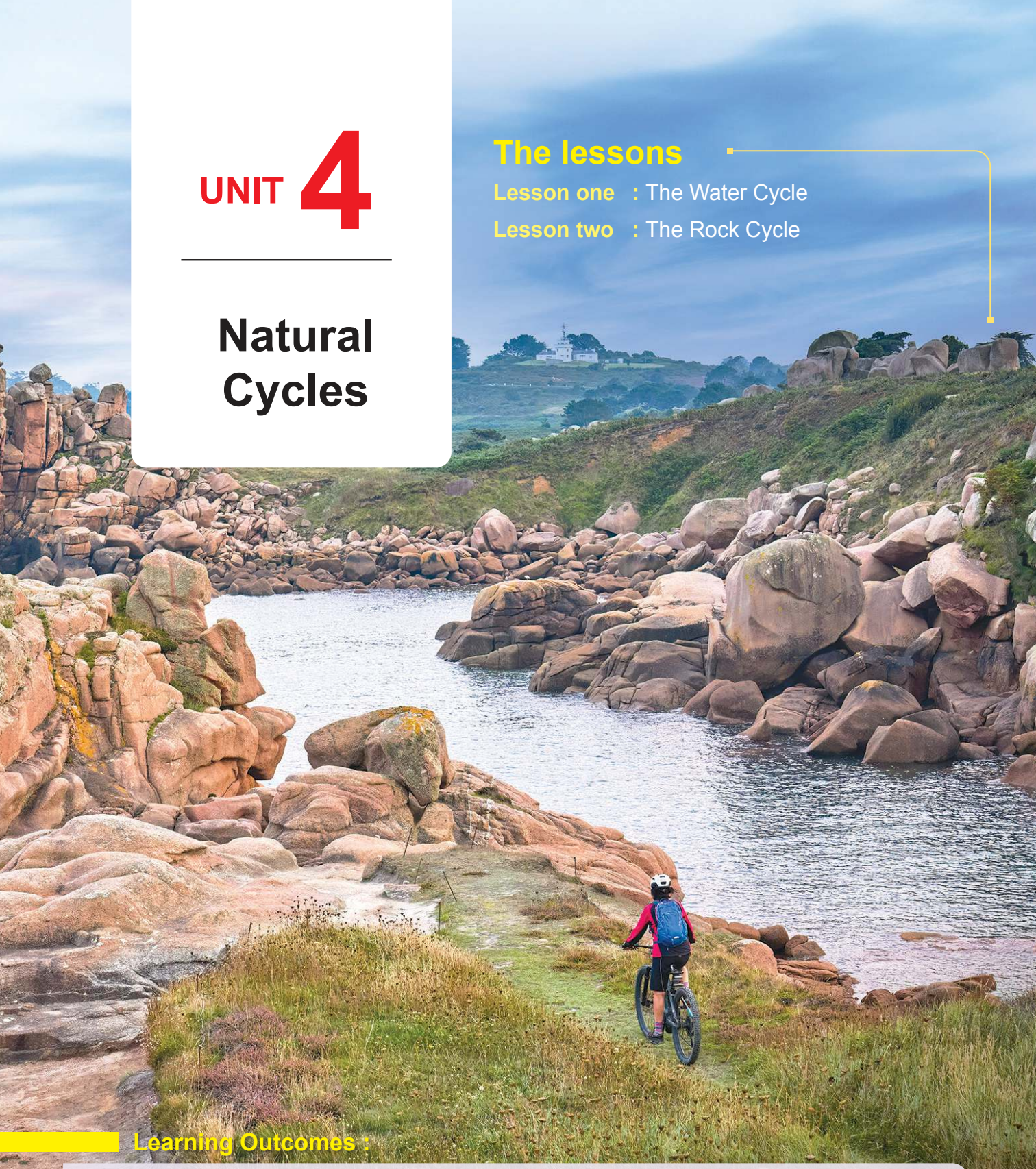
UNIT 4

Natural Cycles

The lessons

Lesson one : The Water Cycle

Lesson two : The Rock Cycle



Learning Outcomes :

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

1. Recognize the multiple pathways of water during its cycle.
2. Analyze the processes to determine the states of water during its movement in its various pathways.
3. Recognize that physical and chemical changes in earth substances and living organisms occur by the effect of the energy from the sun and the Earth's interior.
4. Conclude that all processes on Earth occur as a result of the flow of energy and the cycling of matter within the Earth.
5. Explain the role of weathering, erosion, melting, crystallization and sedimentation in the formation of rocks.

Lesson **one**

The Water Cycle

Lesson Terminology :

- Water Cycle.
- Evaporation.
- Condensation.
- Precipitation.
- Surface Runoff.
- Rain.
- Snow.
- Hail.
- Transpiration.

Included Skills, Values and Issues :

- **Skill** : Practical.
- **Values** : Appreciation of the Creator's greatness – Collaboration.
- **Issue** : Overconsumption of freshwater.

Cross-Cutting Concepts :

- Systems and their models.

Lesson Objectives :

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

1. Recognize the pathways of water during its cycle.
2. Differentiate between the processes of evaporation, condensation, precipitation, surface runoff and infiltration.
3. Determine the role of the sun in the water cycle.
4. Identify the role of gravity in the water cycle.
5. Design a (conceptual - physical) model that describes the water cycle.

Lesson Preparation :

The opposite figure shows the water cycle in nature.

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

- What is the role of the sun in the water cycle?
- What is the role of gravity in the water cycle?
- What are the various pathways of water during its cycle?

Water

• **You may be surprised!!** When you know that water forms approximately 70% of the human body (Figure 1), and about 71% of the composition of the Earth's surface (Figure 2).

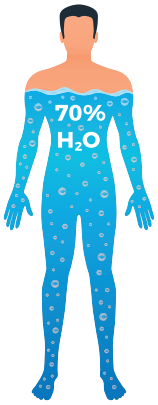


Figure (1)

Water forms approximately 70% of the human body

Figure (2)

Water forms approximately 71% of the composition of the Earth's surface

• Water is used for drinking, agriculture, industry and sanitation, and it has a vital role in regulating the temperature of the Earth planet.

• Water exists in the three states of matter: Solid, liquid and gas (Figure 3), fresh water represents only about 3% of the water available on the Earth's surface, which makes its conservation and prudent use essential for ensuring its sustainability in the future.

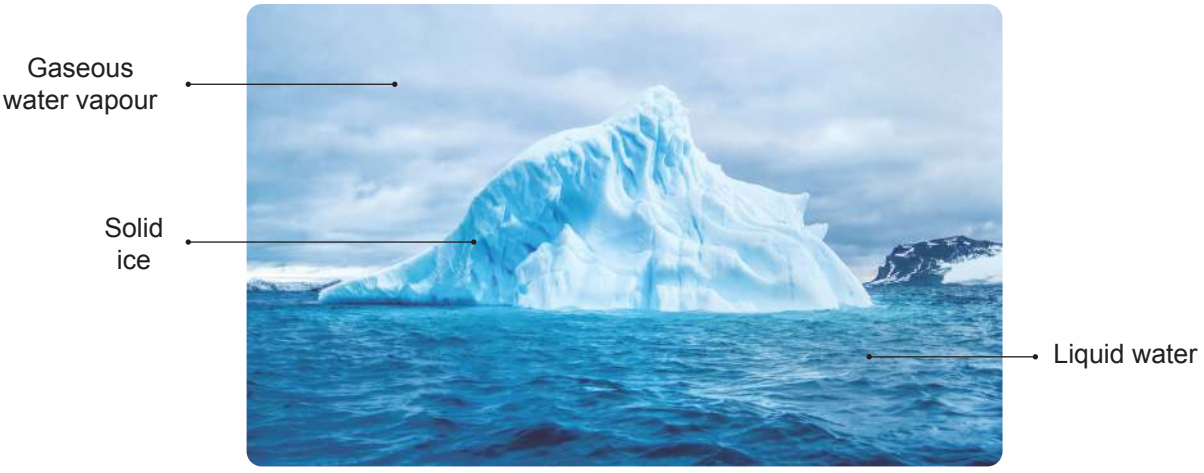


Figure (3)

States of water in nature

How does water transfer from the Earth's surface to the atmospheric air?

Activity 1 Practical

• **Team up with one of your a classmates to carry out this activity:**

Used tools and materials:

• Two cups of water.
• Rubber band.
• Cellophane paper.
• Marker.

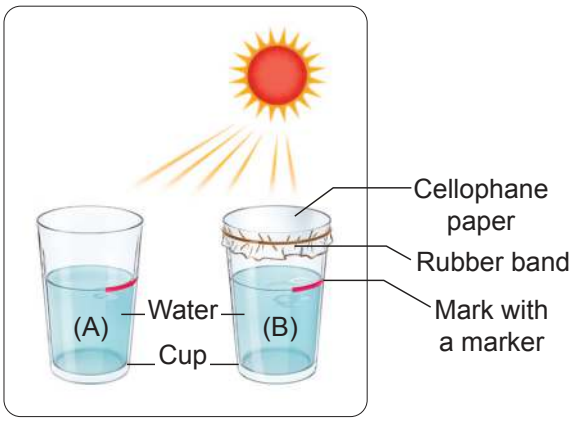


Figure (4)

Steps:

1. Use the marker to mark the water level in both cups and label one cup with the letter (A) and the other with the letter (B).
2. Cover the opening of cup (B) with the cellophane paper and secure it with the rubber band.
3. Place the two cups in a sunny place for 5 to 6 hours (Figure 4).

- Compare between the amount of water in both cups... What do you observe?

.....

- What is the role of the sun in the change in the amount of water?

.....

- Where has the water that decreased from cup (A) gone?

.....

It is clear from the previous that:

• Water converted from its liquid state to the gaseous state (water vapour) upon gaining heat, in a process known as evaporation, which occurs at any temperature.

Evaluate Your Understanding:

(1) Compare between the effect of the sun on the evaporation process in the tropical regions and the polar regions.

.....

(2) What is the difference between the evaporation process and the boiling process?

.....

Research Activity

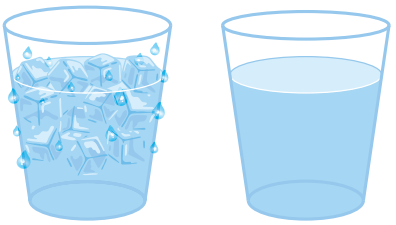
Search in various knowledge sources about the concept of humidity and its effect on life.

- **liquid water can turn into water vapour in the atmospheric air, does the water vapour remain in the atmospheric air, or can it return to the surface of the Earth once again?**

Activity 2 Practical

Used tools and materials:

- Two cups containing water.
- Ice cubes.
- Tissues.



(A) (B)

Figure (5)

Steps:

1. Wipe the outer surface of both cups with the tissues.
2. Place ice cubes in cup (A) only (Figure 5).

- Compare between what happens on the outer surfaces of the two cups (A) and (B) after several minutes.

.....

- **What is the independent variable and the dependent variable in this activity?**

Independent variable: .....

Dependent variable: .....

- **What is the source of the water droplets formed, and how were they formed?**

Their source is .....

They were formed by .....

It is clear from the previous that:

- Water vapour is converted from the gaseous state to the liquid state upon losing heat, in a process known as condensation, which occurs at any temperature, **as illustrated in the diagram of the conversions of water (Figure 6)**.

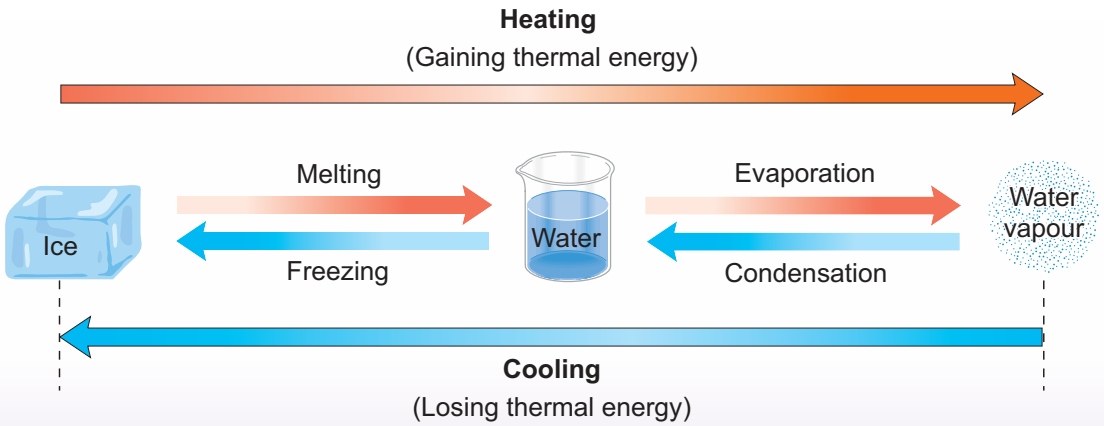


Figure (6) Water conversions

Evaluate Your Understanding:

One of the students prepared the set up shown in figure (7) and noticed the formation of water droplets on the lower surface of the basin,

What can be done to reduce the amount of water droplets formed?

(a) Adding ice cubes to the basin.

(b) Adding water at a temperature of 50°C to the basin.

(c) Adding water at a temperature of 70°C to the beaker.

(d) Adding water at a temperature of 100°C to the beaker.

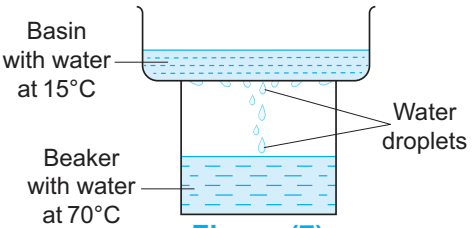


Figure (7)

You may wonder...?!

Where does the water in water bodies such as oceans, seas, rivers and lakes come from?

How are they formed? And where do they go afterwards?!

Activity 3 Practical

Used tools and materials:

- Empty cup.
- Hot water.
- Ice cubes.
- Cellophane paper.
- Marker.
- Tissues.
- Rubber band.

Steps:

1. Pour hot water into the cup (figure 8).
2. Wipe the mouth of the cup with the tissues, then cover the mouth of the cup with the cellophane paper and secure it with the rubber band.
3. Draw a line with the marker to indicate the water level in the cup.
4. Place the ice cubes on the surface of the cellophane paper.

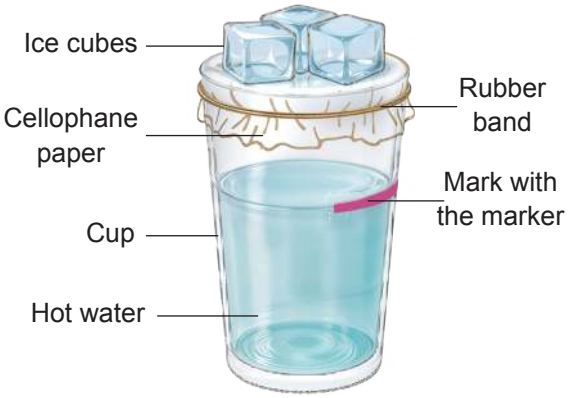


Figure (8)

- What is the importance of the ice cubes in this activity?

.....

- What do you observe on the inner surface of the cellophane paper? What happens afterwards?

.....

- What do you notice regarding the amount of water in the cup over time?

.....

It is clear from the previous that:

- The water in the cup convertes into water vapour, which in turn condenses into water droplets in a closed cycle, representing what occurs in nature and is known as the water cycle.

The Water Cycle in Nature

• The water cycle (Figure 9) is a natural process that involves the movement of water between the atmosphere and the Earth in a closed, multi-path cycle, as follows:

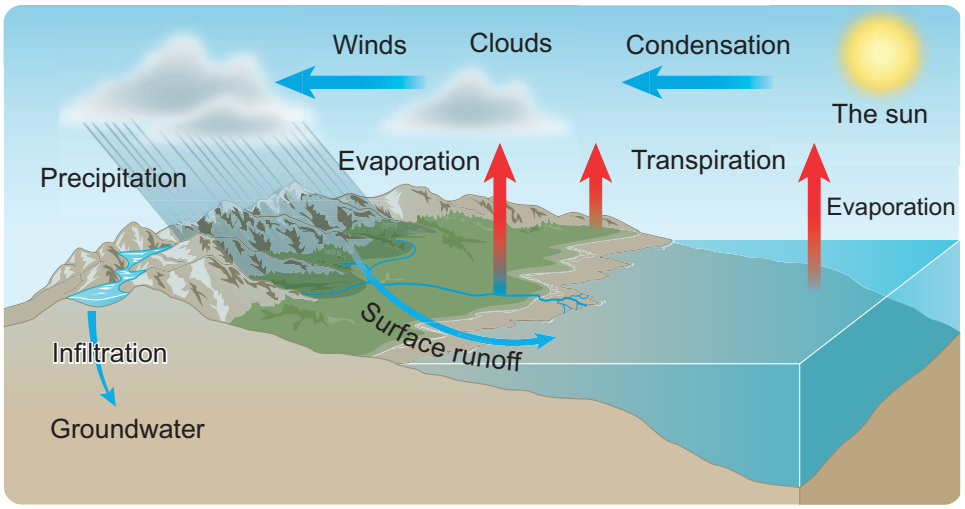


Figure (9) The water cycle

The sources of water vapour in nature are numerous, as follows:

- The evaporation of water from large water bodies such as rivers, seas and oceans.
- The process of transpiration in plants (the process by which plants lose water in the form of water vapour) (Figure 10).
- The evaporation of the water of perspiration (sweat) which is secreted by human and animals.

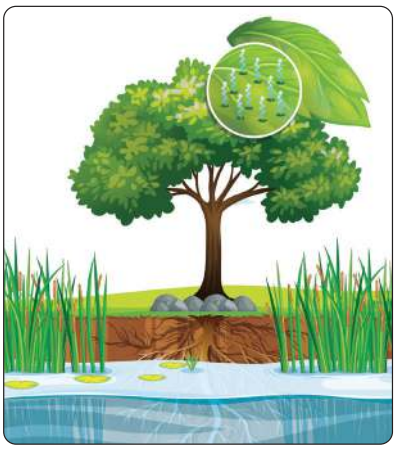


Figure (10)
Transpiration process

The multiple pathways in the water cycle:

1. Evaporation of water occurs on the Earth's surface by the effect of the energy derived from the heat of the sun.
2. Air currents in contact with the Earth's surface carry water vapour upwards, which loses energy, the decrease in its temperature causes the process of condensation, where tiny water droplets accumulate to form clouds.
3. Winds move the clouds, within which tiny water droplets accumulate together forming larger and heavier drops of water.
4. Precipitation occurs as the heavy water drops from the clouds return to the Earth's surface due to gravity in the form of rain, a portion of which infiltrates into the ground and is stored as groundwater, while the other portion flows across the Earth's surface due to Earth's gravity as surface runoff into rivers, seas and lakes, some of it directs to the oceans.
   Through the continuity of these processes, the water in water bodies is renewed.
   When the temperature of the clouds is below the freezing point, Snow precipitates instead of rain, the accumulation of the small ice crystals during thunder storms causes the formation of what is called Hail.

It is concluded from the previous that :

The sun and gravity together maintain the continuity of the water cycle, where the sun causes the movement of water from the earth to the atmospheric air, while gravity works to return the water back to the Earth again, thereby preserving the balance of the ecosystem.

Evaluate Your Understanding

Complete Table (1) to identify the states of water during its movement through the various pathways in the water cycle:

Water pathway	State of water
Evaporation	.....
Condensation	.....
Surface runoff	.....
Transpiration	.....
Precipitation	..... , ...
Infiltration	.....

Table (1)

Issue for Discussion

The over consumption of freshwater and our role in rationalizing consumption to ensure the sustainability of freshwater resources.

Engineering design

Design a conceptual or physical model of the water cycle.

Cross-Cutting Concepts : Systems and Their Models

Water forms a comprehensive ecosystem, in which the various pathways periodicaly interact. The water cycle model (Figure 11) illustrates the mutual relation between the components of the system and their impacts on the environment, which enhances our understanding of natural processes and helps in predicting their future changes.

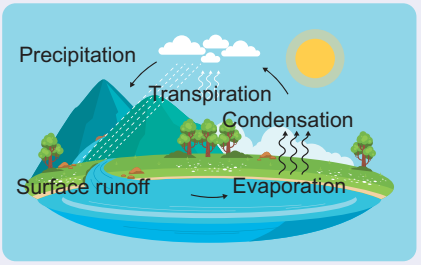


Figure (11)

Life Application

Desalination of seawater is carried out to facing the resources shortages of freshwater suitable for drinking or irrigation, particularly in remote areas. The principle of desalination relies on the processes of evaporation and condensation through a seawater desalination device (Figure 12).

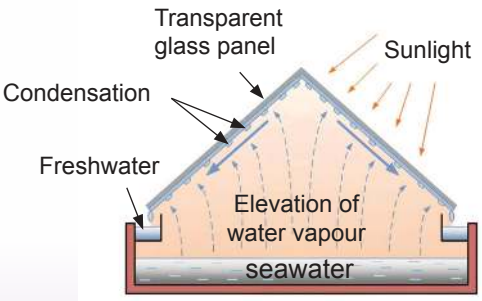


Figure (12)
Seawater desalination device

Evaluation Questions on Lesson one

1 Choose the correct answer for the questions from (1) : (5).

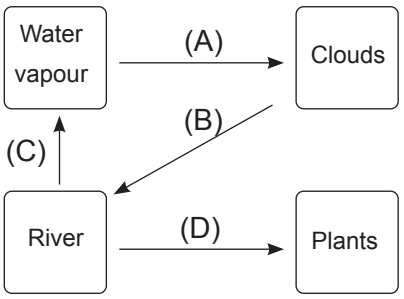
(1) Clouds and rain are formed through the processes of .....

(a) condensation and precipitation.
(b) condensation and evaporation.
(c) evaporation and surface runoff.
(d) precipitation and surface runoff.

(2) A person wearing wet clothes feels cold, despite the warm weather, because .....

(a) water loses heat when it evaporates.
(b) water gains heat when it evaporates.
(c) water vapour loses heat when it condenses.
(d) water vapour gains heat when it condenses.

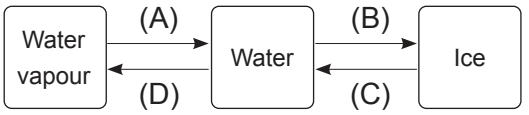
(3) From the following diagram



Which of the following is correct ?

Choices	Liquid → Gas	Gas → Liquid
(a)	(B)	(D)
(b)	(C)	(A)
(c)	(C)	(A), (B)
(d)	(A), (D)	(B)

(4) From the following diagram :



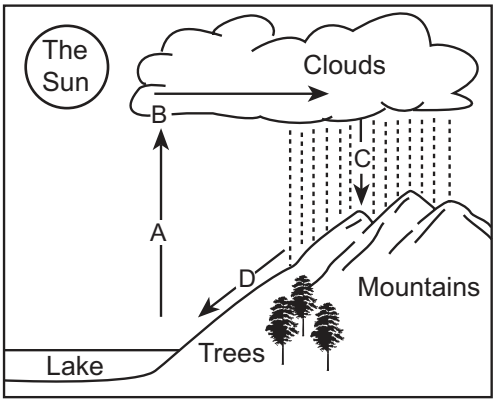
What are the two processes that occur by gaining thermal energy?

(a) (A) , (B)
(b) (A) , (C)
(c) (B) , (D)
(d) (C) , (D)

(5) What are the two processes that occur at any temperature?

(a) Melting and boiling.
(b) Evaporation and condensation.
(c) Melting and evaporation.
(d) Evaporation and boiling.

2 The following diagram represents the water cycle :



Replace the letters (A), (B), (C) and (D) with the appropriate terms from the following:

- Condensation.
- Evaporation.
- Surface runoff.
- Precipitation.

3 Explain the role of living organisms in the water cycle.

4 Why is the boiling point considered a characteristic property of pure substances, not evaporation?

Lesson **two**

The Rock Cycle

Lesson Terminology :

- Weathering
- Sedimentary Rocks
- Igneous Rocks
- Metamorphic Rocks
- Erosion
- Transportation
- Sedimentation
- Crystallization
- Fossils
- Volcano
- Magma
- Lava
- Surface Rocks
- Plutonic Rocks
- Fossil Fuel

Included Skills, Values and Issues :

- **Skill** : Practicality.
- **Value** : Appreciation of the Creator's greatness.
- **Issue** : Sustainable use of natural resources.

Cross-Cutting Concepts:

- Cause and effect

Lesson Objectives :

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

1. Recognize that rocks are composed of one or more minerals.
2. Understand the role of Earth processes in rock formation.
3. Differentiate between weathering and erosion.
4. Identify the types of the rocks.
5. Explain the transformation of the rocks from one type to another.
6. Design a (conceptual - physical) model that describes the rock cycle.
7. Recognize the role of Earth processes in the formation of fossil fuel.

Lesson Preparation :

The opposite figure illustrates one of the processes involved in rock formation.

This lesson explores the ideas that will assist you in answering the following questions:

- What is the role of Earth processes in rock formation?
- What does the rock cycle mean?
- What is the role of Earth processes in the formation of fossil fuel?

Rocks

Rocks are solid materials composed of one or several minerals (Figure 1), and they are found on the surface of the Earth, beneath it, or at the bottom of the oceans.

Rocks are classified into three main types:

- Sedimentary rocks.
- Igneous rocks.
- Metamorphic rocks.

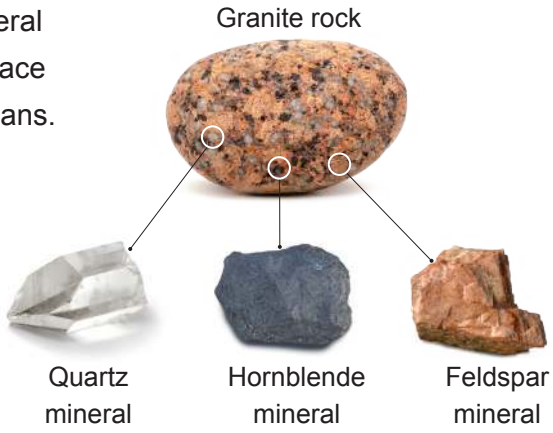


Figure (1)
The minerals constituting granite rock
(Names of minerals are for illustration only)

The Role of Geological (Earth's) Processes in Rock Formation

Physical and chemical changes in the Earth's materials lead to the occurrence of certain geological processes which affect rocks, such as:

First: Weathering. Second: Erosion. Third: Melting and crystallization.

First Weathering

Weathering is the process of breaking and fragmenting the rocks, which may take millions of years. **Types of weathering include:**

1 Mechanical Weathering

Mechanical weathering is the process of breaking and fragmenting the rocks without any change in their chemical structure.

Activity 1 Practical

1. Fill a thin-walled plastic container with water up to its edge, then close it tightly.
2. Place the container in the refrigerator for several hours.

What happens to the volume of the water when it freezes?

.....

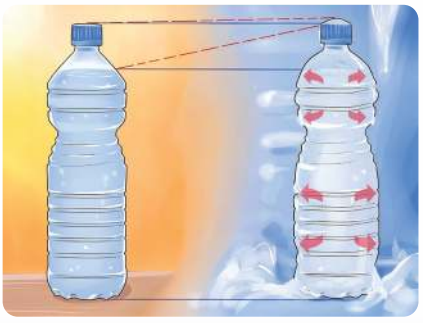


Figure (2)

It is clear from the previous that:

The volume of water increases upon freezing.

The freezing of water in rock crevices (cracks) is one of the causes of mechanical weathering, which leads to their breakage (Figure 3).

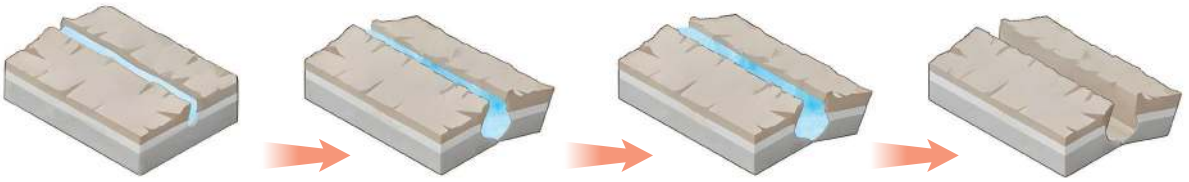


Figure (3)

Other causes of mechanical weathering include the flow of water (Figure 4) and the wind blowing (Figure 5).

Figure (4) Mechanical weathering by water flow

Figure (5) Mechanical weathering by wind blowing

Thermal expansion and contraction of the minerals that make up the rocks, are a result of the difference in temperature between day and night, are illustrated in Figures (6) : (8).

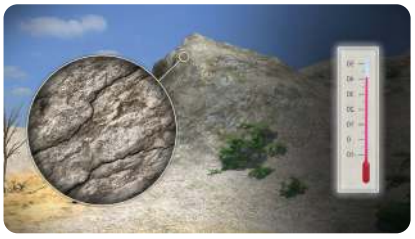


Figure (6) Expansion of rock minerals when temperature rises at the day

Figure (7) Contraction of rock minerals when temperature drops at the night

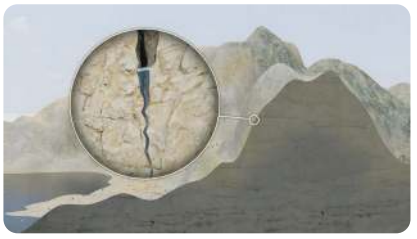


Figure (8) Weathering of rocks due to thermal expansion and contraction

The growth of plant roots within rock crevices (cracks) (Figure 9).

Research Activity

Search in various knowledge sources, including the Internet, about the White Desert Reserve where the rocks illustrated in Figure (5) are found.

Figure (9) Weathering of rocks by plant roots

2 Chemical Weathering

Chemical weathering is the process of breaking down and fragmenting rocks with a change in their chemical structure.

Activity 2 Practical

1. Put a piece of limestone on a glass plate.
2. Add drops of acid to the piece of limestone (Figure 10). What do you observe?

.....

3. What happens when a lit matchstick is brought close to the gas bubbles formed?

.....

4. Do you think that a chemical change occurs in calcium carbonate which makes up the limestone when acid is added to it?

.....

Figure (10)

It is clear from the previous that:

Chemical substances such as acids and mineral materials found in groundwater, as well as the acid rains cause chemical weathering of rocks.

- The hot springs of Yellowstone National Park in the United States (Figure 11) are a good example of chemical weathering caused by mineral-rich hot water.

Spherical weathering (Figure 12) is one form of chemical weathering (Figure 13).

Figure (11)
Yellowstone national park

Figure (12)
Spherical weathering

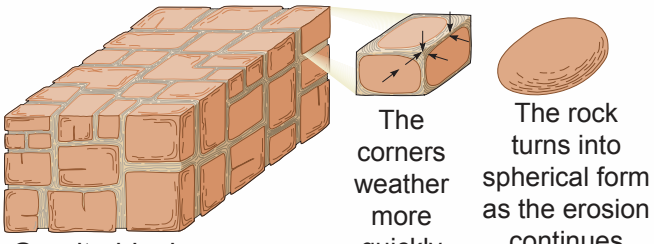


Figure (13)
Mechanism of spherical weathering

Evaluate Your Understanding:

What do you expect to happen to the shape of ice cubes when placed in an open area?

.....

Life Application

Calcium carbonate powder, resulting from the crushing of limestone rock, is used in making casts for individuals with bone fractures (Figure 14).

Figure (14)

Second Erosion

Why does the water coming from the Ethiopian Plateau appear brown?

How was the agricultural soil in Egypt formed over millions of years?

When rainfall occurs on the Ethiopian Plateau, a weathering process of the rocks takes place, followed by an erosion process, during which the rock fragments resulting from the weathering are transported away from the areas where they were originally found (Figure 15).

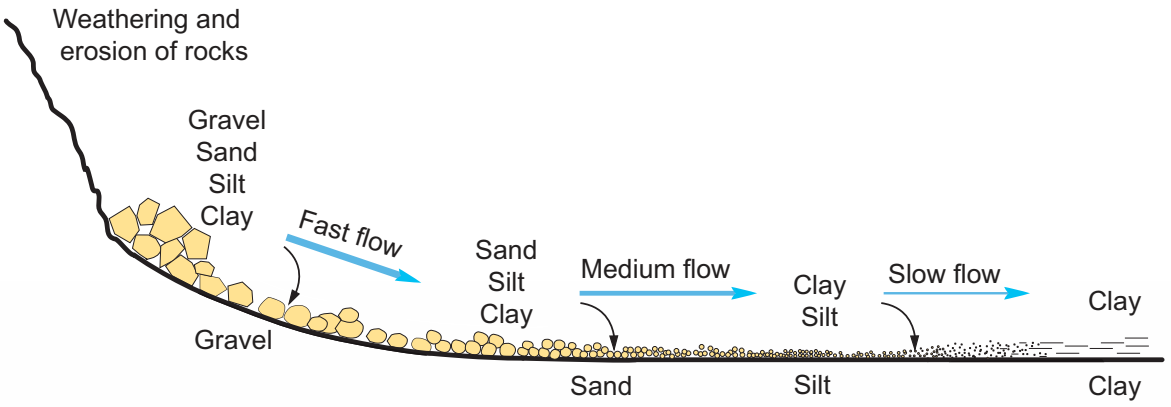


Figure (15)

The processes of transportation and sedimentation

The particles of rock fragments, known as sediments, are deposited in sedimentation areas in a process referred to as sedimentation. Over the years, sediments are compacted into layers that undergo lithification, transforming them into cohesive rocks (Figure 16) known as sedimentary rocks, **examples** of which include limestone, sandstone, and claystone. Sedimentary rocks are characterized by being porous due to the presence of spaces between the sediment particles that compose them, as well as containing fossils (Figure 17).

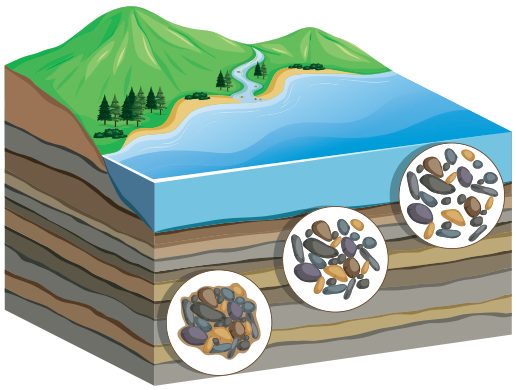


Figure (16)
Sedimentary rocks are composed of layers

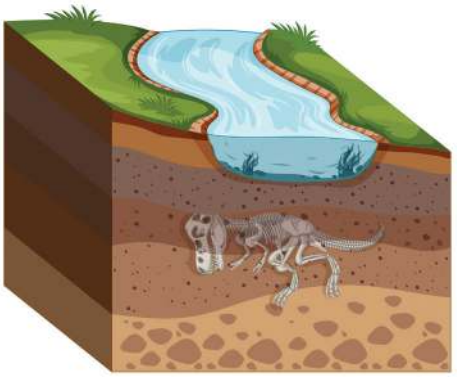


Figure (17)
Sedimentary rocks contain fossils

Among the beneficial effects of erosion processes is the formation of river deltas, while one of their detrimental (harmful) effects is the erosion of coastlines (coastal erosion) due to the action of sea waves.

Information and Communication Technology

Watch in reliable digital sources videos for marine projects aimed at protecting the beaches of Alexandria from erosion.

Evaluate Your Understanding:

Which of Figures (18), (19) represents an erosion process? Explain.

Figure (18)

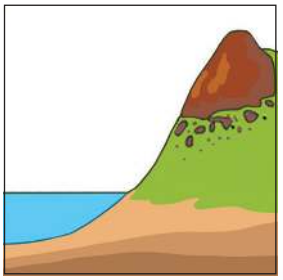


Figure (19)

.....

.....

Third Melting and crystallization

When the rocks located beneath the Earth's surface are subjected to pressure and heat without reaching the melting point, the particles of the rocks come closer together, reducing the spaces present between these particles, which leads to an increase in their hardness (Figure 20), forming new rocks known as metamorphic rocks, their examples include:

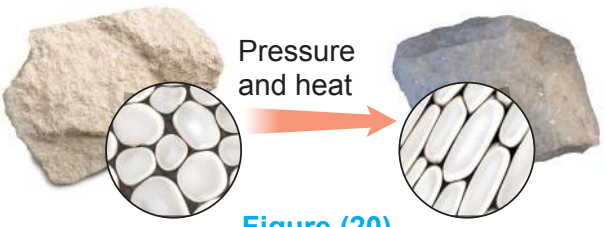


Figure (20)

The transformation (metamorphism) of limestone into marble (Figure 21).

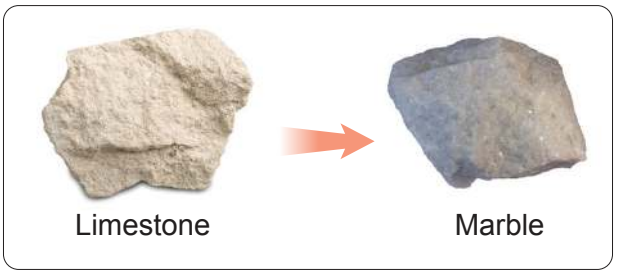


Figure (21)

And the transformation (metamorphism) of sandstone into quartzite (Figure 22).

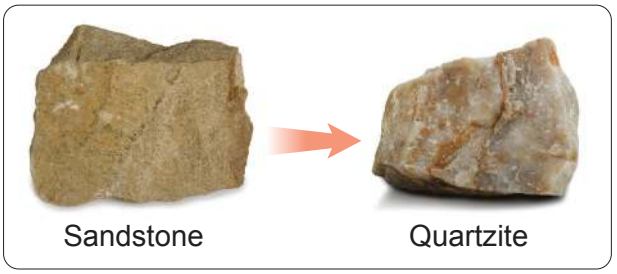


Figure (22)

The increase in temperature and pressure by moving from the Earth's crust towards the Earth's interior leads to the melting of the minerals that comprise certain rocks, resulting in the formation of magma, from which a third type of rocks known as igneous rocks is formed (Figure 23).

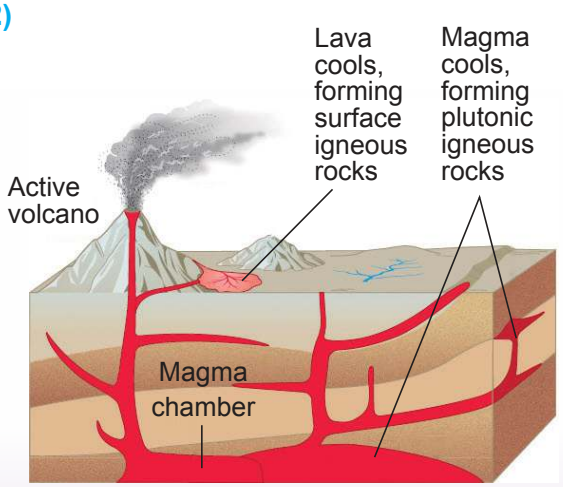


Figure (23) Formation of igneous rocks

Igneous rocks are classified into two types, depending on the location of their solidification. If magma emerges with the remaining volcanic products to the earth's surface, it loses a significant amount of the gases mixed with it, forming what is known as lava, which cools quickly to form rocks with small crystals known as surface igneous rocks, such as basalt (Figure 24) and pumice (Figure 25).

Figure (24)
Basalt

Figure (25)
Pumice

Basalt and pumice are surface igneous rocks

But, if magma overlaps between the cracks and layers of the earth's crust, it cools very slowly, forming rocks with large crystals known as plutonic igneous rocks, such as granite (Figure 26) and gabbro (Figure 27).

Figure (26)
Granite

Figure (27)
Gabbro

Granite and gabbro are plutonic igneous rocks

Integration with the Science of Construction

Rocks of all types are used in construction, as exemplified by the use of limestone in the construction of the Pyramids of Giza in Egypt (Figure 28) and marble in the construction of the Taj Mahal in India (Figure 29).

Issue for discussion

Sustainable use of natural resources

Figure (28)
One of Giza Pyramids

Figure (29)
Taj Mahal in India

Cross-Cuting Concepts : Cause and Effect

Rocks transform from one type to another through several processes, such as: weathering and erosion, extreme pressure and heat, melting and cooling, forming what is known as **the rock cycle** (Figure 30).

Engineering Design

Design a conceptual or physical model of the rock cycle.

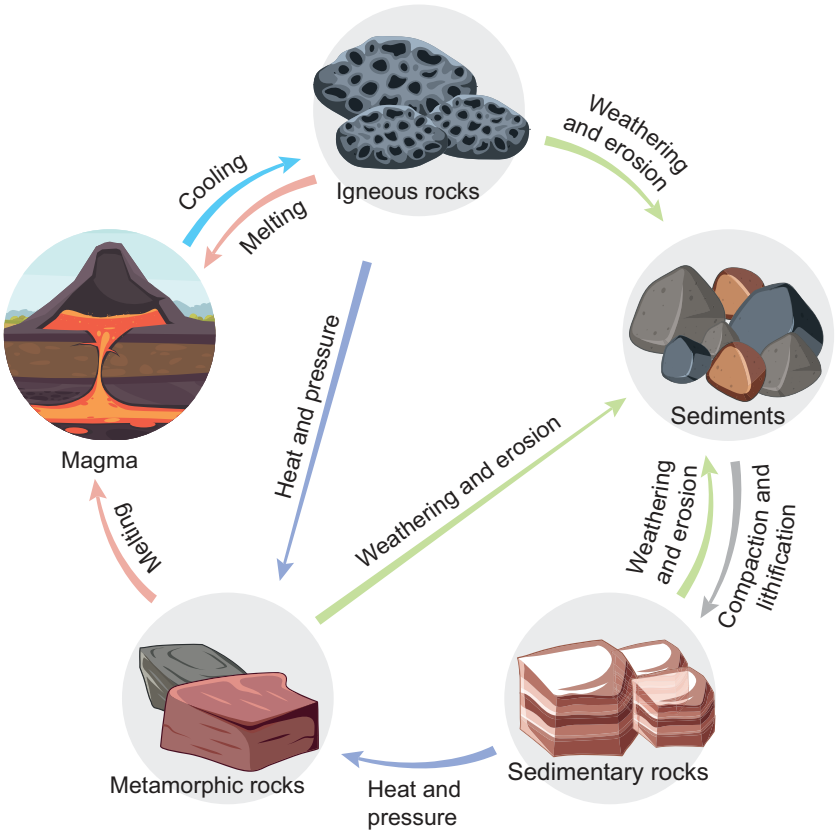


Figure (30) The rock cycle

The Role of the geological (Earth's) Processes in the Formation of Fossil Fuels

The light energy of the sun is converted into chemical energy stored in plants through the process of photosynthesis, and a part of this energy is transferred to living organisms that feed on plants. Fossil fuels (Figure 31) were formed millions of years ago as a result of a series of physical and chemical changes of organic substance in the Earth's interior. Plants-especially large ones-represent the organic origin of coal, while marine microorganisms represent the organic origin of petroleum oil, and natural gas whose major component is methane gas (forms more than 90% of it). Upon the combustion of fossil fuel, the energy stored within it, which is primarily derived from the sun, is released.

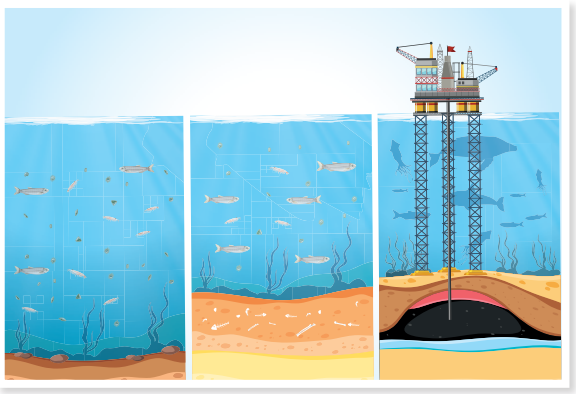


Figure (31)
Formation of petroleum and natural gas

Evaluation Questions on Lesson two

1 Choose the correct answer for the questions from (1) : (5).

(1) The three types of rocks are classified according to .....

(a) the way they are formed.
(b) the depth at which they are found.
(c) their chemical properties.
(d) their relative age.

(2) Metamorphic rocks are formed through the processes of .....

(a) melting and crystallization.
(b) transportation and sedimentation.
(c) heat and pressure.
(d) erosion and weathering.

(3) Which of the following expresses the correct classification of rocks?

Choices	Granite	Limestone	Marble
(a)	Igneous rock	Metamorphic rock	Sedimentary rock
(b)	Igneous rock	Sedimentary rock	Metamorphic rock
(c)	Metamorphic rock	Sedimentary rock	Igneous rock
(d)	Metamorphic rock	Igneous rock	Sedimentary rock

(4) The rock cycle is a model that illustrates .....

(a) the unchanging of rocks.
(b) how magma is formed.
(c) how sediments are formed.
(d) transformations of rocks.

(5) Which of the following illustrates the correct sequence for the formation of sandstone rocks?

(a) Weathering → Transportation → Sedimentation.
(b) Erosion → Weathering → Sedimentation.
(c) Melting → Cooling → Crystallization.
(d) Pressure → Heat → Crystallization.

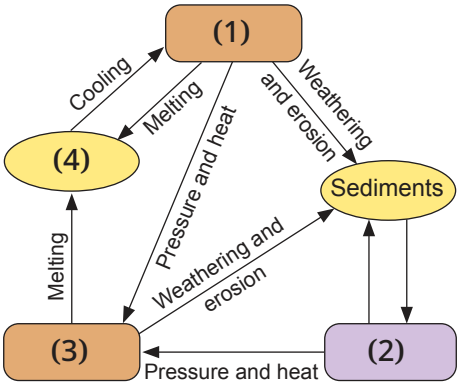
2 Complete the following statements :

(1) ..... is the process of breaking and fragmenting rocks, while ..... is the transport of sediments from one location and their sedimentation in another.

(2) Basalt is an ..... igneous rock, while granite is an ..... igneous rock.

(3) Large plants represent the organic origin of ..... fuel, while marinemicro organisms represent the organic origin of ..... fuel.

3 The following model illustrates the rock cycle:



Replace the numbers from (1) : (4) with the appropriate terms from the following :

• Sedimentary rocks. • Igneous rocks.
• Metamorphic rocks. • Magma

4 What processes lead to the transformation of :

(1) Limestone rocks into marble rocks ?

(2) Quartzite rocks into sandstone rocks ?

Notes

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