

Student's Book

Discover and Learn

SCIENCE

First Preparatory - First Term

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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.

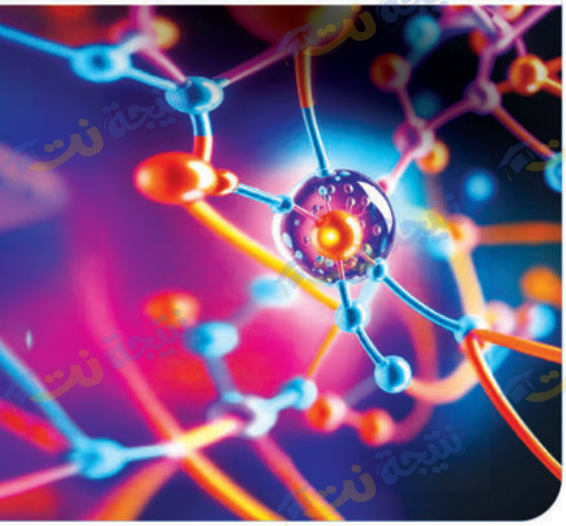
We hope you find inspiration in this book that encourages you to continue your scientific curiosity. Always remember that scientists were once curious young men and women like you, searching for answers to their questions and discovering new wonders. You, too, may be the scientists who discover things 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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UNIT 1

The Matter

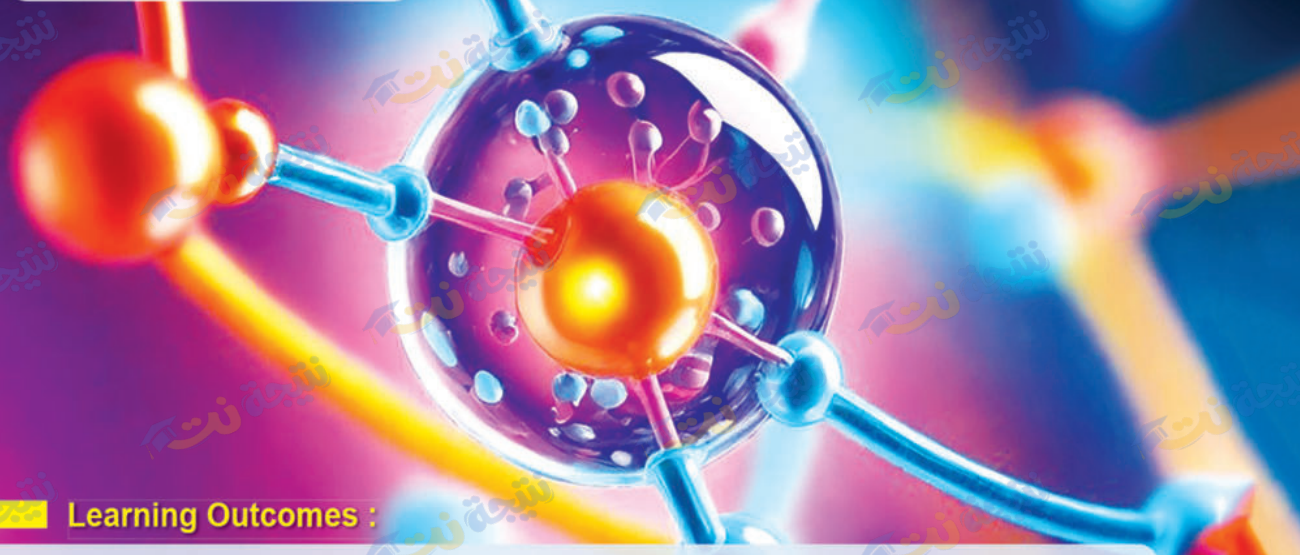
The lessons

Lesson one : Structure of the Atom

Lesson two : The Periodic Table of Elements

Lesson three : Matter and Its Properties

Lesson four : Chemical Bonds



Learning Outcomes :

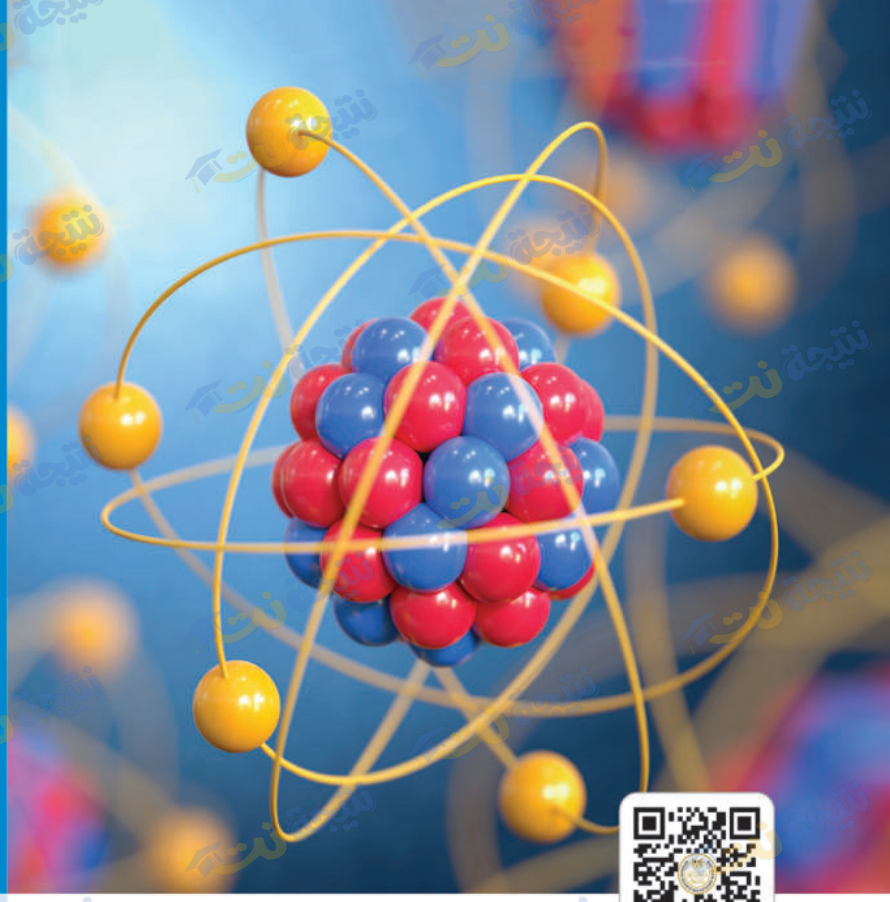
By the end of this unit, the student should be able to:

1. Conclude that the atom is the building unit of any matter.
2. Appreciate the role of the scientist Ernest Rutherford in the discovering of the nucleus.
3. Understand that the atom consists of subatomic particles called protons, neutrons and electrons, which differ in charge, mass and location within the atom.
4. Recognize that the electrons orbit in different energy levels with different shapes, and each level can carry a definite number of electrons, and any extra electron occupies the next higher energy level.
5. Determine the relationship between the number of subatomic particles that form the atom.
6. Recognize some practical applications and uses of the atom in daily life and its benefits.
7. Outline a brief introduction to the chemist Mendeleev.
8. Realize that the periodic table reflects the atomic structure and properties of the atoms, and that some elements' atoms contain the same number of protons but different numbers of neutrons, known as isotopes.
9. Relate the number of electrons in the outer energy level of an element's atom to its position in the periodic table.
10. Gather information to relate the atomic structure and the properties of matter in the periodic table.
11. Conclude the relationship between an element's location in the periodic table and its chemical activity.
12. Analyze and explain data regarding the composition of different substances.
13. Analyze and explain data to demonstrate that pure substances consist of one type of atoms or molecules, and each substance is characterized by its physical and chemical properties, which can be used to identify it.
14. Realize that molecules are made up of different atoms bonded together in different ways, with the number of atoms in molecules ranging from two to thousands.
15. Describe that the materials differ from each other due to differences in the types of atoms that compose them and the way they are bonded together.
16. Explain a model of water molecule as an example of the bonding of the atoms in the ecosystem (combined with ecology).
17. Connect the atomic structure of carbon to its unique properties in forming simple organic materials like methane.

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Lesson **one**

Structure of the Atom



Lesson Terminology :

- Matter.
- Molecule.
- Atom.
- Proton.
- Neutron.
- Electron.
- Nucleus.
- Subatomic Particles.
- Energy level.
- Atomic number.
- Mass number.
- Nucleons.
- Isotopes.

Included Skills, Values, and Issues :

- **Skills** : Prediction - Analysis - Conclusion.
- **Values**: Appreciation of scientists - Collaboration.
- **Issue** : Sustainable development.

Cross-Cutting Concepts :

- Measurement and Proportion.

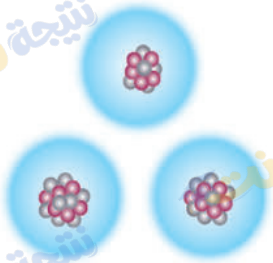
Lesson Objectives :

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

1. Conclude that the atom is the building unit of all matter.
2. Find out the role of the scientist Ernest Rutherford in discovering the atomic structure.
3. Identify the subatomic components of the atom.
4. Recognize the charges and masses of the atomic components.
5. Determine the locations of subatomic components within the atom.
6. Recognize that electrons orbit in different shapes at different energy levels.
7. Explain the chemical symbols of some elements.
8. Conclude the number of electrons that occupy energy levels.
9. Determine the relationship between the number of subatomic particles that form the atom.
10. Identify isotopes.

Lesson Preparation :

These are three atomic nuclei. This lesson explores the ideas that will help you answer these questions :



- What are the components that form the nucleus of an element's atom ?
- Why is the nucleus positively charged, while the atom is neutral ?
- Which two nuclei are isotopes ?

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The Atom is the Building Unit of Matter

Matter is anything that has mass and occupies space.

Activity 1 Conclude

In Figure (1), which shows the Sphinx statue and the Pyramids of Giza in the background, which is made of limestone rocks, which is composed mainly of calcium carbonate.

- What are the units that form calcium carbonate ?

.....

- What are the smaller units that form molecules ?

.....

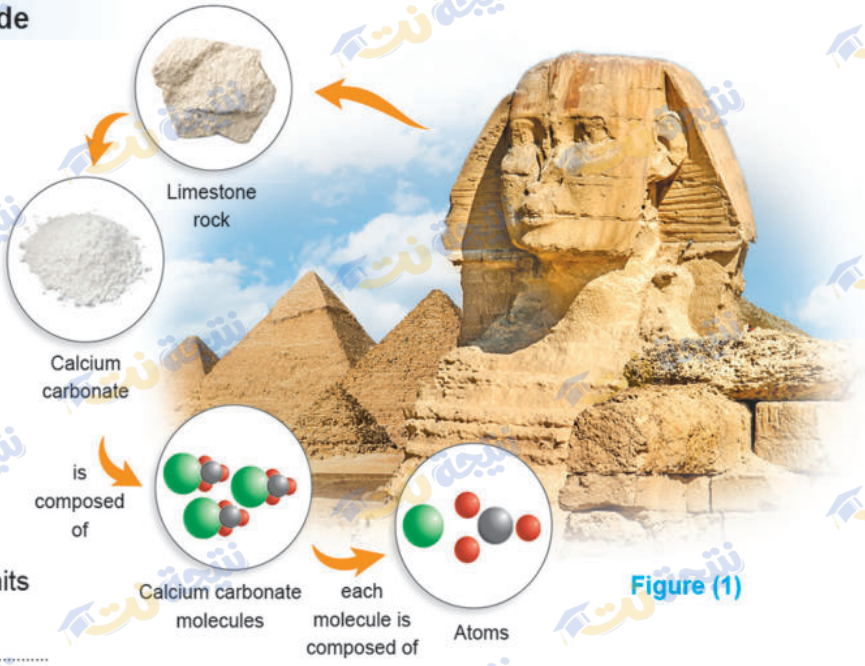


Figure (1)

- **Conclusion :**
  The atom is the building unit of the structure of any matter.

Structure of The Atom

Many attempts were made to discover the structure of the atom. Ancient Greek philosophers believed that matter was composed of small, indivisible parts called atoms.
In the early 19th century, Dalton formulated the first scientific theory about the atom, showing that atoms are indivisible. Rutherford's model of atom (1909) was the first atomic model formulated on experimental basis.
Scientists discovered that there is a very small space in the atom that contains two types of particles: protons and neutrons. This space is called the nucleus, in which electrons revolve around this nucleus at very high speeds in certain energy levels.
Protons, neutrons and electrons are called subatomic particles.

Cross-Cutting Concepts : Measurement and Proportion

If we represent the size of the atom by the size of a baseball field, the nucleus would be represented by the size of a pinhead in the middle of the field (Figure 2).



Figure (2)

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A profile of the scientist

Ernest Rutherford

Rutherford was a New Zealand physicist, born in 1871, he won the Nobel Prize in Chemistry in 1908, and he died in 1937.

In 1992, New Zealand honored him by placing his image on its one hundred-dollar note (Figure 3), in recognition of his efforts.



(Figure 3)

Activity 2 Explain

Table (1) shows the properties of the subatomic particles that compose the atom.

Particle	Symbol	Relative electric charge	Mass
Proton	p	+1	1 u
Neutron	n	0	1 u
Electron	e	–1	$\frac{1}{1836}$ u

Table (1)

① **Why is the nucleus of the atom described as positively charged ?**

.....

.....

② **Why is the mass of the atom concentrated in the nucleus?**

.....

It is concluded from the previous table that :

- The charge of the proton equals the charge of the electron in magnitude but they are opposite in type.
- The masses of the subatomic components are measured in atomic mass units (u).
- The mass of the electrons is neglected in the calculation of the atomic mass due to its smallness compared to the mass of the protons or the neutrons.

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The Energy Levels

Electrons revolve around the nucleus at different energy levels according to their energy.
There are **7** main energy levels in the heavier atoms expressed by the letters **(K, L, M, N, ...)**
the number of each level is represented by the symbol **(n)**.

Activity 3 Analyze

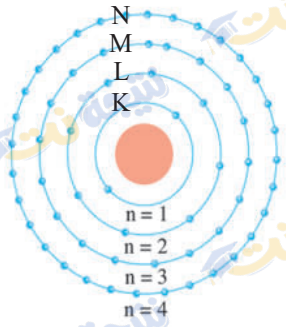


Figure (4) The number of electrons required to saturate the first four energy levels

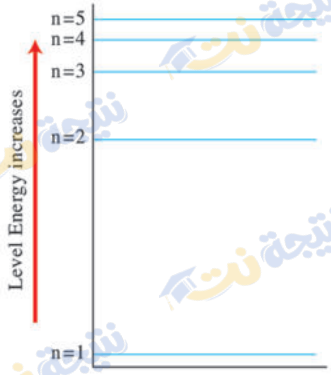


Figure (5) The energy of some levels in which the electrons revolve around the nucleus

Observe : Figures (4),(5) then answer the following questions :

1. **What is the number of the electrons that saturate each of the first four energy levels?**
   - First energy level K (n = 1) : .....
   - Second energy level L (n = 2) : .....
   - Third energy level M (n = 3) : .....
   - Fourth energy level N (n = 4) : .....
2. **What happens to the energy of the electron when it moves farther from the nucleus ?**

.....

Mathematical Understanding :

- The number of electrons required to saturate the first four energy levels can be determined by the mathematical relationship ($2n^2$), where (n) represents the number of the main energy level.
- Verify the results of Activity (3) by applying the relationship ($2n^2$).

- Scientists have found that each main energy level consists of a number of energy sublevels in which electrons orbit in different shapes, and each main level can be occupied by a specific number of electrons. Any extra electrons occupy the next higher energy level.
- The first energy level is filled with electrons, and then the higher energy levels are filled with electrons successively according to the number of electrons in each atom.
- The outermost energy level of any atom does not contain more than 8 electrons.

Evaluate Your Understanding:

According to your understanding of electronic configuration in the energy levels, place dots (•) to represent the electrons in the energy levels of the atomic models shown in Figure (6).



8 Electrons **12 Electrons** **19 Electrons**

Figure (6)

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Symbols of The Elements

Scientists agreed to express the chemical elements are represented by certain symbols to facilitate their expression and writing, especially in chemical equations.
Tables (2) and (3) show the names of some elements in two languages and their chemical symbols.

Element symbol	Element name in	
	English	Latin
C	Carbon	Carbo
N	Nitrogen	Nitrogenium
Cl	Chlorine	Chlorum
Cr	Chromium	Chromium

Table (2)

Element symbol	Element name in	
	English	Latin
Na	Sodium	Natrium
K	Potassium	Kalium
Cu	Copper	Cuprum
Fe	Iron	Ferrum

Table (3)

It is concluded from Tables (2) and (3) that :

The element symbol may be one capital letter or two letters, the first is capital and the second is small. The element symbol usually represents its name in Latin language.

When the element differs between English and Latin name, its symbol is taken from its Latin name.

Life Application

Fertilizers are chemical compounds used to improve the agricultural crops (Figure 7).

Among the most important types of fertilizers is the fertilizer NPK which is composed of three compounds containing the elements :

- Nitrogen (N) : Necessary for the greening of the plant leaves.
- Phosphorus (P) : Necessary for developing strong roots.
- Potassium (K) : Necessary for the healthy growth of the plant.



Figure (7)
Fertilizer NPK

Issue for Discussion

The impact of excessive fertilizer use in agriculture.

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Relation Between The Numbers of The Subatomic Particles

Team up with one of your classmates to discover the relation between the subatomic components by performing Activity (4).

Activity 4 Discover

Figure (8) shows the subatomic particles that form the atoms of some elements.

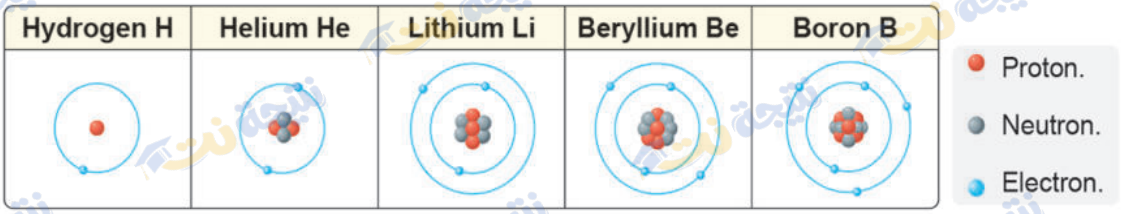


Figure (8)

Record the number of the atomic components in Table (4), and choose the appropriate mathematical symbol (> / = / <) to express the relation between :

- The number of protons and electrons.
- The number of protons and neutrons.

Element	H	He	Li	Be	B
Number of protons	1	.....	.....	.....	5
Number of neutrons	0	.....	.....	.....	.....
Number of electrons	.....	2	.....	.....	.....
Relation between number of protons and number of electrons	P ..... e^-	P = e^-	P ..... e^-	P ..... e^-	P ..... e^-
Relation between number of protons and number of neutrons	P > n	P ..... n	P ..... n	P ..... n	P ..... n

Table (4)

From the previous it is concluded that :

1. The number of positive protons (P) equals the number of negative electrons (e^-) in any atom, so the atom is electrically neutral.
2. The number of protons is called the atomic number, represented by the symbol Z , and is written at the lower left side of the element symbol.
3. The number of protons may equal the number of neutrons in the nuclei of some atoms, or the number of neutrons may exceed the number of protons in the nuclei of other atoms.



Figure (9)

4. The sum of the numbers of the protons and the neutrons which compose the nucleus of an atom represents the number of nucleons which is called the mass number, represented by the symbol A, and is written at the upper left side of the element symbol.
5. The difference between the mass number A and the atomic number Z equals the number of neutrons in the nucleus of the atom.

Evaluate Your Understanding

Complete the numbers Z and A for the elements symbols in Table (5) based on the results in Table (4).

$^{1}_{1}H$	..... He	..... Li	..... Be	..... B .....

Table (5)

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Isotopes

Scientists have observed that the atoms of the same element may exist naturally in different forms that have the same atomic number but differ in mass number, due to the difference in the number of the neutrons in their nuclei. These forms are known as isotopes of the element Figure (10) .

▶ **What is the only isotope of hydrogen that has no neutrons in its nucleus?**

.....

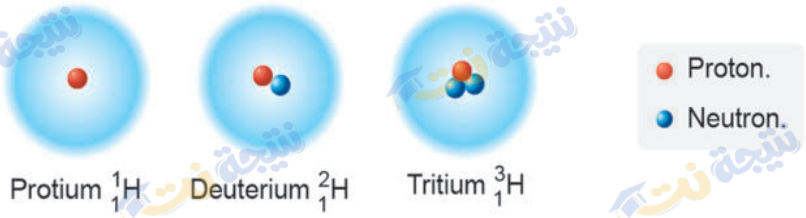


Figure (10) Isotopes of hydrogen

Evaluate Your Understanding

From Table (6), which shows the number of the protons and the neutrons in the atoms of some elements :

Element atom	(1)	(2)	(3)	(4)	(5)
Protons p	20	16	16	7	8
Neutrons n	20	20	18	8	9

Table (6)

Which two atoms are isotopes of the same element ?

(a) (1) , (2) . (b) (2) , (5). (c) (2) , (3). (d) (4) , (5).

Information and Communication Technology

Watch educational videos from reliable digital sources explaining the concept of isotopes.



Research Activity

Search in various knowledge sources, including the internet or the AI applications, about isotopes.

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Evaluation Questions on Lesson one

1 Choose the correct answer for the questions from (1) : (8).

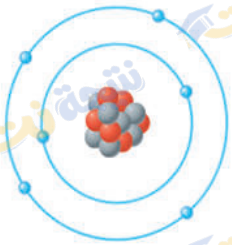
(1) What is the subatomic component that has the smallest mass ?

(a) Proton. (b) Neutron.
(c) Electron. (d) Nucleon.

(2) Which of the following subatomic components has a mass of 1 u ?

(a) Proton only.
(b) Electron only.
(c) Each of neutron and electron.
(d) Each of neutron and proton.

(3) The following figure shows the structure of the atom (X):



What is the symbol that represents this atom?

(a) $^{13}_{7}X$ (b) $^{13}_{6}X$ (c) $^{6}_{7}X$ (d) $^{7}_{6}X$

(4) Which of the following atoms has number of neutrons equals twice the number of protons in its nucleus?

(a) $^{1}_{1}H$ (b) $^{3}_{1}H$ (c) $^{4}_{2}He$ (d) $^{7}_{2}He$

(5) The nucleus of potassium atom contains 19 protons, then the electron with the highest energy in this atom is found in the .....

(a) first energy level.
(b) second energy level.
(c) third energy level.
(d) fourth energy level.

(6) What is the number that is the same in all the atoms of the same element ?

(a) Mass number.
(b) Number of electrons.
(c) Number of neutrons.
(d) Number of nucleons.

(7) Which of the following choices indicates that the atom of the element is neutral?

Choices	Element	Atom components
(a)	Silicon	14 protons, 14 neutrons
(b)	Sodium	11 protons, 23 neutrons
(c)	Chromium	24 protons, 24 electrons
(d)	Iron	26 protons, 30 electrons

(8) The electrons of an atom of an element are distributed in 3 energy levels, and the outermost energy level contains 3 electrons, while its nucleus contains 14 neutrons, its mass number is .....

(a) 3 (b) 13 (c) 14 (d) 27

2 Element (X) has a nucleus that contains 20 neutral particles and 39 nucleons:

(1) What is the number of negatively charged particles in this atom ?

(2) Write the symbol of this element, including the numbers of Z and A

3 In one of the isotopes of oxygen, Oxygen –17

Why is it not possible to determine the number of neutrons in the nucleus of this isotope based only on the number 17 ?

4 The opposite figure represents a model of the atom:

What do the bees and the beehive represent in this model ?



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Lesson **Two**

The Periodic Table of elements



Lesson Terminology :

- Periodic Table.
- Block.
- Period.
- Group.
- Metals.
- Nonmetals.
- Metalloids.
- Alkali metals.
- Alkaline earth metals.
- Transition elements.
- Noble gases.
- Halogens.
- Valency.
- Atomic radius.
- Melting point.
- Boiling point.

Included Skills, Values, and Issues :

- **Skills** : Investigation, Prediction, Research.
- **Values** : Collaboration, Appreciation of scientists.
- **Issue** : The relativity of science.

Cross-Cutting Concepts :

- Structure and Function.

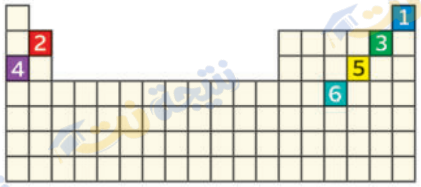
Lesson Objectives :

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

1. Explain the role of the scientist Dmitri Mendeleev in arranging the elements in an ascending order regarding their atomic masses.
2. Confirm that the modern periodic table reflects the electron configurations and properties of atoms.
3. Relate the atomic numbers of group A elements to their locations in the modern periodic table.
4. Identify the electron configurations of the atoms of the elements according to the modern periodic table.
5. Show that chemical properties are similar in some groups of the modern periodic table.
6. Conclude the relation between an element location in the periodic table and its chemical activity.
7. Appreciate the role of the scientists in the evolution of the elements classification attempts.

Lesson Preparation :

Here is a table for classifying elements: This lesson explores the ideas that will help you answer the following questions :



- Can the electron configuration of element 5 be predicted without knowing its atomic number ?
- What are the names of the blocks of the elements 1, 2, 3, and 4 ?
- Can the properties of elements 4 and 5 be compared based on their positions in the periodic table ?
- Is element 6 a metal, nonmetal or something else ?

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Attempts of Elements Classification

1 Mendeleev's Table

Scientists have made several attempts to classify elements to facilitate their study and conclude relations between them and their physical and chemical properties. Mendeleev's periodic table is considered the first periodic table for the classification of the elements, where elements were arranged in an ascending order according to their atomic masses without a regular pattern upon moving from the left of the table to the right in horizontal rows. He discovered that their properties repeated periodically at the beginning of each new row.

A profile of the scientist

Dmitri Mendeleev

Dmitri Mendeleev was a Russian chemist who published his periodic table of elements in 1869 and later he modified it.
He was honored 48 years after his death by naming one of the discovered elements after him, which is called Mendelevium (Md)

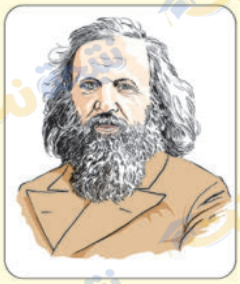


Figure (1)

2 Moseley's Table

After Rutherford discovered the protons, Moseley discovered that the periodicity of elements properties is related to their atomic numbers rather than to their atomic masses. Thus, he modified Mendeleev's table by arranging the elements in an ascending order according to their atomic numbers, so that the atomic number of each element exceeds the atomic number of the preceding element in the same period by **1**.
He also added the noble (inert) gases and other new elements discovered after Mendeleev formulated his table.

Information and Communication Technology



Watch reliable digital sources to learn about the elements of the modern periodic table.

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3 The Modern Periodic Table

Some inadequacies in Moseley's table prompted the scientists to try to modify it. The elements were rearranged in a regular ascending order according to their atomic numbers and the way to fill the energy sublevels with the electrons in the modern periodic table (Figure 2), which consists of 7 horizontal periods, 18 vertical groups, and contains 118 elements.

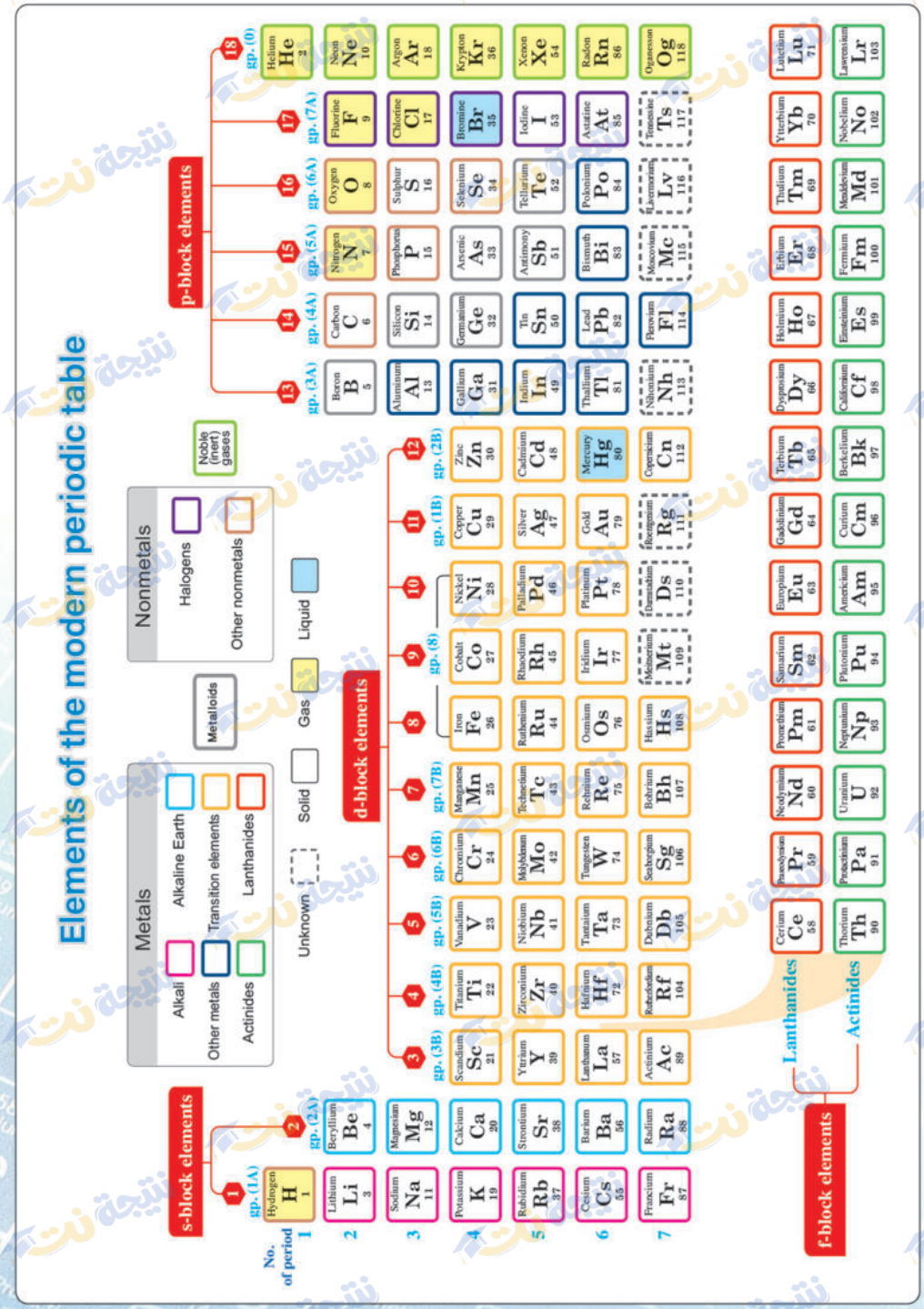


Figure (2) The Modern periodic table

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Activity 1 Collaborate and discover

Team up with your classmates to form a collaborative group to study the periodic table (Figure 2), then record your observations about the following questions :

(1) **What are the blocks of the modern periodic table? and what types of elements are found in each block ?**

Location of the block	Left of table	Right of table	Middle of table	Bottom of table
Block	.....	p	.....	f
Types of the block elements	All are metals except	..... in addition to ..... and ..... and other metals	All are metals	All are metals

(2) **What are the two groups of the s-block ? And what are the names given to the metals in each of them?**

Group	1A	2A
Name of metals group	.....	.....

(3) **How many groups are found in the p-block ?** .....

(4) **What are the names and the numbers of the last two groups in the table ?**

Group	Last group	The group before the last (Penultimate group)
Group name	Noble Gases	.....
Group number	.....	.....

(5) **What is the period number in which the d-block starts ? What name is given to most of its elements ?**

• Period number : ..... • Name of their elements : .....

(6) **How many elements are located in each of the first four periods ?**

• Period (1) : ..... • Period (2) : .....

• Period (3) : ..... • Period (4) : .....

(7) **What is the physical state of most elements ?**
Which two elements exist in a liquid state ?

Most of the elements exist in the ..... state.
The two liquid elements are ..... metal, its symbol is ..... and ..... nonmetal whose symbol is .....

A topic for Discussion

Based on your study of the modern periodic table, Does the science stagnant or developing ?
Can the current form of the periodic table be more developed ?

(8) **Classify the gaseous elements in the periodic table.**

	Inert gases						Other nonmetal gases				
Element symbol	He	.....	Ar	.....	.....	.....	H	.....	.....	.....	Cl
Number	..... elements						..... elements				

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⑨ **What are the locations of the metalloids in the modern periodic table ?**

Metalloids	Boron B	Silicon Si	Germanium Ge	Arsenic As	Antimony Sb	Tellurium Te
Period number	.....	3	.....	4	.....	5
Group number	3A	.....	4A	.....	5A	.....

Activity 2 Discover

Table (1) : Represents a section of the modern periodic table, showing the electron distributions of elements :

	1A	2A	3A	4A	5A	6A	7A	0
Period 2	Li	Be	B	C	N	O	F	Ne ....
Period 3	Na			Si	P			Ar ....
Period 4	K	Ca						Kr

Table (1)

① Write the number of energy levels and the number of electrons in the outermost energy level below each element in the first horizontal row of (Table 1).

② Place dots to indicate the distribution of electrons in the energy levels of the atoms of $_{11}Na$, $_{14}Si$, $_{15}P$, $_{18}Ar$ and determine the number of energy levels and the number of electrons in the last energy level in each atom. What can be concluded ?

.....

③ Conclude the relation between the number of occupied energy levels in the atom of an element and its period number in the modern periodic table.

.....

④ Conclude the relation between the number of electrons in the last energy level of the atoms of the elements in the groups of (p) , (s) blocks and the group number of the element in the modern periodic table (except noble gases).

.....

⑤ Predict the number of electrons in the last energy level in the atoms of :

- Potassium K : ..... - Calcium Ca : ..... - Krypton Kr : .....

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According to the two activities (1) and (2), it is clear that :

- The periodic table reflects the electron configuration and properties of atoms.
- The location of an element in the periodic table is determined by the number of occupied energy levels in its atom (period number) and the number of electrons in its last energy level (group number).
- The electron distribution of most metals ends with 1, 2 or 3 electrons, while the electron distribution of most nonmetals ends with 5, 6 or 7 electrons.
- Metalloids cannot be identified by the number of electrons in their outermost energy levels.
- Elements in the same group have similar chemical properties, and the chemical activity increases in alkali metals group and alkaline earth metals group with increasing the atomic number. The chemical activity of alkaline earth metals is less than that of the alkali metals which are highly active, while the chemical activity in the halogens group decreases with increasing the atomic number.

Valency of the element

The electrons in the last energy level are called "valence electrons" and are represented by dots around the element's symbol on four sides individually first, then they are paired up until they are distributed completely, this is known as Lewis structure (Table 2).

Group number	1A	2A	3A	4A	5A	6A	7A	0
Element	Li	Be	B	C	N	O	F	Ne
Valency	Monovalent	Divalent	Trivalent	Tetravalent	Trivalent	Divalent	Monovalent	Zero

Table (2)

The valency of an element can be concluded from the number of the unpaired electrons in its Lewis structure. It is noted from (Table 2) that the valency of elements in groups (1A to 4A) equals the group number, while the valency of elements in groups 5A to group 0 equals (8 minus the number of electrons in the last energy level).

Evaluate Your Understanding

(Figures 3 and 4) illustrate the electron distribution of the atoms of two elements (X) and (Y). Determine the valency and the location of each of them in the periodic table.



Figure (3)

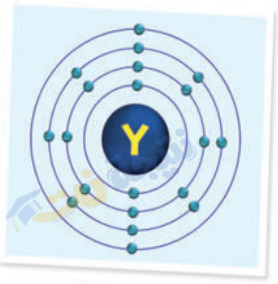


Figure (4)

• Element (X) : .....

.....

• Element (Y) : .....

.....

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► **The electron configuration of elements' atoms reflects its properties.**

Activity 3 Predict

(1) The following data are the possible values for atomic radius, melting point, and boiling point of some elements :

157 pm	883°C	99 pm	181°C	235 pm	– 34°C

Discuss with your classmate the suitable value for each blank cell in the following tables :

Metals	Atomic radius	Melting point	Boiling point
Lithium $_{3}Li$ 2,1	157 pm	.....	1347°C
Sodium $_{11}Na$ 2,8,1	191 pm	98°C	.....
Potassium $_{19}K$ 2,8,8,1	.....	64°C	774°C

Table (3) Properties of some alkali metals

Halogens	Atomic radius	Melting point	Boiling point
Chlorine $_{17}Cl$ 2,8,7	.....	–101°C	.....
Bromine $_{35}Br$ 2,8,18,7	114 pm	– 7°C	59°C
Iodine $_{53}I$ 2,8,18,18,7	133 pm	114°C	184°C

Table (4) Properties of some halogens

(2) What happens to the atomic radii in the same group by increasing the atomic number ?

.....

.....

(3) Compare between the graduation in the melting and the boiling points in both the alkali metals (Table 3) and the halogens (Table 4) as the atomic number increases.

.....

.....

(4) Determine the physical state of elements (Tables 3 and 4) at room temperature (25°C) based on their melting and boiling points.

Element	Lithium	Sodium	Potassium	Chlorine	Bromine	Iodine
Physical state	.....	Solid	.....	.....	.....	.....

From the previous, it is concluded that :

- The atomic radii of elements in the same group increase as the atomic number increases.
- The melting and boiling points of alkali metals decrease as the atomic number increases.
- The melting and boiling points of halogens increase as the atomic number increases.

Cross-Cutting Concepts : Structure and function

The chemical properties of elements depend on the number of electrons in the last energy level of their atoms, while the difference, in the number of neutrons in their nuclei results in different physical properties.

Creative Thinking

Design a 3D-model for the periodic table where each side of this model includes the elements of each block of the modern periodic table.

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Evaluation Questions on Lesson Two

1 **Complete the following statement :**

The elements in the modern periodic table are arranged according to ..... and in Mendeleev's table according to .....

2 **The following figure represents a section in the modern periodic table :**



(1) Which two elements are in the same period ?

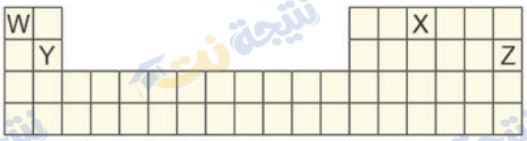
(2) Which two elements are in the same group ?

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

(1) Which of the following choices represents the two metals lithium and potassium ?

Choices	Metal with higher melting point	More reactive metal with water
(a)	Lithium	Lithium
(b)	Lithium	Potassium
(c)	Potassium	Lithium
(d)	Potassium	Potassium

(2) The following figure represents a section in the periodic table :



Which of the following represents the correct electron configuration for the mentioned element ?

(a) Element (W) : 2 , 8 , 1

(b) Element (X) : 2 , 4

(c) Element (Y) : 2 , 8 , 2

(d) Element (Z) : 2 , 8

(3) The following figure illustrates some groups of the periodic table :



Which of the following is correct about the elements in these groups ?

(a) Group (A) : Monovalent nonmetals.

(b) Group (B) : Their atomic radii decrease with increasing the atomic number.

(c) Group (C) : The physical states of its elements are not the same.

(d) Group (D) : Octavalent nonmetals.

(4) Three cubes of materials (1), (2), (3) at room temperature, and the following table shows their melting and boiling points :

	Material (1)	Material (2)	Material (3)
Melting point	16°C	3°C	60°C
Boiling point	117°C	50°C	220°C

After raising the temperature of the three cubes to X°C, their physical states became as follows:



(1) **(2)** **(3)**

What is the temperature X°C ?

(a) 15°C (b) 45°C (c) 55°C (d) 75°C

(5) Two elements (X) and (Y), if element (X) is in period 2 of the periodic table and the number of the protons in the nucleus of element (Y) exceeds that in the nucleus of element (X) by 5, Which of the following is correct ?

(a) Elements (X) and (Y) are definitely in the same period.

(b) The number of electrons in the energy level K of both elements (X) and (Y) is equal.

(c) The number of electrons in the last energy level of element (Y) definitely exceeds that in element (X) by 5.

(d) The number of nucleons in the nucleus of element (Y) exceeds that in the nucleus of element (X) by 5.

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Lesson Three

Matter and Its Properties



Lesson Terminology :

- Mixture.
- Homogeneous mixture.
- Heterogeneous mixture.
- Pure substance.
- Element.
- Compound.
- Molecule.
- Organic compound.
- Physical properties.
- Chemical properties.

Included Skills, Values, and Issues :

- **Skills** : Research - Analysis - Interpretation - Conclusion.
- **Values** : Collaboration.
- **Issue** : Preservation of resources.

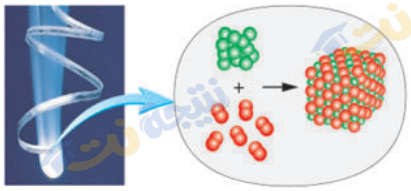
Lesson Objectives :

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

1. Analyze data showing that pure substance consists of one type of atoms or molecules.
2. Explain the difference between the molecules of elements and compounds.
3. Analyze data about the composition of different substances.
4. Explore that the number of the atoms that compose the molecules of compounds ranges between two atoms to several thousands.
5. Differentiate between substances based on their physical and chemical properties.
6. Predict the uses of materials based on their properties.

Lesson Preparation :

You have a strip of magnesium that ignites/burns by the oxygen of the air, glowing brightly and turning into a white powder.



This lesson explores ideas that help you answer these questions :

- What is the difference between the molecules of the reactants and the products ?
- Does the figure represent a physical or chemical change ?
- Can the components of the resulting compound be separated ?

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Pure Substances and Mixtures

What is the difference between :

- A mixture of sand in water and a mixture of table salt in water? (Figure 1)
- Red mercury oxide and both mercury and oxygen? (Figure 2)



Figure (1)

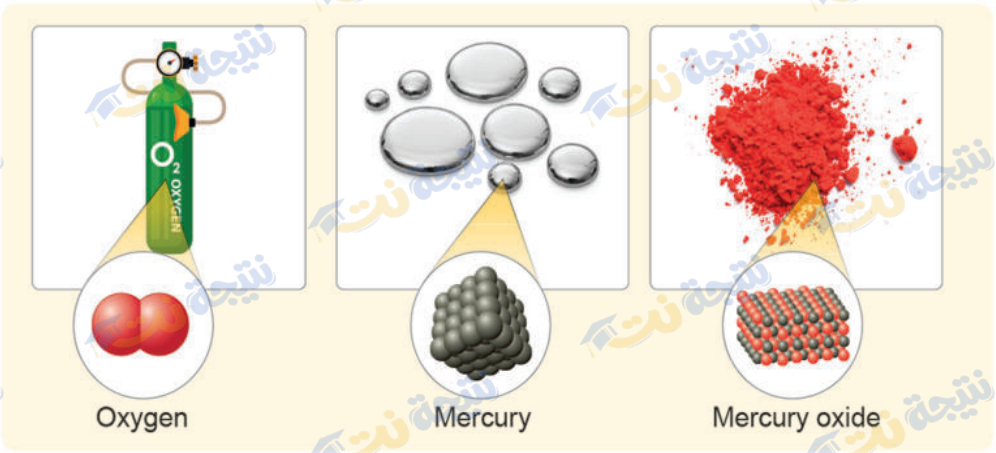


Figure (2)

- **Diagram (1) below shows the classification of some substances :**

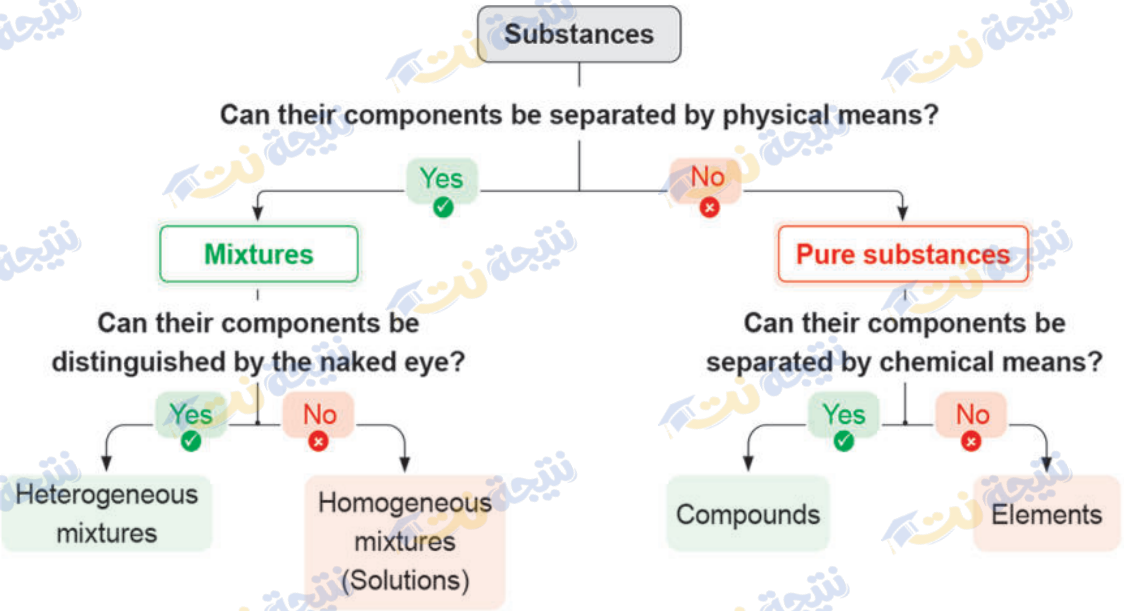


Diagram (1)

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It is clear from Diagram (1) that :

- **Mixtures** are substances composed of two or more materials that are not chemically combined. Their components can be separated by physical methods, such as filtration, magnetic separation, evaporation and condensation.
- As shown in Figure (1), the mixture of table salt in water is a homogeneous mixture, its components can be separated by evaporation and condensation, While the mixture of sand in water is a heterogeneous mixture, its components can be separated by filtration .
- Pure substances can be either compounds or elements.
  Compounds are substances formed by the chemical combination of two or more elements in fixed mass ratios, and their components can be separated by chemical methods. For example, mercury oxide (red colour) can be separated into its components (oxygen and mercury) by heating .
- Element, such as mercury and oxygen, is the simplest pure form of matter and cannot be dissociated into simpler forms, either by physical or chemical methods.

Evaluate Your Understanding

The Hoffman voltameter (Figure 3) is used to obtain hydrogen and oxygen gases by the electrolysis of water acidified with sulphuric acid :

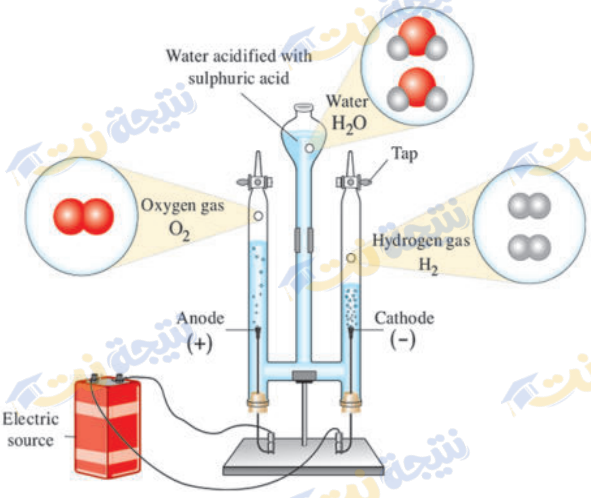


Figure (3) Electrolysis of water

(1) Why is hydrogen classified as an element ?

.....

(2) Why is water classified as a compound ?

.....

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Activity 1 Analyze and Explain

First : Fill in the blanks in (Diagram 2) using the following terms :

Diatomic	Organic	Polyatomic	Molecules of compounds	Monatomic

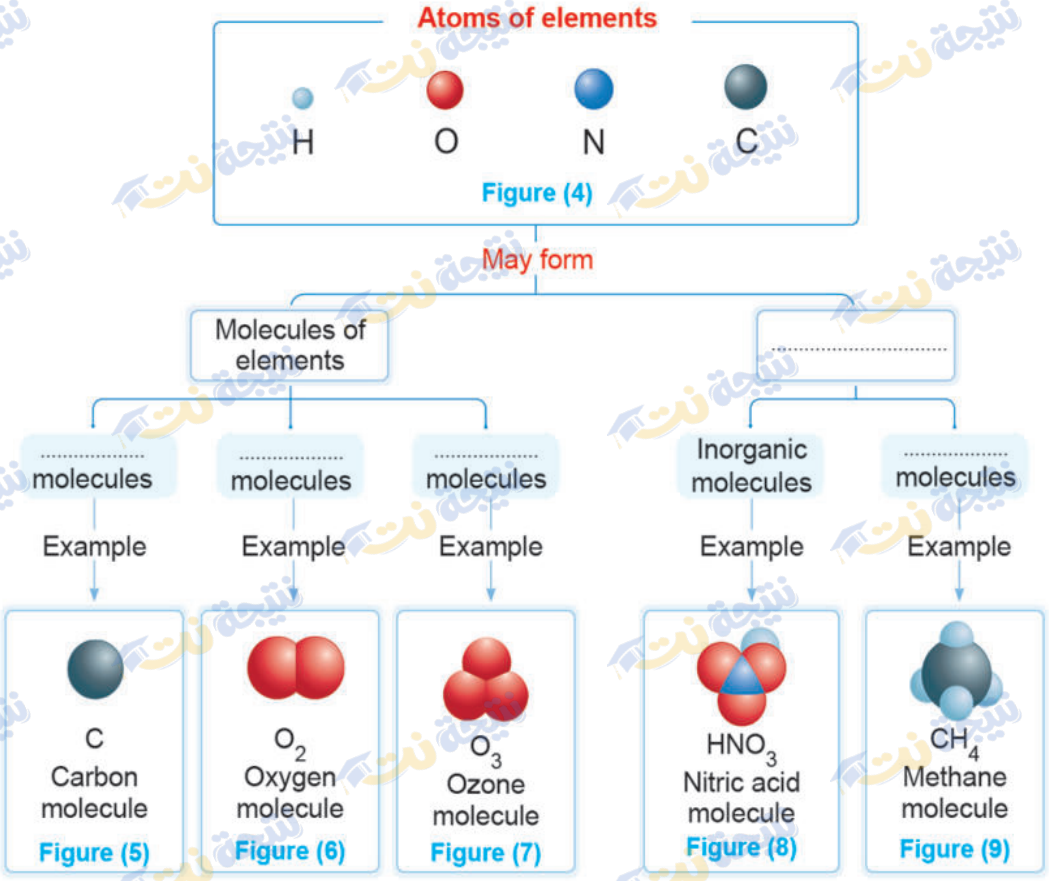


Diagram (2)

Second : Think as a scientist by answering the following questions using (Diagram 2) :

1. Identify the molecules composed of one type of atoms.

.....

2. What is the difference between oxygen molecule and ozone molecule ?

.....

- A chemical compound is represented by an abbreviated (shortened) formula known as the molecular formula, which is a symbolic formula that expresses the type and number of atoms of the elements that form the molecule such as HNO_3 , CH_4

The number of atoms in a single molecule of some organic compounds can reach several thousands, as in plastic polymers, hemoglobin in blood and vitamin (D) that regulates calcium and phosphorus levels in the blood to prevent osteoporosis.

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Organic compounds, also known as carbon compounds, are characterized by the presence of carbon element, that are bonded mainly to hydrogen atoms, as in Figure (10).
They may also be bonded to other atoms such as oxygen and nitrogen.

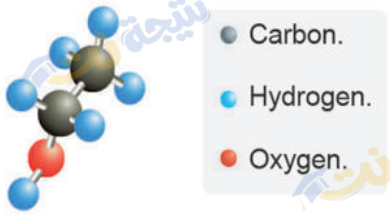


Figure (10)
Organic compound molecule

Evaluate Your Understanding

State, with explanation, what the Figures (11 , 12) represent, using the following concepts :

Molecules | Mixture | Elements

- Figure (11) : .....
- Figure (12) : .....

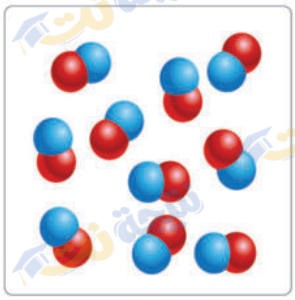


Figure (11)

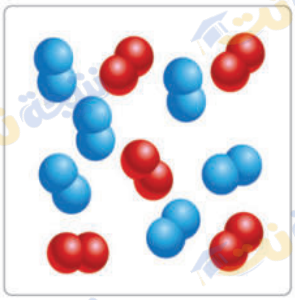


Figure (12)

Life Application

The Egyptian blue dye ($CaCuSi_4O_{10}$) is a chemical compound. Its molecule is composed of the elements shown in Table (1)
The Ancient Egyptians used Egyptian blue dye (Figure 13) for coloring papyri (Figure 14) and statues.
It is still used up till now to color the facades of houses in Nubian villages, that form a major tourism destination for both domestic and international tourism.

Element	Number of its atoms
Ca	1
Cu	1
Si	4
O	10

Table (1)
Components of the Egyptian blue dye molecule



Figure (13)
Egyptian blue dye



Figure (14)
Ancient Egyptian papyrus

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Distinguishing Substances by Their Properties

Physical properties of substances can be observed and measured in some cases, while their chemical properties only appear when a chemical reaction occurs, leading to a change in the form and the composition of the substance.

Activity 2 Distinguish

Identify the property used to distinguish between each pair of substances by filling in the blank with the letter P if the property is physical, or C if the property is chemical.



Figure (15)

The difference in viscosity between water and honey is a ..... property

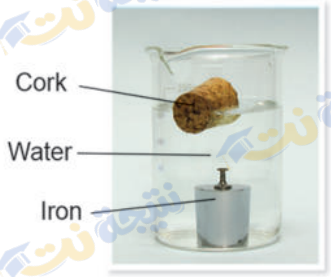


Figure (16)

The difference in density between cork and iron is a ..... property



Figure (17)

The difference in the color of a litmus paper in lemon juice from its color in toothpaste is a ..... property



Figure (18)

The difference in the effect of heat on a block of butter and an aerogel sheet is a ..... property

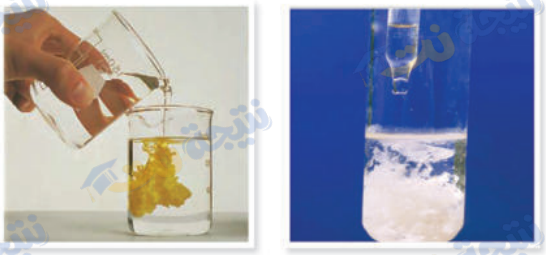


Figure (19)

The difference in the color of the solid precipitate formed by adding a single reagent to two different solutions is a ..... property

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Uses of Substances Based on Their Properties

Activity 3 Conclude

According to the properties of the following substances, conclude the appropriate use for four of them by filling in the blanks under Figures (20) : (23).

- **Helium :** An inert gas, less dense than air, and non-flammable.
- **Nitrogen :** A nonmetal gas that is not affected relatively by temperature changes and does not react with rubber.
- **Silicon :** A metalloid that conducts electricity poorer than metals but better than nonmetals.
- **Stainless steel alloy :** Made from iron with added elements, it is resistant to rusting in the ordinary conditians .
- **Aluminum-Titanium alloy :** Lighter than aluminum and retains its strength at high temperatures.



Figure (20)

..... is used in filling car tires instead of air



Figure (21)

..... is used in the construction of military aircraft frames/structure



Figure (22)

..... is used in manufacturing cooking utensils



Figure (23)

..... is used in filling balloons

Technological Application

Aerogel (Figure 24) is a transparent, low-density solid material, where 99.8% of its composition is of air only, so aerogel is the lightest known solid material, with high durability. It has excellent insulating properties, so it is used in making the jackets of the researchers in Antarctica as a substitute for polar bear fur to protect its species from extinction.

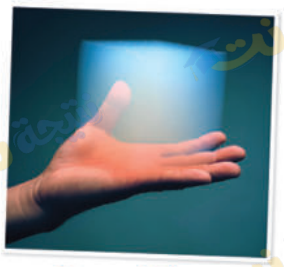


Figure (24)

Information and Communication Technology

Watch educational videos that demonstrate the properties and uses of aerogel using reliable digital sources.

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Evaluation Questions on Lesson Three

1 Mark (✓) or (×), with correction :

(1) Stirring both table salt and sand in water gives a homogeneous mixture . ( )

(2) NaBr compound is formed by the combination of two metals in a fixed mass ratio. ( )

(3) The melting of ice is a chemical change. ( )

(4) Water in some rivers is covered with ice in winter season, and this means that ice density is greater than water density. ( )

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

(1) Which of the following describes the properties of copper metal ?

Choices	Melting point	Sinking in water	Conducting electricity
(a)	–40°C	×	✓
(b)	8°C	×	✓
(c)	100°C	✓	×
(d)	1083°C	✓	✓

(2) All the following are physical properties of a piece of calcium carbonate, except that it .....

(a) is solid.

(b) does not dissolve in water.

(c) is white in color.

(d) produces gas bubbles with vinegar.

(3) The following table shows samples of different substances :

Sample	Shiny	Flexible	Conducts electricity
(1)	×	×	✓
(2)	✓	×	×
(3)	×	✓	×
(4)	✓	✓	✓

Which sample its substance can be used in making water hose?

(a) Sample (1). (b) Sample (2).

(c) Sample (3). (d) Sample (4).

3 Classify the following materials into two groups, elements and compounds:

Al	CO_2	N_2	H_2SO_4
SiO_2	Cu	NH_3	O_3

4 Mention one difference between each of the following :

(1) Hydrogen molecule **and** water molecule.

(2) Oxygen molecule **and** ozone molecule.

5 Mention one use of aerogel according to its high ability of insulation.

6 Design a table showing the number of elements and the number of atoms composing one molecule of each of the following :

(1) Nitric oxide NO

(2) Magnesium carbonate $MgCO_3$

(3) Ethanol C_2H_5OH

7 When a white powder in a test tube is heated, nitrogen dioxide gas and oxygen gas evolve and a red substance remains in the tube :

(1) Is the white powder an element or a compound ? Explain.

(2) What are the elements that are certainly found in the white powder ?

(3) Heating the red substance leads to the formation of mercury and oxygen. What are the elements that compose the white powder ?

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Lesson **Four**

Chemical Bonds



Lesson Terminology :

- Chemical bonding.
- Ionic bonding.
- Covalent bonding.
- Ionic compound.
- Covalent compound.
- Single bond.
- Double bond.
- Triple bond.

Included Skills, Values, and Issues :

- **Skills** : Inquiry - Conclusion.
- **Values** : Collaboration.
- **Issue** : Protecting the environment from pollution.

Cross-Cutting Concepts :

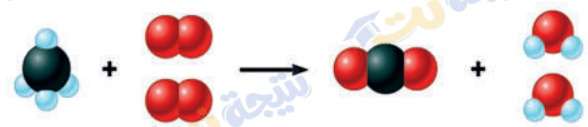
- Cause and effect.

Lesson Objectives :

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

1. Differentiate between ionic and covalent bonding.
2. Express covalent bonding with single valence electrons.
3. Relate the atomic structure of carbon to its distinctive properties in forming organic materials.
4. Explain the bonding in a methane molecule as the simplest organic compound.

Lesson Preparation :



The figure in above shows the reaction of methane with oxygen to form carbon dioxide and water vapor.

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

- What is the similarity between methane molecule and water vapor molecule ?
- What is the overall charge of the compound ?
- How do atoms bond to each other in each of oxygen and methane molecules ?

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Chemical Bonding

The molecules of substances around us differ in the type, number of atoms, and how they are bonded together. (Table 1) shows some properties of sodium chloride (NaCl) and hydrogen chloride (HCl).

Compound	Sodium chloride	Hydrogen chloride
Physical state	Solid	Gas
Ability to react with caustic soda solution	Doesn't react	Reacts

Table (1)

Think : Why do the properties of the two compounds differ from each other despite both containing chlorine ?

The difference in how atoms are bonded leads to differences in the physical and chemical properties of the resulting compounds' molecules.

Types of chemical bonding include : Ionic bonding and covalent bonding.

Ionic Bonding

Atoms become positive or negative ions by losing or gaining electrons to reach the stable electronic configuration of the nearest noble gas in atomic number on the periodic table.

Activity 1 Discover

(Table 2) shows the electronic configuration of four elements' atoms:

 Sodium $_{11}Na$					 Chlorine $_{17}Cl$	 Argon $_{18}Ar$
						 Neon $_{10}Ne$

Table (2)

1. **Explain : The stability of the atoms of a noble gas according to their electron configuration.**

.....

2. **What is the nearest noble gas to each of sodium and chlorine ?**
   - Sodium : .....
   - Chlorine : .....

3. **Fill in blanks in (Tables 3 and 4) :**

	Sodium atom	Sodium ion
Number of protons	.....	.....
Number of electrons	.....	.....
Electric charge	.....	.....

Table (3)

	Chlorine atom	Chloride ion
Number of protons	.....	.....
Number of electrons	.....	.....
Electric charge	.....	.....

Table (4)

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4 **What is the change that occurs in each of sodium atom to form sodium ion, and chlorine atom to form chloride ion ?**

- Sodium : .....
- Chlorine : .....

5 **Conclude the definitions of positive and negative ions.**

- Positive ion : .....
- Negative ion: .....

6 **What happens when a positive ion approaches a negative ion ?**

.....

The ionic bonding in a sodium chloride molecule is represented as follows:

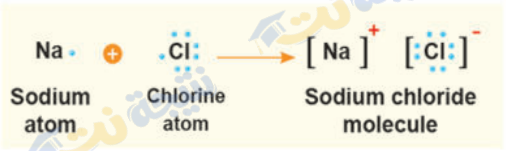


Figure (1)
Ionic bonding using Lewis dot structures

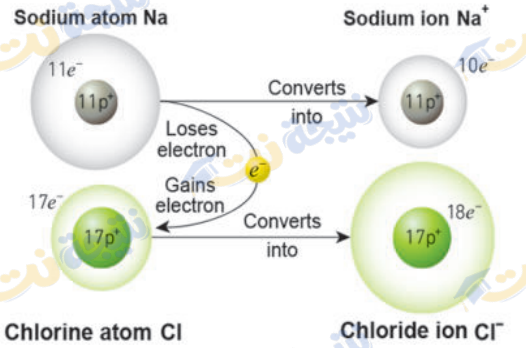


Figure (2)
Ionic bonding in sodium chloride molecule

Cross-Cutting Concepts : Cause and Effect

- When most metals react with nonmetals, the metal atom (M) tends to lose its valence electrons, forming a positive ion (cation) with a number of positive charges equal to the number of the lost electrons. The nonmetal atom (X) gains one or more electrons according to its valence, forming a negative ion (anion) with a number of negative charges equal to the number of the gained electrons.
- The electron configuration of each of the cation and the anion is similar to that of the nearest noble gas.
- The electrostatic attraction between the cation and the anion is called an ionic bond, and the compound formed by them is called an ionic compound. The compound is electrically neutral due to the equal number of positive and negative charges.

Evaluate Your Understanding

Figure (3) illustrates the formation of an ionic bond between the metal A from the alkaline earth metals group and the nonmetal B from group (6A).

(1) Determine the Charges number of each of the cation and the anion.

Cation charge : .....
Anion charge : .....

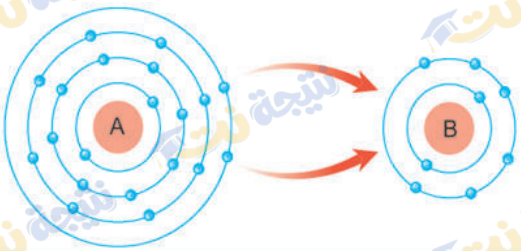


Figure (3)

(2) What is the molecular formula of the resulting ionic compound ?

.....

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Covalent Bonding

If chlorine is bonded to sodium with an ionic bond, so why doesn't it bind to hydrogen in the same way ?

Figure (4) shows that hydrogen atom needs one electron to reach the same electron configuration as helium, and chlorine atom also needs one electron to reach the same electronic configuration as argon.

How can this be achieved?

- Each atom shares a single valence electron to form together a single covalent bond, and the pair of electrons which forms the bond rotates around the two atoms in the covalent compound molecule of hydrogen chloride (HCl).

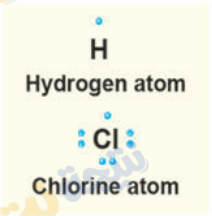


Figure (4)
Lewis structures of hydrogen and chlorine atoms

The covalent bond in hydrogen chloride molecule is represented in (Figure 5), where the dash (–) between the two atoms represents the single covalent bond in the molecule.



Figure (5)
The formation of covalent bond in hydrogen chloride molecule

Activity 2 Conclude

Illustrate by drawing the bond formation in the following molecules using Lewis dot structures :

- Hydrogen molecule : H • + ... ⟶ .....
- Oxygen molecule : ..... + ... ⟶ O = O
- Nitrogen molecule : ..... + • N • ⟶ .....

It is clear from the previous that covalent bonds are formed between two atoms of the same nonmetal element or between atoms of two different nonmetal elements, and the covalent bond may be single (–), double (=), or triple (≡) bond.

Evaluate Your Understanding

Use dots (•) and dashes (–) to represent valence electrons and covalent bonds in water molecule H_2O as shown in (Figure 6) using Lewis dot structure:



Figure (6)

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Properties of Ionic and Covalent Compounds

Most ionic compounds dissolve in water; both their aqueous solutions and their moltens conduct electricity; their melting and boiling points are high.
On the other hand, most covalent compounds do not dissolve in water and mostly do not conduct electricity, and they have low melting and boiling points.

Unique properties of carbon as the main element in organic compounds

The outermost energy level of carbon atom contains 4 single electrons, and carbon atoms have very unique properties because of their ability to bind to each other in organic compounds in the form of straight chains (Figure 7), branched chains (Figure 8) or cyclic structures (cycles or rings) (Figure 9).



Figure (7)
Straight chain

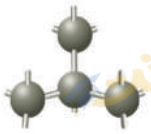


Figure (8)
Branched chain



Figure (9)
Cyclic structure

Methane CH_4 (Figure 10) is the simplest organic molecule, in which a carbon atom binds to four hydrogen atoms through single covalent bonds. .

► Represent the covalent bonding in methane molecule using Lewis structure.

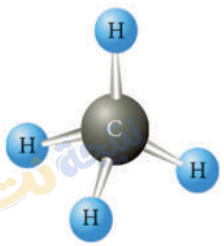


Figure (10)
Structure of methane molecule CH_4

Information and Communication Technology



You can design images of molecular shapes using modelling software like **Chemsketch chem draw**.

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Evaluation Questions on Lesson four

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

(1) Which of the following represents an ionic bonding ?

(a) $[\ddot{K}]^+[\ddot{F}]^-$ (b) $H\ddot{O}H$

(c) $[Li]^+[\ddot{Br}]^-$ (d) $\ddot{O}C\ddot{O}$

(2) What is the molecular formula of the compound formed through the bonding of an alkali metal A with an element B from group 6A ?

(a) A_2B_2 (b) A_2B (c) AB_2 (d) AB

(3) An atom of element X binds to two hydrogen atoms as shown in the following figure:

$H\ddot{X}H$

What is the type of bonding in this molecule? And what is the group number of element X in the periodic table?

(a) Ionic / Group 6A
(b) Ionic / Group 2A
(c) Covalent / Group 6A
(d) Covalent / Group 2A

2 Water and methane are two well known compounds:

(1) Which of them is an organic compound ?

(2) Explain how the atoms bind together in the inorganic compound molecule using Lewis structure.

3 The following table shows the electron configuration of the atoms of 4 elements :

(A)	(B)	(C)	(D)
2, 2	2, 8, 8	2, 8, 1	2, 8, 7

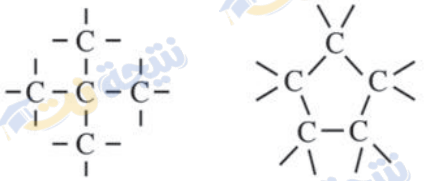
(1) Which element its molecule is diatomic ?

(2) Write the molecular formulas of the compounds, which can be formed from these elements.

4 Complete the following table with the suitable ion charges and their atomic components:

Number of \ Ion	$^{37}R^-$	..... X	..... Y	..... Z .....
Protons	17	11	.....	20
Neutrons	.....	12	10	.....
Electrons	.....	10	10	18
Nucleons	.....	.....	19	40

5 The following figures show the carbon structure of two organic compounds:



(1) (2)

What is the form of the carbon structure in each compound?

6 Among the elements in the periodic table are :

- $_7N$
- $_{12}Mg$
- $_{13}Al$
- $_{16}S$
- $_{15}P$
- $_{19}K$

(1) What are the two elements which can combine together to form a compound whose molecule is diatomic ?

(2) Conclude the relation between the number of electrons in the outermost energy level in the atoms of these elements and their type.

7 Compare in a table between:

Properties of covalent compounds and ionic compounds. **"Only two points are enough"**

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UNIT 2

Force Fields

The lessons

Lesson one : Electric Forces

Lesson two : Magnetic Forces

Lesson three : Gravitational Forces



Learning Outcomes :

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

1. Recognize some types of fields (electric, magnetic, gravitational).
2. Conduct an experiment to prove the existence of fields between non-contact objects that exert forces on each other.
3. Differentiate between types of forces.
4. Design a model to describe how electric forces act over a certain distance.
5. Identify the factors that affect gravitational forces.
6. Provide evidence that gravitational forces are always attractive.
7. Provide evidence of the existence of a very weak gravitational force between any two objects.
8. Appreciate the role of the science and the physicists in serving humanity and the environment.
9. Acquire values of work, cooperation, and positive attitudes.
10. Acquire some cross-disciplinary skills and practices.

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Lesson One

Electric Forces



Lesson Terminology :

- Static electricity.
- Electrostatic plating.
- Electric field.
- Electric field lines.

Included Skills, Values and Issues :

- **Skills** : Conclusion - Investigation - Research - Models design.
- **Values** : Appreciation of the scientists - Self-protection.
- **Issue** : Protecting installations from the lightning strikes.

Cross-Cutting Concepts :

- Cause and effect.
- The System and its models.

Lesson Objectives :

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

1. Conduct activities that illustrate the concept of static electricity.
2. Explain how objects acquire static charges.
3. Provide evidence of the existence of an electric field between non-contact objects.
4. Recognize the electric field.
5. Describe the properties of electric field lines.
6. List the uses of an electroscope.
7. Design a model showing that electric forces act at a distance .

Lesson Preparation :



The figure in the front of you shows the attraction of lightweight paper scraps to a plastic comb.

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

- What happened to the comb that allowed it to attract the paper scraps ?
- How did the paper pieces get attracted to the comb without touching ?
- Can paper scraps be attracted to a comb made of iron ?
- What device can determine whether the comb is electrically charged or not ?

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The Concept of Static Electricity

- You hear a slight crackling sound when removing woolen clothes in winter (Figure 1).



Figure (1)

- You feel a slight shock when you touch a metal door handle after walking barefoot on carpet (Figure 2).

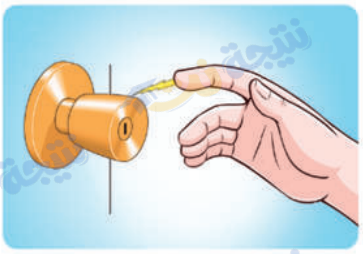


Figure (2)

What happens when two objects are rubbed together ?!

Activity 1 Practical

(1) Rub the end of an ebonite (hard rubber) rod with a piece of wool (Figure 3), then bring the rod close to light paper scraps (lightweight small pieces) (Figure 4) or small foam pieces.

What do you notice ?

.....

(2) Repeat the step (1) using a copper rod instead of the ebonite rod.

What do you observe ?

.....

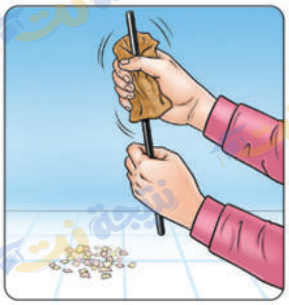


Figure (3)



Figure (4)

What do you conclude?

When objects made of certain materials are rubbed with others made of suitable materials, they gain the ability to attract lightweight objects because they have been charged with static electricity (electrostatic charges). These charges settle on the surface of the rubbed part of the object and do not transfer to the rest of it.

Objects that can be charged with an electrostatic charge can be :

- Objects made of nonconducting materials, such as wood, paper, wool, silk, and glass.
- Objects made of materials that conduct electricity, but the charged part must be insulated to prevent the leakage of electric charges, such as metals and carbon.

Evaluate Your Understanding

▸ **Why** do fuel transport vehicles have metal chains dangling to ground ?

.....

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Electric Forces

• When objects are rubbed, the electric charges are generated on it.

Does the type of electric charge that is generated on a glass rod rubbed with silk differs from that generated on an ebonite rod rubbed with the same silk ?

Activity 2 Practical

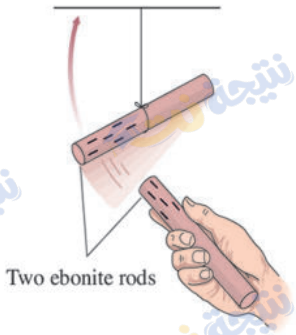


Figure (5)

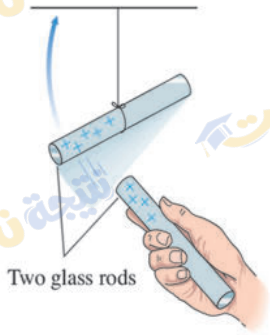


Figure (6)

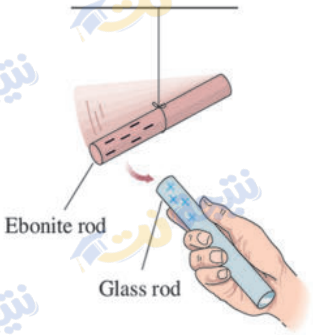


Figure (7)

(1) Rub two ebonite rods with a silk cloth, hang one freely, and then bring the other rod close to it. Figure (5) ... **What do you notice ?**

.....

(2) Repeat the step (1) with two glass rods instead of the ebonite rods, using the same cloth. Figure (6) ... **What do you notice ?**

.....

(3) Hang the ebonite rod after rubbing it with silk, and then bring a glass rod rubbed with silk close to it. Figure (7) ... **What do you notice ?**

.....

Are the electric charges formed on the ebonite rod the same as those on the glass rod ?

How can this be indicated ?

.....

This can be explained as follows :

When two uncharged objects are rubbed together, electrons move from the atoms of the surface of one object to the surface of the other; charging both with equal and opposite electric charges. Figure (8).

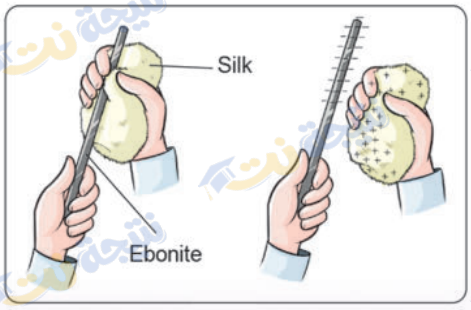


Figure (8)

What is the charge of the object that :

- Loses electrons ? .....
- Gains electrons ? .....

The accumulated charges on the surfaces of objects when they lose or gain electrons are called static electricity (electrostatic).

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It is observed that the type of charge acquired by the rubbed object differs depending on the material of the rubbing object.
(Table 1) shows the order of some materials in the electrostatic series according to the easiness of losing electrons.
When a material is rubbed with another material that follows it in this series, the preceding material will be charged with a positive electric charge, and the following one will be charged with a negative electric charge. Weak electric charges are measured by a device known as a coulometer (Figure 9).
Charged objects affect each other with mutual forces, which may be attractive forces or repulsive forces.
Attraction may occur between an uncharged object and a charged object, such as the attraction of paper scraps to the comb after rubbing it.
When do electrically charged objects attract or repel each other ? .....

Glass
Hair
Wood
Synthetic leather
Silk
Wool
Cotton
Paper
Ebonite

Table (1)
Electrostatic series



Figure (9)
Coulometer

Evaluate Your Understanding

▶ **What is the type of charge** formed on each of a piece of synthetic leather and a wooden rod when rubbed together ? **Explain.**

.....

Cross-Cutting Concepts : Cause and effect

The type of charge acquired by the rubbed object differs depending on the material of the rubbing object.

Scientific Skills Prediction

When passing a beam of subatomic particles through an electric field composed of two plates, one is positively charged and the other is negatively charged (Figure 10), then :
- Neutrons .....
- Protons ..... toward the ..... plate.
- Electrons ..... toward the ..... plate.

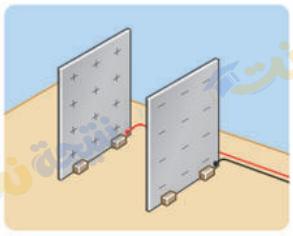


Figure (10)

Life Applications

1. When metal is coated using the electrostatic coating method, Figure (11), the object to be coated is charged with negative electric charge, and the paint spray with positive electric charge. When the paint is sprayed, attraction occurs between the object and the paint spray due to the difference in charge; resulting in a uniform paint layer and reducing paint waste.

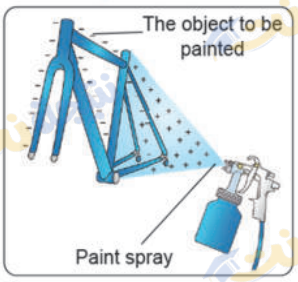


Figure (11)
Electrostatic coating

2. Lightning Rod is a system used to protect installations and buildings from lightning strikes, Figure (12). It consists of a metal rod whose lower end is fixed in a metal plate that is buried in the ground, while its upper end is pointed, through which, the electric charges that are accumulated on nearby clouds pass to the ground without causing any damage to the building.



Figure (12) **Lightning Rod**

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Electric field

- The region of space around an electric charge, in which its influence appears without contact, is called the electric field.
- The electric field of a charge can be represented by lines known as electric force lines or electric field lines, which are imaginary lines that show the path taken by a small free-moving positive charge placed in it.

Activity 3 Conclude

Study the Figures (13) : (18), then answer the following questions :



Figure (13)
Electric force lines for a positive charge



Figure (14)
Electric force lines for a negative charge

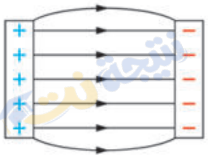


Figure (15)
Electric force lines between two metal plates charged with opposite charges

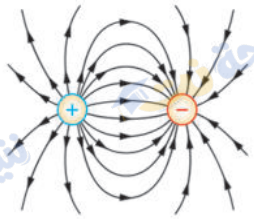


Figure (16)
Electric force lines for two opposite charges

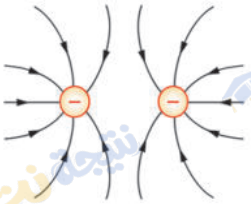


Figure (17)
Electric force lines for two similar charges

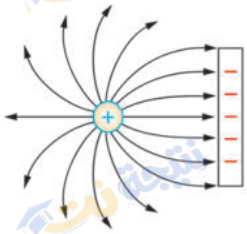


Figure (18)
Electric force lines between a charged plate and an opposite charge

1. Where do the force lines start, and where do they end ?

.....

2. Do the force lines intersect with each other ?

.....

3. Do the force lines penetrate the surfaces of charged metallic objects, or do they end there ?

.....

Cross-Cutting Concepts : System and its models

Electric force lines are imaginary lines which simplify the representation of the system (model) and are used to understand how the system works.

Conclude from the previous the properties of the electric force lines :

1. Electric force lines are imaginary lines that do not ..... .
2. They start from the ..... charge and end at the ..... charge.
3. Force lines ..... on ..... charged objects and do not ..... .

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Designing a Model of an Electroscope

Use available materials to design a model of an electroscope, you can follow these steps:

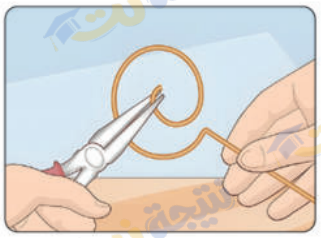


Figure (19)
(1) Wrap the end of a copper wire into a spiral



Figure (20)
(2) Pierce the cap of a glass bottle

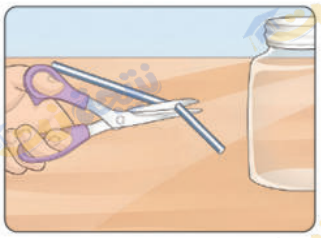


Figure (21)
(3) Cut a piece of a juice straw and pass it through the hole in the cap

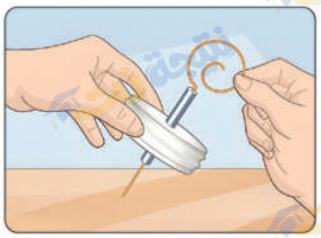


Figure (22)
(4) Insert the copper wire into the juice straw



Figure (23)
(5) Bend the straight end of the copper wire into a hook

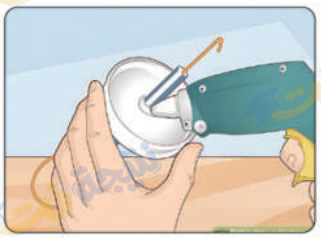


Figure (24)
(6) Fix the juice straw in the bottle cap using hot glue

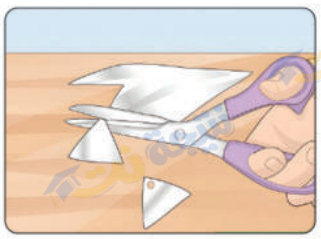


Figure (25)
(7) Cut two identical pieces of foil to make two triangles

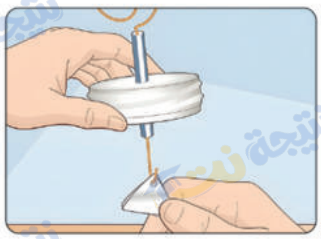


Figure (26)
(8) Hang the two foil pieces in the hook and ensure they do not touch each other



Figure (27)
(9) Fix the cap tightly on the glass bottle with duct tape



Figure (28)
(10) Place the electroscope model in a dry, non-humid place



Figure (29)
(11) Rub a piece of foam with wool

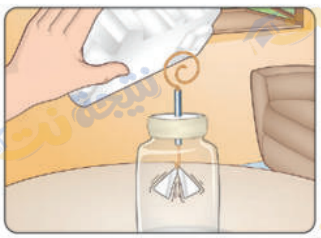


Figure (30)
(12) Bring the foam close to the copper spiral. What do you notice?

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Electroscope

The electroscope is also known as the electric detector.

What is this device used for ?

Activity 4 Practical

1. Touch the metal disc of the electroscope, Figure (31), with your hand to ensure that it is free of any electric charge.
2. Bring the object which is required to be tested close to the electroscope's disc until it touches the disc. Figure (32).

What do you conclude if :

- The electroscope's leaves diverge (separate) ?

.....

- The electroscope's leaves do not diverge ?

.....

3. Bring the object whose charge type is to be tested close to a charged electroscope disc (assuming it is positively charged).

What do you conclude if :

- The electroscope's leaves diverge further?

.....

- The electroscope's leaves diverge less?

.....

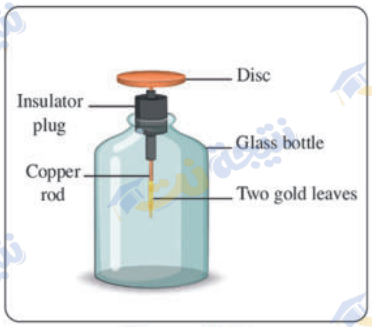


Figure (31)
The electroscope

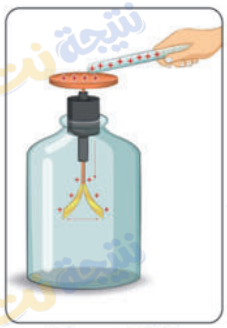


Figure (32)
Charging by touching

From the previous it is concluded that the electroscope is used for :

(1) Determining if an object is electrically charged.

(2) Identifying the type of charge on the charged object.

It is also used to compare the magnitude of the charges on different charged objects.

Analytical Thinking

Mention two methods to charge objects with electrostatic charges.

.....

Evaluate Your Understanding

▸ **Explain** why the divergence of the leaves of a positively charged electroscope decrease when an ebonite rod rubbed with wool touches the electroscope disc.

.....

.....

A profile of the Scientist

Charles-Augustin de Coulomb



Figure (33)

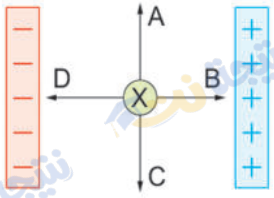
A French physicist who formulated a law describing electric forces between charged particles, known as Coulomb's Law or the Inverse Square Law. His studies and discoveries in the late 18th century laid the foundation for the development of electromagnetic theory. In his honor, the unit of electric charge (Coulomb) is named after him

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Evaluation Questions on Lesson One

1 **Choose the correct answer to the questions (1) : (3).**

(1) The following figure shows a free-moving particle (X) charged with a negative electric charge, placed between two plates of opposite charges. :

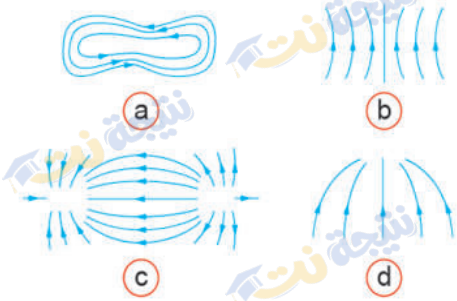


In which direction will particle (X) move ?

(a) (A). (b) (B).

(c) (C). (d) (D).

(2) Which of the following represents the electric field between two charged points ?



(3) When a wooden ruler is rubbed with a piece of cotton, an electric force is generated between them.
What is the type of charge formed on the ruler, and what type of electric force exists between them ?

(a) Positive / Repulsion.

(b) Negative / Repulsion.

(c) Positive / Attraction.

(d) Negative / Attraction.

2 **Draw** the electric field lines between two parallel plates charged with opposite charges.

3 A copper rod is rubbed with a piece of silk, then the rod is brought close to paper scraps.

What happens to the paper scraps ? Explain.

4 **Material (X) gains a negative charge when rubbed with a piece of material (Y), while it gains a positive charge when rubbed with a piece of material (Z) :**

(1) Suggest, based on what you have studied, the type of each of the materials (X) , (Y) and (Z).

(2) What is expected to happen when material (X) is brought close to material (Y) before rubbing ? Explain.

5 **The following figure shows an electroscope after the body (X) has touched its metal disc :**



(1) What is the charge of body (X).

(2) What happens when :

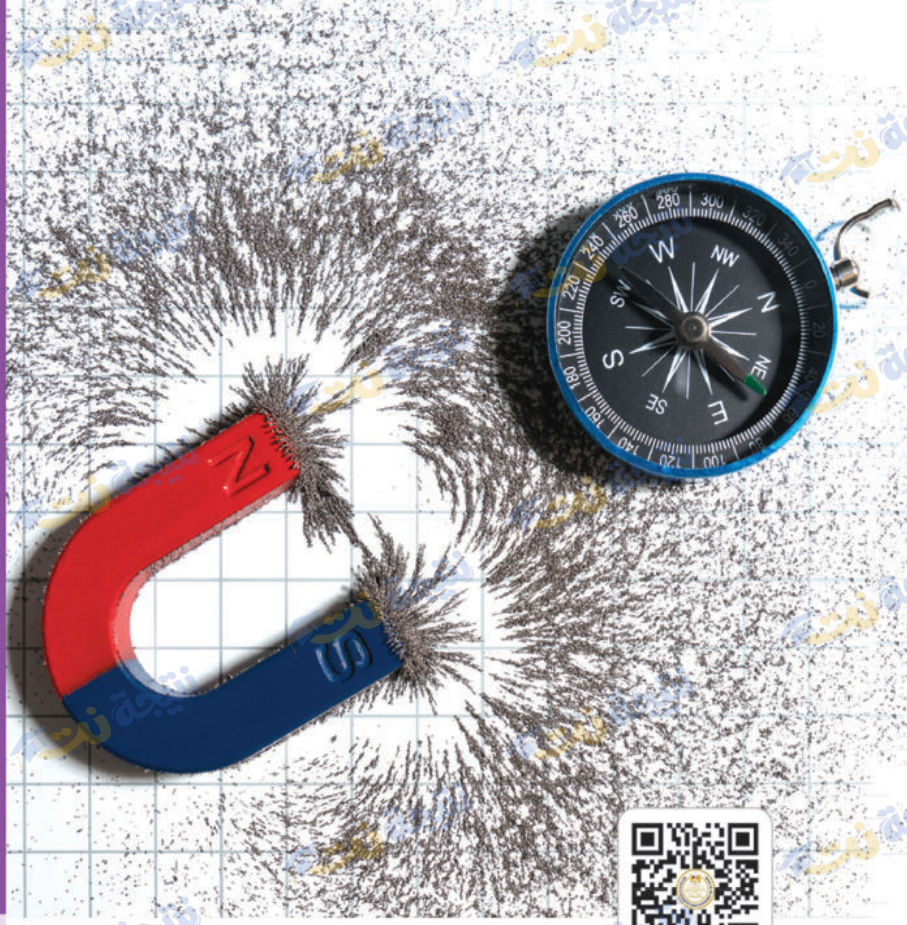
1. A positively charged object is brought close to the electroscope disc.

2. A negatively charged object is brought close to the electroscope disc.

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Lesson **Two**

Magnetic Forces



Lesson Terminology :

- Lodestone.
- Permanent magnet.
- Bar magnet.
- U-Shaped magnet.
- Cylindrical magnet.
- Horse shoe magnet.
- Magnetic needle.
- Compass.
- Magnetic substances.
- Non-magnetic substances.
- Magnetic poles.
- Attraction and repulsion.
- Magnetic field.
- Magnetic field lines.

Included Skills, Values and Issues :

- **Skills** : Research - Investigation.
- **Values** : Justice.
- **Issue** : Electromagnetic pollution.

Lesson Objectives :

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

1. Recognize the shapes of magnets.
2. Differentiate between magnetic and non-magnetic materials.
3. Explore the properties of magnets.
4. Conclude the law of attraction and repulsion.
5. Recognize the magnetic field.
6. Draw magnetic field lines for a magnet.
7. Draw magnetic field lines for the opposite poles of two magnets .

Lesson Preparation :

The given figure shows several magnets placed on a hand, that attract metallic paper clips. This lesson explores ideas that help you answer the following questions :



- Why do not the paper clips fall even though they are not touching the magnet ?
- What are the materials of the objects that are attracted to a magnet ?
- Why do magnets appear to attract together ?
- What happens when a single magnet is divided into several parts?

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Shapes of Magnets

Lodestone, (Figure1), is a natural magnet rock that was first found in Magnesia (a regional unit) of ancient Greece, and its distinguishing characteristic is the ability to attract certain metallic objects. The production of the industrial magnets began in the 19th century. There are different shapes of magnets, some of which are shown in (Figure 2).



Figure (1) Natural magnet (Lodestone)

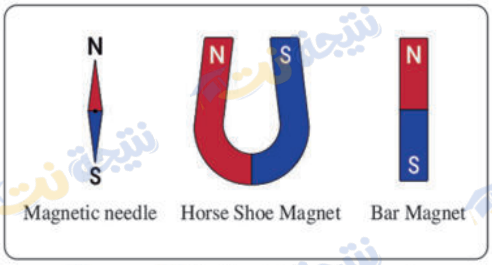


Figure (2) Industrial magnets

Activity 1 Experiment

- **What is the effect** of bringing a magnet close to a mixture of copper filings, iron filings and sand (Figure 3) ?

.....

- **Can** the magnet attract all metals ?
  It is evident from this activity that there are materials that are attracted to the magnet, known as **magnetic materials** (Figure 4), and others that are not attracted to it, known as **non-magnetic materials** (Figure 5).

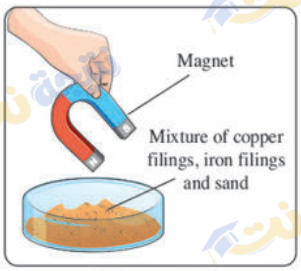


Figure (3)

Magnetic materials

- Materials that are attracted to a magnet.



Figure (4) Magnetic materials

Non-magnetic materials

- Materials that are not attracted to a magnet.



Figure (5) Non-magnetic materials

Life Application

The compass is an old tool used to determine the Earth's four main geographical directions.
It consists of a free-moving magnetic needle fixed at its pivot (Figure 6). It is placed inside a box made of copper or plastic... **Why** ?
Can you make a compass using materials available in your environment ?



Figure (6) Compass

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Properties of Magnets

Activity 2 Practical

1. Insert a magnet into iron filings (Figure 7).
What do you observe ?

Do the iron filings attract to all parts of the rod with the same density ?



Figure (7)

2. Hang a bar magnet from its middle using a silk thread, allowing it to move freely (Figure 8) until it settles.
What do you observe ?



Figure (8)

It is evident from this activity that :

- The attraction force of the magnet is the strongest at its ends, (that are known as the poles of the magnet), and it decreases as it gets closer to the middle of the magnet.
- When a magnet is suspended freely, its north pole (N) almost points towards the Earth's geographical North Pole, while its south pole (S) points towards the Earth's geographical South Pole (Figure 9).

The Earth acts as a giant magnet, which affects the freely suspended magnet and always causing it to take a certain direction.

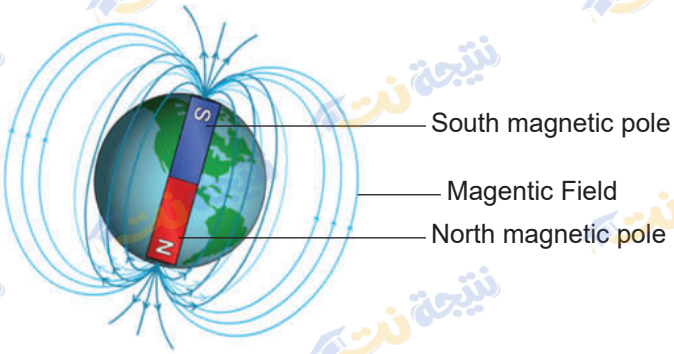


Figure (9)

It is also observed that when a single magnet is divided into several parts, each part forms a new magnet with two poles, one is the north (N) and the other is the south (S) (Figure 10).

It is impossible to obtain an isolated (only one) magnetic pole.

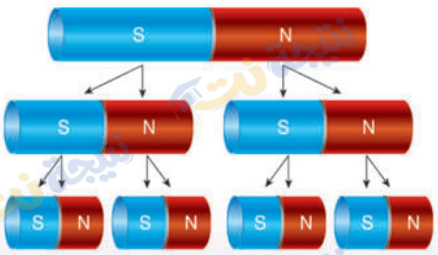


Figure (10)

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Law of Attraction and Repulsion

Activity 3 Conclude

Suspend two magnets freely as shown in (Figures 11 : 13):



Figure (11)



Figure (12)



Figure (13)

What happens when :

- You bring together two different poles of two magnets (Figure 11) ? .....
- You bring together the south poles of two magnets (Figure 12) ? .....
- You bring together the north poles of two magnets (Figure 13) ? .....

Conclude the law of attraction and repulsion

Like magnetic poles ..... each other, and unlike magnetic poles ..... each other.

Evaluate Your Understanding

Figure (14) shows four ring magnets placed in such a way that they pass through a vertical rod. Knowing that the lower magnetic pole of magnet (A) is the north pole.

Conclude the type of the poles (1) and (2) according to your understanding of the law of attraction and repulsion.

.....

.....

.....

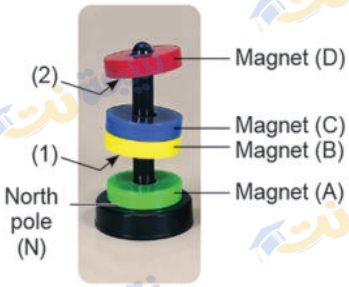


Figure (14)

Life Application

Forensic and criminal investigation experts use a magnetic brush and iron filings in criminal investigations to reveal the unclear fingerprints (Figures 15 , 16) where the brush is passed over surfaces with the unclear fingerprints, causing some iron filings to stick to the traces left by the fingerprints, which makes them visible.



Figure (15)



Figure (16)

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Magnetic Field

What is the similarity between an electric field and a magnetic field ?

An electric charge has an electric field that extends through the space around it, and exerts a certain force on the charged objects found inside it at a distance. The electric forces are represented by imaginary lines called electric field lines. Similarly, a magnet has a magnetic field that extends through the space around it and affects magnetic materials placed in it at a distance by a magnetic force. The magnetic field is represented by imaginary lines called magnetic field lines, as shown in (Figures 17 : 19).

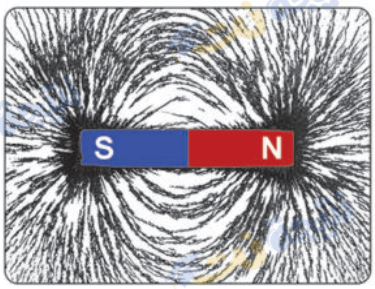


Figure (17)
Magnetic field lines of a magnet

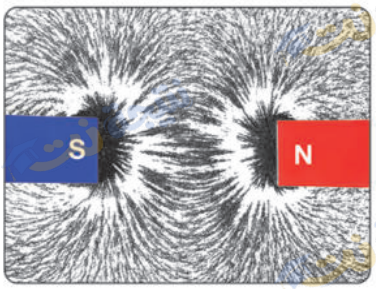


Figure (18)
Magnetic field lines between two opposite poles of two magnets

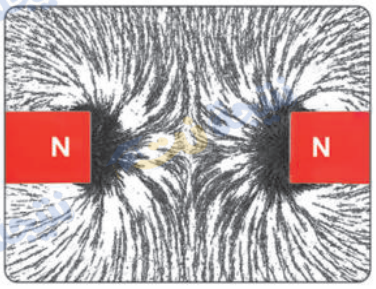


Figure (19)
Magnetic field lines between two similar poles of two magnets

Conclude the properties of magnetic field lines from (Figure 20).

(1) Imaginary lines that do not ..... each other.

(2) They start from the ..... pole of the magnet and end at the .....

(3) They are denser near ..... and far separated ..... from them.

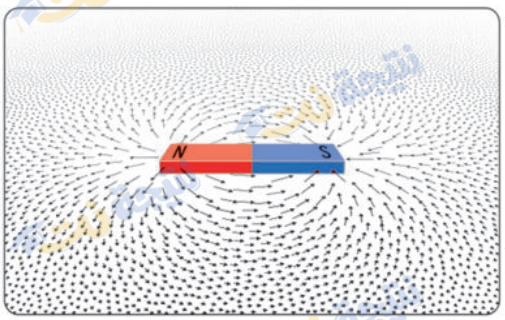


Figure (20)

According to the above, conclude the definition of the magnetic field.

- The magnetic field is the region of space ..... the magnet, where the effect of the magnetic ..... appears in it.

- **Does the mutual forces** among a magnet and the magnetic substances that are found within its field considered a force of repulsion **or** attraction **or** both ?

.....

Research Activity

Search in the different knowledge sources, including the internet or the Egyptian Knowledge Bank, about the advantages of each of the electric monorail and the maglev (magnetic levitation) train.

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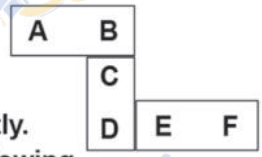
Evaluation Questions on Lesson Two

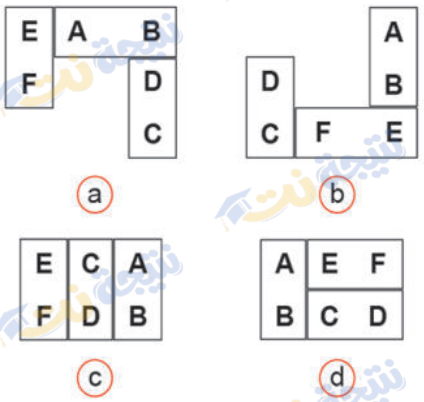
1 Choose the correct answer to the questions (1) : (3).

(1) One end of a rod is attracted to a bar magnet. Which of the following describes the nature of the rod?

(a) A rod of nickel only.
(b) A rod of nickel or a magnet.
(c) A magnet only.
(d) A rod of nickel or copper.

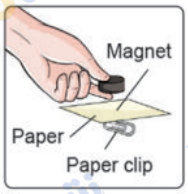
(2) The opposite figure shows three magnets arranged correctly. Which of the following shapes represents them when rearranged correctly ?





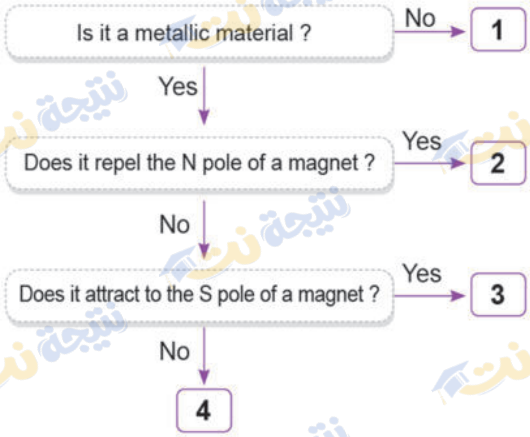
(a) (b) (c) (d)

(3) The opposite figure shows a paper clip attracted to a magnet despite the presence of a paper between them. What can be concluded ?

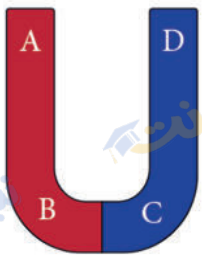


(a) Opposite poles attract each other.
(b) The magnetic force is an attractive force.
(c) The paper clip is attracted to the north pole of the magnet.
(d) The magnetic force acts at a distance.

2 Which of the numbers shown in the following diagram represents a rod of silver? With explanation.



3 When the magnet (shown in the opposite figure) is placed in iron filings, the density of the filings was high at certain positions. Identify these positions



4 The following table shows the number of pins attracted to four magnets placed at the same height from a container containing a load of pins

Magnet	(A)	(B)	(C)	(D)
Number of pins attracted to it	4	6	2	8

Arrange these magnets ascendingly according to the strength of their magnetic fields.

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Lesson Three

Gravitational Forces



Lesson Terminology :

- Force.
- Gravitational force.
- Gravitational field intensity.
- Gravitational field lines.
- Orbital motion.
- Mass.
- Weight.

Included Skills, Values and Issues :

- **Skills** : Comparison - Observation - Discovery - Engineering design.
- **Values** : Appreciation of the scientists.
- **Issue** : Health awareness.

Cross-Cutting Concepts :

- Patterns.

Lesson Objectives :

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

1. Recognize the gravitational field.
2. Provide evidence of the existence of gravity between non-contacting objects.
3. Distinguish between contact forces and field forces.
4. Identify the factors that affect the gravitational forces.
5. Provide evidence that gravitational forces are always attractive.
6. Provide evidence that gravitational forces are very weak between any two objects whose masses are small.

Lesson Preparation :

The figure shows a hand holding a device with an apple attached to it.

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

- What force acts on the apple downwards ?
- Does the device measure the mass of the apple or its weight ?
- Do the mass and weight of the apple differ from one planet to another ?
- What is the relation between mass and weight ?



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Classification of The Forces

The governorate of your country, Egypt have many beautiful tourist attractions. You can enjoy safari trips in Wadi El-Rayan in Fayoum Governorate and practice sand skiing on its soft dunes. **What force** affects the skier person in (Figure 1) and causes him to descend from the top of the sand dunes towards the ground?



Figure (1)
Sand skiing in Wadi El-Rayan

Activity 1 Compare

What is the similarity between electrostatic forces (Figure 2), magnetic forces (Figure 3), and gravitational force (Figure 4)?



Figure (2)
Electrostatic forces

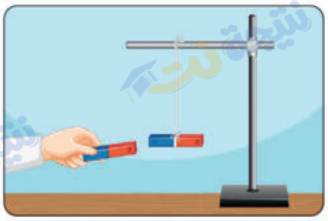


Figure (3)
Magnetic forces



Figure (4)
Gravitational force

What is the difference between gravitational force (Figure 4) **and** both collision forces (Figure 5) **and** elasticity forces (Figure 6)?



Figure (5) Collision forces



Figure (6) Elasticity forces

It is clear from the above that the force that pulls (attracting) all objects downward towards the center of the Earth (Figure 4) is called the gravitational force.
In general, forces are either contact forces that act on objects when they touch each other, such as collision forces, elasticity forces and friction forces or field forces that act over a certain distance, such as gravitational forces, electrostatic forces and magnetic forces.

Evaluate Your Understanding

- **Why** do gravitational, electric and magnetic forces have **fields,** while frictional forces do not have a field ?

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Earth's Gravitational Field

Earth's gravitational force causes all objects to fall downwards in the direction of Earth's center (Figure 7).

The space in which Earth's gravitational force affects material objects with an attraction towards Earth's center is known as **Earth's gravitational field**.



Figure (7)

Earth's gravitational force is represented by lines called **Earth's gravitational field lines** (Figure 9), and the direction of the arrow indicates the direction of the gravitational force acting on an object placed in its field.

A profile of the scientist

Isaac Newton



Figure (8)

The scientist Newton discovered that all material objects in the universe attract each other, and in recognition of his scientific contributions, the unit of force (Newton) was named after him



Figure (9)

Earth's gravitational field lines

The Mutual Attraction Forces between Two Objects

Gravitational force is not only between the Earth and objects within its gravitational field but also between any two objects.

Activity 2 Observe

Figure (10) shows the mutual attraction forces between two spherical objects made of the same material, and the arrows indicate the direction of the mutual attraction forces F

- Do the attraction forces work in one direction only or in two directions ?

.....

- Why are the attraction forces represented in Figure (11) greater than the attraction forces represented in Figure (10) ?

.....

.....

- Why are the attraction forces represented in Figure (11) greater than the attraction forces represented in Figure (12) ?

.....

.....



Figure (10)



Figure (11)



Figure (12)

Information and Communication Technology



Watch videos from reliable digital sources that show evidence of the small gravitational force between small masses.

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According to activity (2), it is clear that gravitational forces are mutual forces between two objects, it acts on each of the two objects by equal magnitude but in opposite directions, it increases as the masses of the two objects increase and it decreases as the squared distance between the centers of the two objects increases.

- Despite the weakness of the gravitational force compared to other forces in the universe, its effects are extremely important as it is responsible for the stability of the objects, rainfall, and all the objects falling towards Earth.
  The phenomenon of **tides** is one of the results of the gravitational force between the moon and Earth.
  This phenomenon is most noticeable in **the Bay of Fundy in Canada**, where the difference between the elevation and the recession of water reaches 19 meters (Figure 13).
  The tides occur twice daily, "once every 12 hours," and are at their peak when the moon is either new moon or full moon.
  The phenomenon of tides can be used to generate electricity as a source of renewable energy and is naturally used to cleanse water bodies from impurities.

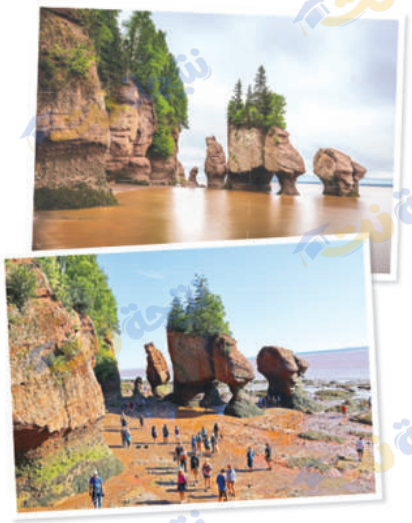


Figure (13)
Tides in the Bay of Fundy

Combination with Space Science

Scientists in the early 20th century discovered regions in the space known as **black holes** (Figure 14), which are formed when a massive star collapses at the end of its life.
Black holes are characterized by **immense gravity**, so that even light cannot escape from them.

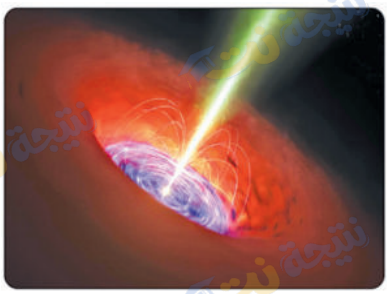


Figure (14) **Black hole**

Issue for Discussion

Discuss the effects of the absence of gravity in space on bone fragility, lung capacity, the circulatory system and blood pressure on astronauts.

Information and Communication Technology

Watch educational videos from reliable digital sources that show the effect of the mutual gravitational forces between the moon and Earth on the occurrence of the tide phenomenon.

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Cross-Cutting Concepts : Patterns

Electric, magnetic and gravitational forces are similar in that they all act at a distance.
In case of electric forces, an electric charge affects another electric charge, while in case of magnetic forces, one magnetic pole affects another magnetic pole.
In case of gravitational forces, the mass of one object affects the mass of another object.

Role of Gravity in Orbital Motion

There is a gravitational attraction between any object moving in a curved path in space around another central object (orbiting this central object). This motion is known as orbital motion, such as the motion of the moon around Earth, Earth's motion around the sun (Figure 15), and the motion of satellites around Earth (Figure 16).

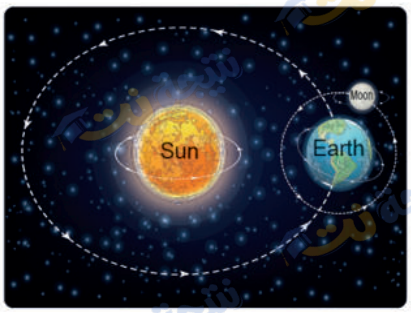


Figure (15)

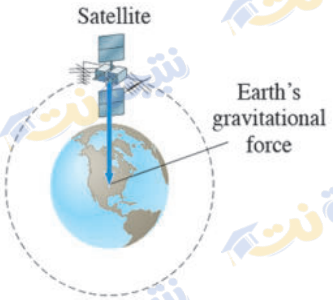


Figure (16)
Orbital motion of satellites depends on Earth's gravitational force

Evaluate Your Understanding

According to what you have studied, **explain** the types of field forces in a helium atom $_2He$ (Figure 17), and **identify** the weakest force among them.

.....

.....

.....

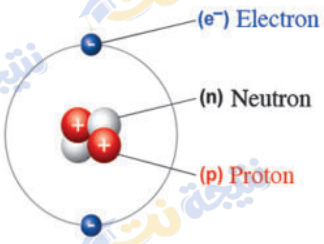


Figure (17)
Helium atom

The Relation Between Weight and Gravity

Why is the mass of an ostrich egg greater than the mass of a chicken egg as in Figure (18) ?

Does the weight of the egg equal to its mass ?

The mass of an object (m) is the amount of matter it contains, while the weight of an object (w) is the gravitational force that Earth exerts on it.



Figure (18)

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Activity 3 Practical

(1) Hang a mass of 1 kg on the hook of a spring balance (Newton meter) (Figure 19) and record the weight in Newtons (N) in Table (1):

Mass (kg)	1	2	3	4	5
Weight (N)	.....	.....	.....	.....	.....

Table (1)



Figure (19)

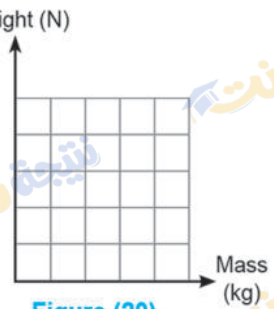


Figure (20)

(2) Repeat step (1) with different masses.

(3) Represent the results with a graph in which weight in Newtons is represented on the vertical axis and mass in kilograms is represented on the horizontal axis (Figure 20).

It is evident from practical activity (3) that the weight of an object is calculated using the mathematical relation :

Weight (w) = Mass (m) × Gravitational field intensity (g)

Knowing that Earth's gravitational field intensity is approximately 10 N/kg, i.e. any mass of 1 kg at Earth's surface is attracted towards Earth's center by a force that equals approximately 10 N

Activity 4 Discover

What is the relation between the weight of an object **and** the gravitational field intensity acting on it ?

Figures (21) : (23) show the masses and weights of an object in three different locations.



Figure (21)

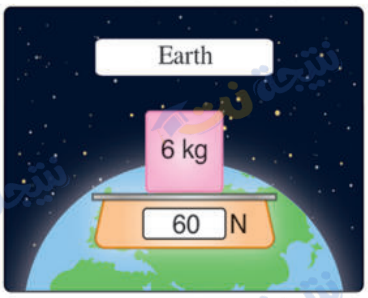


Figure (22)



Figure (23)

(1) Does the mass of an object change depending on its location ?

.....

(2) Does the weight of an object change depending on its location ?

.....

(3) Which is greater: Earth's gravitational pull on the objects or the moon's gravitational pull on them ?

.....

(4) Why does the weight of an object become zero in outer space ?

.....

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It is evident from the previous that :

The moon's gravitational field intensity at its surface is $\frac{1}{6}$ of Earth's gravitational field intensity at its surface.

It is noted that :

- Earth's gravitational field intensity decreases as we move away from Earth's center (upwards).
- The weight of an object changes from one planet to another due to the change of the gravitational field intensity.

Engineering design

Designing bridges requires a precise understanding of physics and mathematics to prevent them from collapsing due to Earth's gravitational pull on the large combined masses of the heavy vehicles that travel on them. This requires choosing suitable strong materials during designing the bridges and distributing loads appropriately on the bridge foundations.

Design a bridge from materials available in the environment, as shown in Figure (24), and test the maximum load your design can hold.

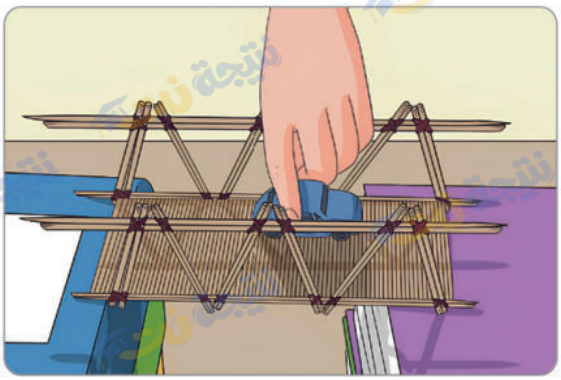


Figure (24)

Scientific Skills Comparison

Compare between mass **and** weight in three points :

Comparison point	Mass (m)	Weight (w)
Definition	.....	.....
Measuring unit	.....	.....
Change in magnitude with changing object's position	.....	.....

Table (2)

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Evaluation Questions on Lesson Three

1 **Mark (✓) or (✗) next to each of the following statements that describe Earth's gravity :**

(1) A force that acts at a distance. ( )

(2) It affects the masses of objects. ( )

(3) It causes objects to fall towards Earth's center. ( )

(4) Its intensity decreases with increasing the distance from Earth's center. ( )

2 **Choose the correct answer for the questions (1) to (3):**

(1) You have two objects, the mass of the first is 5 kg and the mass of the second is 20 kg. Which of the following describes the attraction forces between the two objects?

(a) The force of attraction of the first object to the second is greater.

(b) The force of attraction of the second object to the first is greater.

(c) Both objects attract each other with the same force.

(d) There is no attraction force between the two objects.

(2) What is the force that causes a ball to fall from a high position to Earth's surface?

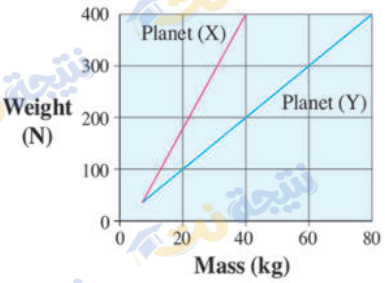
(a) Gravity. (b) Magnetism.

(c) Friction. (d) Collision.

(3) An object weight is 600 N at the base of a high mountain. Which of the following could describe its mass and weight at the top of this mountain?

Choices	Mass	Weight
(a)	60 kg	600 N
(b)	6 kg	600 N
(c)	60 kg	598 N
(d)	6 kg	598 N

3 **The graph below shows the relation between weight and mass for several different objects on the surfaces of two different planets:**

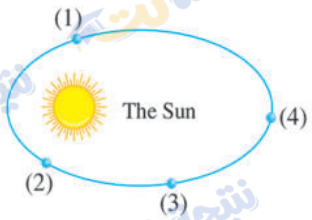


Which planet has lower gravitational field ? Explain.

4 **Identify** the similarity and the difference between gravitational force and magnetic force.

5 **Mention one difference between** elasticity forces and gravitational forces.

6 **The following figure shows the orbit of a planet around the sun :**



At which point is the gravitational force between the sun and the planet is the weakest ? **Explain** the affecting factor.

7 **From the following figure :**



Explain the relation between Earth's gravitational pull on the moon **and** the moon's gravitational pull on Earth.

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UNIT 3

Living Organisms, Their Structure and Processes

The lessons

Lesson one : Cells and Life

Lesson two : General Characteristics of Living Organisms

Lesson three : Microbes



Learning Outcomes :

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

1. Provide evidence that all living organisms are composed of cells as the basic unit of structure and function.
2. Classify living organisms into prokaryotes and eukaryotes.
3. Classify living organisms into unicellular and multicellular organisms.
4. Recognize the role of stem cells in the differentiation of tissues and organs in the multicellular organisms.
5. Relate the general characteristics of life to the cell functions.
6. Describe examples of beneficial types of microorganisms.
7. Relate harmful types of prokaryotes and eukaryotes to diseases caused by food contamination.
8. Appreciate the efforts of the scientists in discovering diseases and methods for their treatment.

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Lesson One

Cells and Life



Lesson Terminology :

- Cell.
- Tissue.
- Organ.
- System.
- Living Organism.
- Unicellular Organisms.
- Multicellular Organisms.
- Eukaryotes.
- Prokaryotes.
- Specialized Cells.
- Differentiated Cells.
- Plant Cell.
- Animal Cell.
- Bacteria.
- Stem Cells.

Included Skills, Values, and Issues :

- **Skills** : Providing evidences – Classification – Collaboration – Observation.
- **Values** : Collaboration.
- **Issue** : The role of stem cell banks in future medical treatment.

Cross-Cutting Concepts :

- Structure and function.

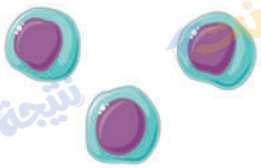
Lesson Objectives :

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

1. Provide evidence that all living organisms are composed of cells as the basic unit of structure and function.
2. Classify living organisms into prokaryotes and eukaryotes.
3. Classify living organisms into unicellular and multicellular organisms.
4. Compare between prokaryotes and eukaryotes.
5. Recognize the role of stem cells in the differentiation of tissues and organs in multicellular organisms.

Lesson Preparation :

The figure here shows one type of the living cells found in your body.



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

- What is the name given to this cell ?
- Is this cell specialized or unspecialized ?
- Does this cell contain cytoplasm, a nucleus and a plasma membrane ?
- Does this cell have the same characteristics of an amoeba cell ?
- What is the term that describes a group of similar cells that result from the transformation of such cells ?

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The Cell as The Basic Unit of Structure and Function in Living Organisms

You have previously concluded in the first unit that the atom is the basic unit of structure of all matters.

What is the basic unit of structure and function in living organisms ?

Activity 1 Providing evidences

Provide evidence from Figure (1) proving that most living organisms, such as human, are composed of simpler structural units.

The living organism is composed of several .....

each is made up of several .....

each organ is composed of several .....

which in turn are made up of several .....

and these perform various vital processes such as nutrition, growth and respiration.

It is obvious from the above that the cell is the basic unit of structure and function in any living organism.

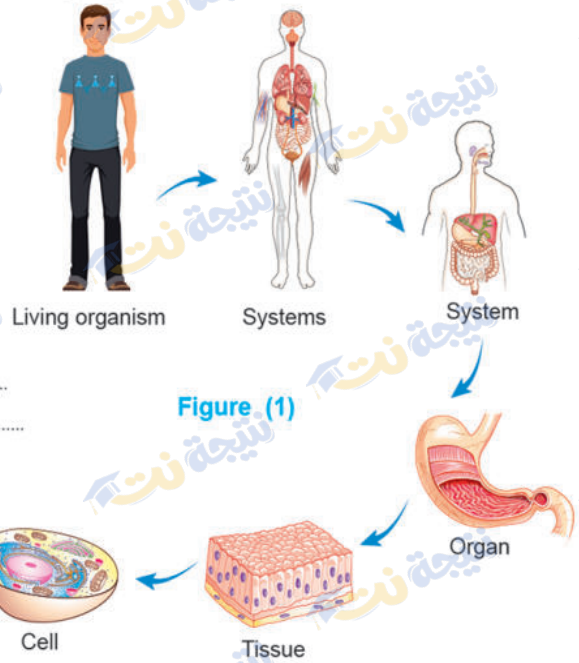


Figure (1)

An attempt to classify living organisms

Living organisms are grouped according to their similarities and differences to facilitate their study and identification, which is known as classification.

Activity 2 Classification

Diagram (1) shows an attempt to **classify** a group of living organisms according to the type of their cells.

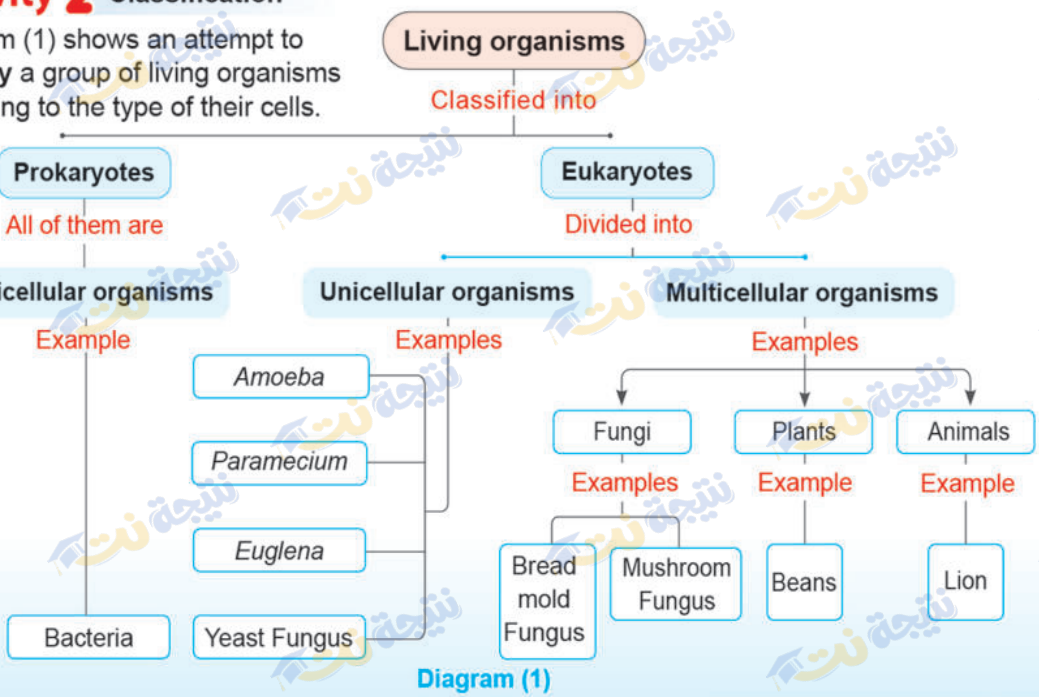


Diagram (1)

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Analyze the data in Diagram (1) by answering the following questions :

1 What is the classification of each of :

- Bacteria : .....
- Bread mold fungus : .....



Figure (2) Bread mold fungus

2 State a similarity and a difference between bacteria and *amoeba*.

- Similarity : .....
- Difference : .....

3 State a similarity and a difference between yeast fungus and mushroom fungus.

- Similarity : .....
- Difference : .....



Figure (3) Mushroom

You may wonder .. What are the differences between :

- Prokaryotes **and** eukaryotes.
- Unicellular **and** multicellular living organisms.

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Prokaryotes and Eukaryotes

- What is the similarity between the nucleus of an animal cell **and** that of a plant cell ?
- What is the difference between the nucleus of a bacterial cell **and** the nucleus of either of an animal cell or a plant cell ?

Activity 3 Compare

Team up with your classmates to compare the structures of an animal cell (Figure 4), and a plant cell (Figure 5) which belong to eukaryotes, with the structure of a bacterial cell (Figure 6) which belongs to prokaryotes.

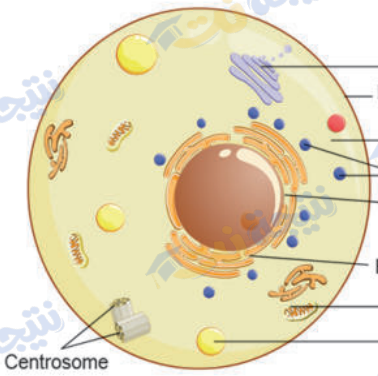


Figure (4)
Animal cell

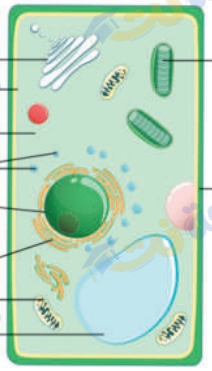


Figure (5)
Plant cell

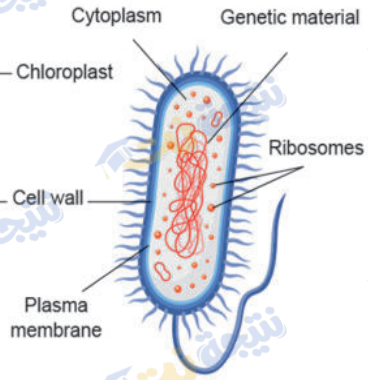


Figure (6)
Bacterial cell

Record your observations by placing a check mark (√) or (×) in the appropriate place in Table (1):

Structures or Organelles	Animal cell	Plant cell	Bacterial cell
(1) Presence of cell wall	.....	.....	.....
(2) Presence of plasma membrane (Cell membrane)	.....	.....	.....
(3) Presence of nucleus	.....	.....	.....
(4) Presence of cytoplasm	.....	.....	.....
(5) Presence of Golgi apparatus	.....	.....	.....
(6) Presence of ribosomes	.....	.....	.....
(7) Presence of endoplasmic reticulum	.....	.....	.....
(8) Presence of mitochondria	.....	.....	.....
(9) Presence of centrosome	.....	.....	.....
(10) Presence of chloroplasts	.....	.....	.....
(11) Presence of vacuoles	.....	.....	.....

Table (1)

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It is obvious from the previous that :

- **Prokaryotes** are unicellular living organisms that have simple structures and very small sizes, their genetic material in the cell is located in the cytoplasm and not surrounded by a nuclear membrane.
- **Eukaryotes** are living organisms that may be unicellular or multicellular, much more complex than prokaryotes, large in size, visible to the naked eye , while others are microscopic and can only be seen under a microscope and contain a true nucleus where its genetic material is surrounded by a nuclear membrane that separates it from the cytoplasm.

Evaluate Your Understanding

Complete the Venn diagram (Figure 7) with the appropriate statements numbers from the following:

(1) From prokaryotes.
(2) Contains chloroplasts.
(3) Contains a centrosome.
(4) The genetic material is surrounded by a nuclear membrane.
(5) Surrounded by a cell wall.
(6) Contains cytoplasm.
(7) Contains vacuoles.

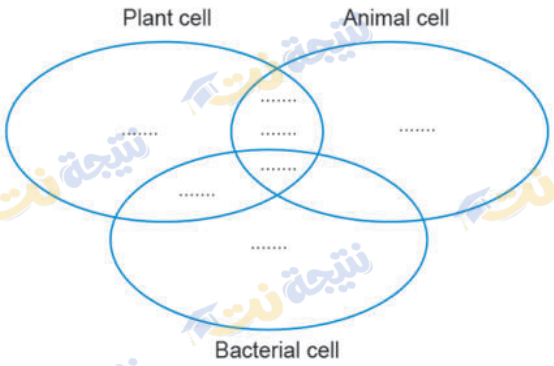


Figure (7)

Unicellular and Multicellular Organisms

As the name suggests, unicellular organisms consist of a single, unspecialized cell that performs all the vital processes necessary for life. They are microscopic organisms that cannot be seen by the naked eye but can be observed under a light microscope.
The unicellular organisms may be prokaryotes like bacteria, or eukaryotes like *Euglena* (Figure 8) and protozoa like *Amoeba* (Figure 9), and *Paramecium* (Figure 10).



Figure (8) *Euglena*



Figure (9) *Amoeba*



Figure (10) *Paramecium*

Multicellular organisms, as the name suggests, consist of many cells that are specialized and differentiated to perform specific vital processes. These organisms are relatively large in size, so they can be seen by the naked eye, and all of them are eukaryotes, such as plants and animals.

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The Stem Cells

Have you visited the pottery village in Fustat city, which is very close to the Museum of Civilizations ?!

There, you can watch the Egyptian artists creating various pottery artefacts from clay (Figure 11), these artistic pieces are used for different purposes (Figure 12).



Figure (11) Clay



Figure (12) Pottery

Like clay which can be transformed into various shapes of pottery, there is a type of cells known as stem cells that can be transformed into many types of cells in higher animals and human.

Stem Cells in Human

Activity 4 Observe

Figure (13) shows examples of specialized cells resulting from the transformation of stem cells in human.

What are these cells ?

- .....
- .....
- .....
- .....

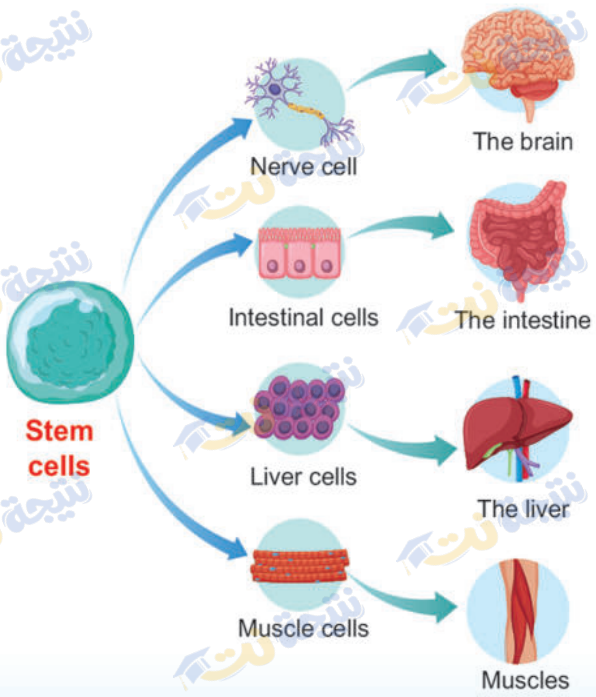


Figure (13)

Some specialized cells resulting from the transformation of stem cells

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Stem cells are characterized by many properties, including :

(1) Their ability to renew themselves through division and produce more stem cells.

(2) Their ability to be differentiated into specialized types of cells found in the body.

It is concluded from the previous that stem cells are undifferentiated cells that have the ability to be transformed and differentiated into all the differentiated cells of the body, that perform specialized functions.



Cross-Cutting Concepts : Structure and Function

The function of a cell differs depending on its structure. For example, the composition of muscular tissue of long muscle cells (fibers) allows it to perform the contraction and relaxation functions.



Evaluate Your Understanding

▶ **Can** prokaryotes act as stem cells ? **Explain.**

.....

.....



Medical Applications

Researchers hope that stem cells studies will help to :

- Increase understanding of how diseases occur, by watching cell differentiation; it is possible to understand when they turn into healthy and diseased cells.
- Generate healthy cells to replace cells infected by disease.
- Test new drugs before they are used, to determine their safety and effectiveness, where stem cells are grown in the laboratory and treated with the tested drug.



Issue for Discussion

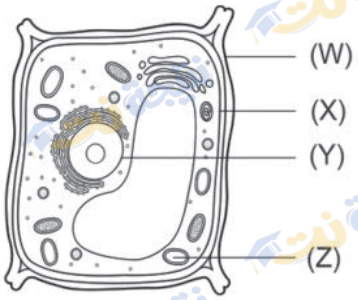
The role of stem cell banks in the future medical treatment.

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Evaluation Questions on Lesson One

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

(1) The following figure represents the structure of a plant cell :



Which of the following are found in liver cells as well as in this shown cell ?

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

(2) Which of the following distinguishes the cell in prokaryotes from the cell in eukaryotes ?

(a) Smaller in size and contains more organelles.
(b) Larger in size and contains more organelles.
(c) Smaller in size and contains fewer organelles.
(d) Larger in size and contains fewer organelles.

(3) Which of the following describes yeast fungus ?

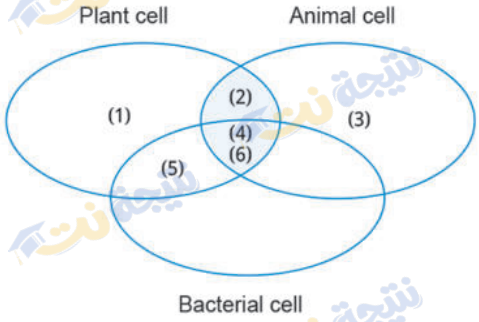
(a) A unicellular prokaryote.
(b) A unicellular eukaryote.
(c) A multicellular prokaryote.
(d) A multicellular eukaryote.

2 Protozoa are considered living organisms :

(1) Mention two examples of protozoa.

(2) What is the classification of the nucleus in protozoa ?

3 In the following Venn diagram :



Replace the numbers with appropriate cellular structures.

4 Mark (√) or (×) next to the following statement, with explanation :

Stem cells are specialized cells that can transform into muscle cells. ( )

5 Classify the following living organisms regarding the number of cells into unicellular or multicellular :

(1) *Paramecium*.
(2) Bacteria which cause tonsillitis.
(3) Lizard.
(4) Bat.
(5) Yogurt bacteria.

6 Compare between prokaryotes **and** eukaryotes.

7 What are the properties that characterize stem cells in human ?

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Lesson Two

General Characteristics of Living Organisms



Lesson Terminology :

- Nutrition.
- Photosynthesis.
- Respiration.
- Cellular Respiration.
- Transport.
- Circulation.
- Excretion.
- Movement.
- Growth.
- Reproduction.
- Sensation.
- Adaptation.

Included Skills, Values and Issues :

- **Skills** : Observation - Comparison - Conclusion - Practical.
- **Values**: Appreciation of science.
- **Issue** : Health awareness.

Cross-Cutting Concepts :

- Energy and matter.

Lesson Objectives :

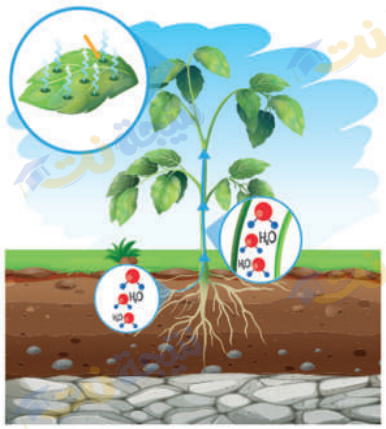
By the end of the lesson, the student should be able to :

1. List the general characteristics of living organisms.
2. Relate the general characteristics of life to the cell functions in prokaryotes.
3. Relate the general characteristics of life to the cell functions in eukaryotes.
4. Explain the combination between the photosynthesis process and the cellular respiration.
5. Recognize about the transport in each of animals and plants.
6. Compare between the means of movement in some unicellular organisms.

Lesson Preparation :

Here is an image of a plant. This lesson explores ideas that help you answer the following questions :

- Does the nutritional process in plant different from that in animal ?
- What is the similarity between the circulatory system in human and the transport system in plants ?
- Do cells respire ?
- What is the difference between the movement in plants and the movement in animals ?



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• What makes you describe a ball as a non-living material, and a rabbit as a living organism, even though they both can move ?
All living organisms share general characteristics that distinguish them from non-living materials.. **What are these characteristics ?**

1 Nutrition :

Living organisms obtain their food in different ways. They may be autotrophs, making their own food, hence they are called producers or they may be heterotrophs depending directly or indirectly on other producers to obtain their food, hence they are called consumers.
For example, bacteria, as prokaryotes, can be either autotrophs or heterotrophs.
On the other hand, eukaryotes such as human and animals depend directly or indirectly on other producers to obtain their food, so they are described as heterotrophs (consumers) (Figure 1).



Figure (1)
Cows are consumers and plants are producers

Whilst, green algae and plants produce their own food through photosynthesis (Figure 2), which occurs in the chloroplasts which contains chlorophyll, and hence they are described as autotrophs (producers).

Activity 1 Observe

Analyze the data in Figure (2) to answer the following questions :

- What are the inorganic materials that are used in photosynthesis ?

.....

- What are the two substances that are produced from photosynthesis ?

.....

- What is the substance that is responsible for absorbing light energy in plants ?

.....

- What is the substance that the plant produces as food, from which it obtains energy ?

.....

- Complete the following equation representing the conversion of light energy into stored chemical energy in photosynthesis :

..... + ... + ... ⟶ ..... + ...

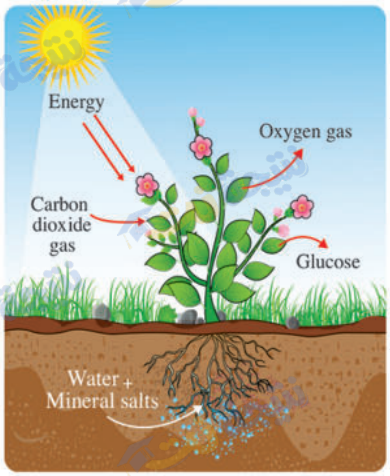


Figure (2)
The Photosynthesis process

Nutrition is considered one of the characteristics of the living organisms, in which they obtain food, that represents the main source of energy and produces substances that are used in building their bodies.

Cross-Cutting Concepts : Energy and Matter

Energy and matter are two forms of the same thing and they can be transformed into one another. For example, light energy is converted into stored chemical energy in the form of glucose during photosynthesis.

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Technological Application

Artificial photosynthesis : Scientists have developed a technological method that mimics photosynthesis in the form of artificial leaves that resemble green plant leaves (Figure 3).



Figure (3)

These leaves are supplied with hydrogen gas and absorb carbon dioxide gas emitted from car exhausts, factories, and the power stations to produce environmentally friendly fuel, and to reduce the global warming caused by increased percentage of carbon dioxide gas in the atmosphere, that leads to the elevation of Earth's temperature.

2 Respiration :

Unicellular organisms, whether prokaryotes or eukaryotes, obtain oxygen directly from their surrounding environment, and release CO_2 during gas exchange.
However, the methods of obtaining oxygen differ in multicellular organisms (eukaryotes).

Activity 2 Comparison

Team up with your classmate to compare the respiratory organ and the medium through which oxygen is obtained in human, fish and insects by filling in the blanks in Table (1) :

Points of comparison	Human	Fish	Insects
Respiratory organ	.....	.....	.....
Medium from which oxygen is obtained	.....	.....	.....

Table (1)

- Different living organisms have different respiratory organs required for obtaining oxygen. For example, amphibians like adult frogs breathe through both lungs and skin, while insects breathe through tracheal tubes (Figure 4).

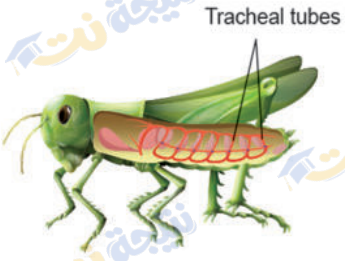


Figure (4)
Respiration in insects

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- Plants, however, do not have specialized respiratory system, but they obtain oxygen required for respiration from the atmospheric air through natural openings on the leaves called **stomata**.

Cellular respiration occurs in the mitochondria, found in eukaryotic cells (Figure 5). This vital process involves breaking down the organic nutrients, especially glucose, in the presence of oxygen to release the energy required to carry out all the biological activities. This process takes place throughout the day and night.

- Conclude the equation that represents the cellular respiration, knowing that it is the reverse of the equation of photosynthesis.

..... + ... ⟶ ..... + ... + ...

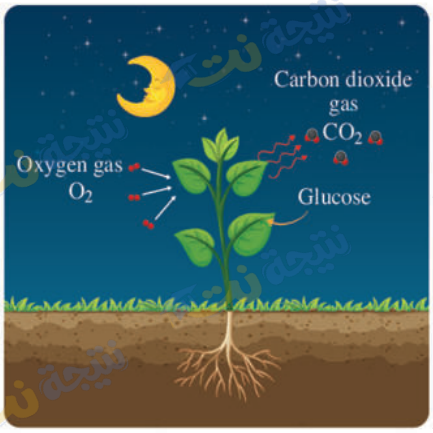


Figure (5)

Cellular respiration process takes place throughout the day and night

3 Transport :

Eukaryotic organisms, such as human, have specialized transport systems that transport digested food and oxygen extracted from the atmospheric air through the blood. The blood carries them to the heart, that pumps them to all the cells of the body and then it returns to the heart once again in a closed cycle described as the circulation.

Activity 3

Study (Figure 6), then answer the following questions :

- What are the substances that are transported (carried) by the blood in most arteries ?

.....

- What are the substances that are transported (carried) by the blood in most veins ?

.....

Circulation process in human body corresponds to the process of transport in plants (Figure 7),

where: - Xylem tissue transports water and mineral salts from the roots to the rest of the plant, reaching the leaves.
- Phloem tissue transports food from the leaves to the rest of the plant.

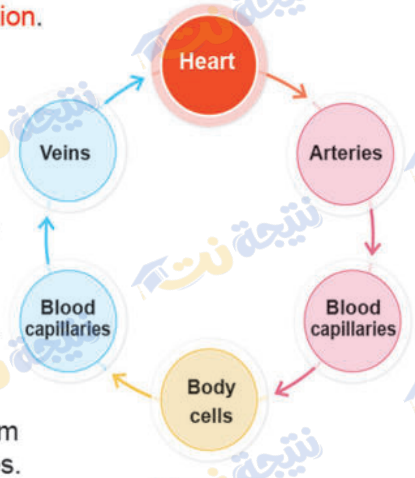


Figure (6)

Circulation in the human circulatory system

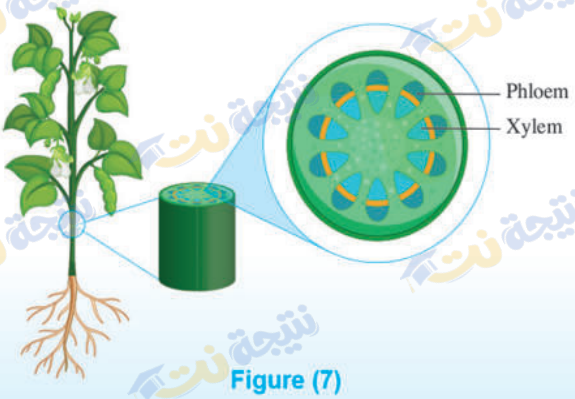


Figure (7)

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Evaluate Your Understanding

• **Is** the path of food in the digestive system a closed path ? **Explain.**

.....

Scientific Skills Conclusion

Study (Figure 8) and then conclude the letter representing each part of the plant (roots, stem, leaves, flowers or fruits) based on its role in the transport process.

• ..... • .....

• ..... • .....

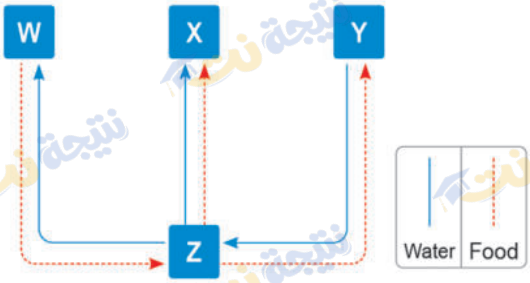


Figure (8)

4 Excretion :

In eukaryotic organisms, waste products and excess substances resulting from vital processes must be eliminated.

In human, the elimination of :

- Water vapour and carbon dioxide gas takes place through the lungs by exhalation.
- Excess water, salts and urea takes place through the kidneys in the form of urine.
- Excess water and salts takes place through sweat glands in the skin in the from of sweat.

Plants eliminate excess water vapour and CO_2 gas through minute pores called the stomata, where their opening and closing are controlled by specialized cells known as guard cells (Figure 9).

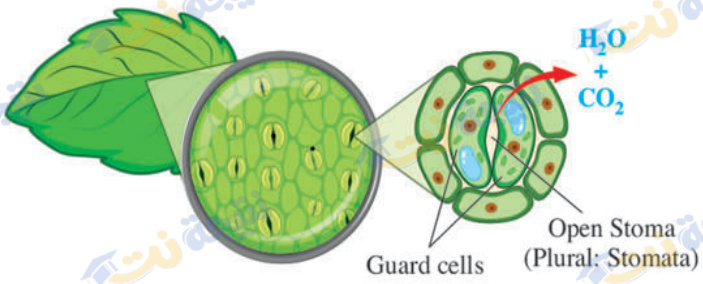


Figure (9)

Technological Application

The dialysis machine is used for the patients who suffer from kidney failure (Figure 10). This device performs the function of the kidneys throught purifying the blood from the toxins when the kidneys stop working properly.



Figure (10) **The dialysis machine**

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5 Movement :

Movement is the process that enables the living organism to move from one place to another.
In human, it is the musculoskeletal system (Figure 11) that is responsible for this function.

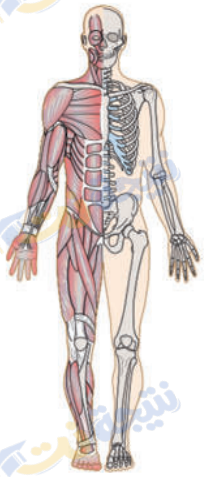


Figure (11)
Musculoskeletal system

Do plants move like animals?
Plant movement is not locomotion (movement to change the position and the location) like in animals, but it is limited and appears in several forms, such as :

1. The opening of Gazania flowers during the day and closing at night (Figure 12).
2. The drooping and folding up of Mimosa plant leaves upon touch (Figure 13).
3. The movement of the sunflowers to follow the movement of the sun as it rises and sets (Figure 14).



Daytime



Nighttime

Figure (12)
Gazania flower

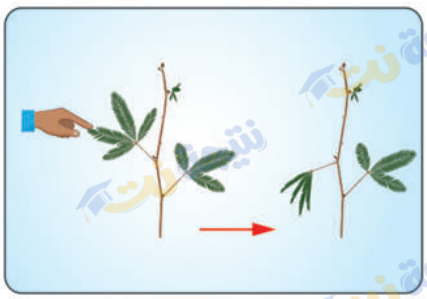


Figure (13)
Drooping Mimosa plant leaves upon touch



Figure (14)
Movement of the sunflowers to follow the sun

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Activity 4 Practical

1. **Examine** prepared slides of unicellular organisms using a light microscope.
2. **Determine** the means of movement in some unicellular organisms as represented in (Figures 15 : 17).

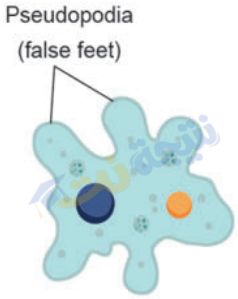


Figure (15)
Amoeba moves using pseudopodia (false feet)

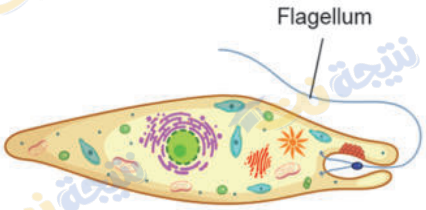


Figure (16)
Euglena moves using a flagellum

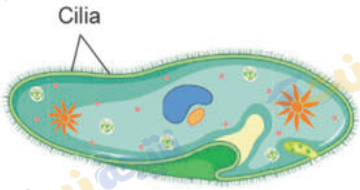


Figure (17)
Paramecium moves using cilia

Research Activity

Search in the different knowledge sources about common characteristics shared by living organisms **such as** : Growth, reproduction, sensation and adaptation.

Information and Communication Technology



You can create concept maps or mind maps for the general characteristics of living organisms using simulation programs like **EDraw Max**.

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Evaluation Questions on Lesson Two

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

(1) Among the general characteristics shared by all living organisms are .....

(a) digestion and excretion.
(b) digestion and nutrition.
(c) excretion and nutrition.
(d) nutrition and photosynthesis.

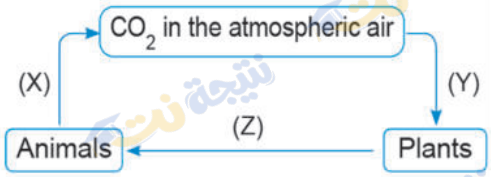
(2) What is the equation that represents the inputs and outputs of photosynthesis ?

(a) Glucose + Oxygen ⟶ Water + Carbon dioxide
(b) Glucose + Carbon dioxide ⟶ Water + Oxygen
(c) Carbon dioxide + Oxygen ⟶ Glucose + Water
(d) Carbon dioxide + Water ⟶ Glucose + Oxygen

(3) Living organisms get rid of carbon dioxide gas in the process of .....

(a) excretion. (b) movement.
(c) nutrition. (d) sensation.

(4) In the following diagram :



Which of the following represents the biological processes (X), (Y) and (Z) ?

Choices	(X)	(Y)	(Z)
(a)	Respiration	Photosynthesis	Transport
(b)	Excretion	Respiration	Nutrition
(c)	Excretion	Photosynthesis	Respiration
(d)	Respiration	Transport	Nutrition

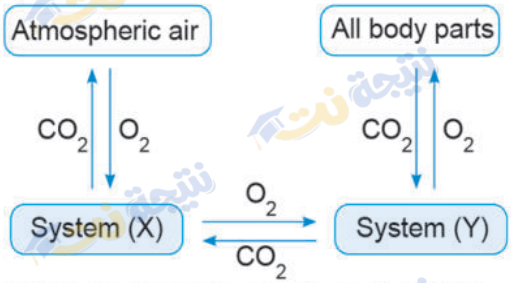
2 Protozoa are microscopic living organisms :

(1) Why are these organisms considered eukaryotes ?

(2) Explain the methods of movement in examples of them (from what you have studied).

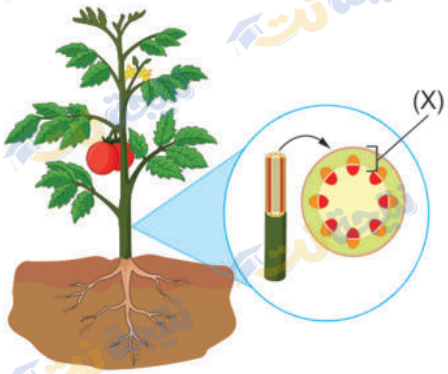
3 Compare between the respiratory organ in each of mammals, fish **and** insects.

4 Study the diagram below that illustrates the relation between two body systems in the human then answer the following questions :



(1) What is the main organ in system (X) ?
(2) What are the other substances that are exchanged between system (Y) and all parts of the body rather than CO_2 and O_2 gases?

5 The following figure shows a section in a plant stem:



Explain why the fruit size increases despite the removal of the outer part (X) of the stem in the part shown in the figure.

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Lesson Three

Microbes



Lesson Terminology :

- Microbes.
- Protozoa.
- Fungi.
- Root nodule bacteria.
- Decomposition bacteria.
- Lactic acid bacteria.
- *Penicillium Roqueforti.*
- *Penicillium Notatum.*
- Penicillin.
- Yeast.
- Dysentery.
- *Entamoeba Histolytica.*
- Typhoid fever.
- *Salmonella Typhi bacteria.*

Included Skills, Values and Issues :

- **Skills** : Practical work.
- **Values** : Appreciation of the scientists - Perseverance.
- **Issues** : Health awareness - Industry and innovation.

Cross-Cutting Concepts :

- Structure and function.

Lesson Objectives :

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

1. Classify microbes into prokaryotes and eukaryotes.
2. List types of microbes.
3. Describe examples of beneficial types of microbes.
4. List the benefits of microbes to humans.
5. Describe examples of harmful types of microbes.
6. Identify diseases resulting from food contamination.
7. Appreciate the efforts of the scientists in discovering diseases and the methods for their treatment.

Lesson Preparation :

The figure shows the shapes of some microbes. This lesson explores ideas that help you answer the following questions :



- Are all microbes harmful ?
- Can microbes have benefits ?
- What is the relation between microbes and yogurt production ?
- What are the similarities and differences between dysentery and typhoid fever ?

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Microbes

There are many products in the market that are used in the houses and the public places to eliminate harmful microbes (Figure 1).



Figure (1) Disinfectants

Do you think all microbes are harmful ?

Microbes are microscopic living organisms, most of them cannot be seen by the naked eye, but they are found everywhere around us, including inside our bodies.

Microbes can be either beneficial or harmful.

Diagram (1) illustrates the classification of some microbes that we will study.

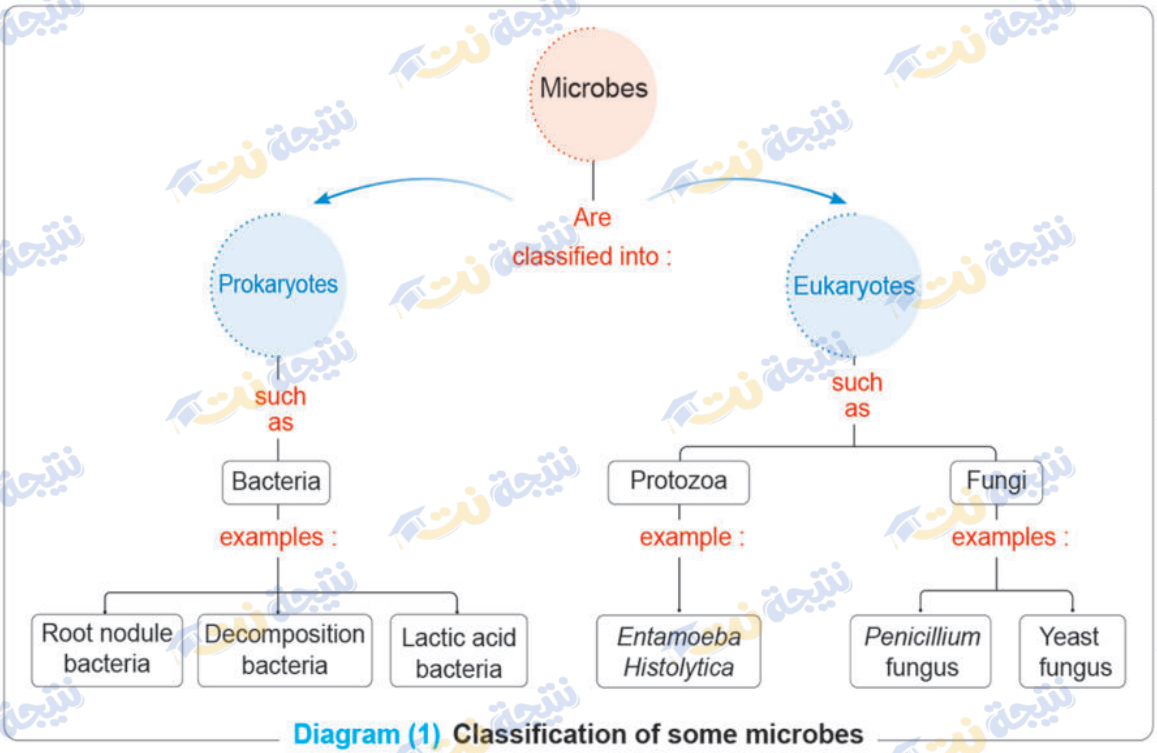


Diagram (1) Classification of some microbes

Information and Communication Technology

Search reliable sources (paper or digital) for reasons why viruses are not classified as prokaryotes or eukaryotes despite their severe harms.

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First Beneficial Microbes

1 Beneficial Bacteria

1 Root Nodule bacteria and decomposition bacteria

Green plants need carbon, hydrogen and oxygen elements to produce carbohydrates through the photosynthesis process. They also need nitrogen element to produce the proteins which are used in the growth of their cells and tissues.

However, plants cannot use nitrogen in its gaseous form from the air or soil, so types of beneficial microbes in the soil provide the plant with nitrogen in a usable form, such as root nodule bacteria (Figure 2), which live on the roots of leguminous plants like clover, bean and peas in specialized structures known as root nodules.

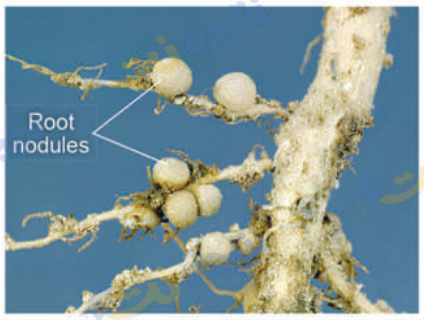


Figure (2)
Bacterial nodules on legume roots

Life Application

Farmers often leave the roots of leguminous plants in the soil after harvesting the crops to be decomposed by the decomposition bacteria into nitrogenous compounds soluble in water, which increases soil fertility and maintains the cycle of the necessary elements in nature.

2 Lactic acid bacteria

Yogurt is a food which is rich in the protein necessary for building the body and muscle growth, and it is also rich in calcium which is necessary for healthy bones and teeth.

Activity 1 Practical

Make yogurt by following these steps :



Figure (3)



Figure (4)



Figure (5)

1. Heat one liter of milk with continuous stirring until it boils for 25 minutes to kill any bacteria that may be found in the milk.
2. Let the milk cool down to warm (42°C).
3. Add half a cup of previously prepared yogurt (containing lactic acid bacteria) to the milk (Figure 3).

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4 Pour the milk into suitable containers (Figure 4) and leave them in a warm place (35°C to 45°C) suitable for bacterial growth for 4 to 5 hours until the milk ferments.
What do you observe about the change in the thickness and the taste of the milk?

.....

5 Put the yogurt containers in the refrigerator until it is used (Figure 5).
What happened in Activity (1) is that a type of bacteria converts lactose (milk sugar) into lactic acid, which gives yogurt its distinctive taste and thickness.
Keeping yougurt out of refrigerator allows the lactic acid bacteria to continue its action, leading to the production of more lactic acid, which increases the yogurt acidity and spoils its taste.

Life Application

Some mothers, during making pickled olives (Figure 6), add a spoonful of sugar to the salt solution used to reduce the bitterness of the olives and improve their taste.
The scientific explanation for this is that the sugar acts as a food source for beneficial bacteria, which convert the sugar into lactic acid.



Figure (6)

2 Beneficial Fungi

What is the green color you see in Roquefort cheese (Figure 7)?
Did you ever imagine that the distinctive taste and various colors in Roquefort cheese are caused by a fungus known as *Penicillium Roqueforti* ?

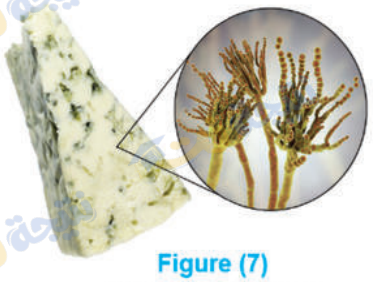


Figure (7)
Roquefort cheese

Beneficial fungi come in many forms, including :

1 *Penicillium Notatum*

In 1928, the English scientist Alexander Fleming discovered that *Penicillium Notatum* (Figure 8) secretes a substance that stops the growth and reproduction of a certain type of bacteria. This substance was extracted and became known as penicillin, the well known antibiotic, which is used to kill the bacteria that cause some diseases like diphtheria and tonsillitis.



Figure (8)
***Penicillium Notatum* fungus**

Cross-Cutting Concepts : Structure and Function

The difference in structure between *Penicillium Notatum* fungus and *Penicillium Roqueforti* fungus led to a difference in their function.

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A profile of the Scientist

Alexander Fleming

Fleming, a Scottish scientist, is famous for discovering penicillin, extracted from *Penicillium Notatum* fungus, which is considered the first effective antibiotic. He noticed the formation of a green fungus on the surface of one of the bacterial cultures in his laboratory when it was exposed to air, this fungus killed the surrounding bacteria. He was awarded the Nobel Prize in Medicine in 1945 for this discovery



Figure (9)
Alexander Fleming

2 Yeast Fungus

Yeast fungus (Figure 10) is used in bread and ethyl alcohol production, it is also a source of vitamin B complex and is rich in antioxidants.



Figure (10) **Yeast fungus**

Life Application

You can start your small business in food industries, **such as** making yogurt, pickles, jams or mushroom cultivation.

Second Harmful Microbes

Harmful microbes can enter the human body through breathing, eating (ingesting) contaminated food or when they penetrate the skin and reach the bloodstream.

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Examples of diseases resulted from food contamination :

1 Dysentery

This disease is caused by a unicellular protozoan known as *Entamoeba Histolytica* (Figure 11), which lives in the large intestine of the patient.

This disease is transmitted through ingesting food contaminated with the microbe.

The symptoms include repeated bloody diarrhea, stomach pain, loss of appetite, weight loss and continuous fatigue.
This disease is treated with antiprotozoal drugs.

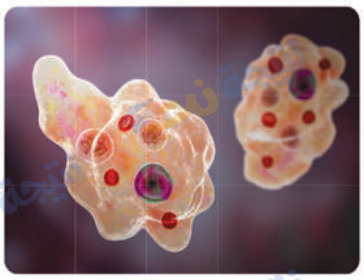


Figure (11) *Entamoeba Histolytica*

2 Typhoid Disease

Typhoid is a bacterial disease caused by a type of bacteria called *Salmonella Typhi* (Figure 12), which infects the digestive (gastrointestinal) tract and is transmitted to humans through the ingestion of food and water contaminated with *Salmonella Typhi*.

The symptoms include high fever, where the body temperature can reach 40°C, in addition to fatigue, headache, flatulence, stomach and muscle pain.
This disease is treated with antibiotics.

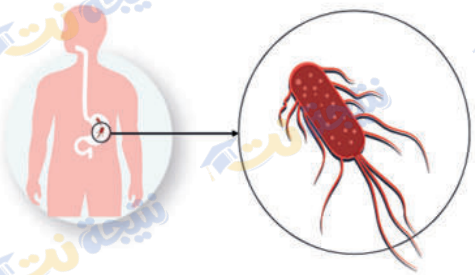


Figure (12) *Salmonella Typhi* bacteria infecting the digestive tract

Health Awareness

There are healthy habits that should be followed for the prevention of many diseases, including :

1. Wash vegetables and fruits thoroughly before eating them.
2. Do not leave food uncovered to protect it from contamination.
3. Wash your hands before eating and after using the bathroom.
4. Brush your teeth with a personal toothbrush after meals.
5. Drink at least 3 liters of pure water daily.

Evaluate Your Understanding

▸ **What is the importance** of brushing your teeth after meals ?

.....

.....

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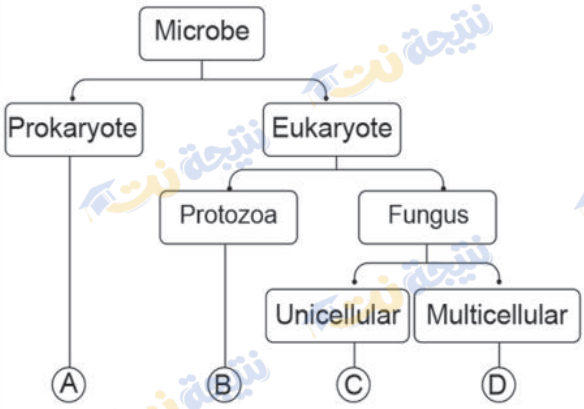
Evaluation Questions on Lesson Three

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

(1) ***Entamoeba Histolytica*** **is a type of .....**

(a) fungi. (b) protozoa.
(c) bacteria. (d) algae.

(2) From the following diagram :



What is the microbe that is used in the production of Roquefort cheese ?

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

(3) The microbe used in the production of ethyl alcohol differs from the microbe that causes typhoid fever in containing .....

(a) plasma membrane. (b) cytoplasm.
(c) cell wall. (d) nucleus.

(4) Which of the following represents the microorganism that causes typhoid fever ?

(a) Unicellular protozoan.
(b) Unicellular bacterium.
(c) Unicellular fungus.
(d) Multicellular fungus.

(5) Yogurt industry produces .....

(a) ethyl alcohol only.
(b) lactic acid only.
(c) ethyl alcohol and lactic acid.
(d) lactose and lactic acid.

2 Why is a small amount of previously prepared yogurt added to milk during making yogurt ?

3 An antibiotic was added to the milk prepared for making yogurt.
What is the expected result ? Explain.

4 Compare between the microbe inside the root nodules of fava bean plant **and** the microbe that causes dough fermentation **regarding the presence of :**

- Cell wall.
- Plasma membrane.
- Nucleus.
- Chloroplasts.

5 Explain the role of the microbes in food industries, from what you have studied.

6 A patient is suffering from high fever accompanied by flatulence and stomach pain with a headache :

(1) What disease is this patient suffering from ?
(2) What is the name and classification of the microbe causing this disease ?
(3) How is this disease treated ?
(4) How can this disease be prevented ?

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UNIT 4

The (Earth - Sun - Moon) System

The lessons

Lesson one : The Earth and the Solar System

Lesson two : Lunar Eclipse



Learning Outcomes :

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

1. Understand the (Earth-Sun-Moon) system.
2. Explain data collected from monitoring devices about some characteristics of the planets in the solar system
3. Conclude the similarities and differences among the planets in the solar system.
4. Conclude the relation between the tilt of the Earth's axis and its orbiting around the Sun with changing of seasons.
5. Explain the phenomenon of the lunar eclipse as one of the phases of the Moon's cycle.
6. Write a report on the causes of solar eclipse.

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Lesson **one**

The Earth and the Solar System



Lesson Terminology :

- Solar system.
- Planet.
- Atmosphere.
- Volcanic activity.
- Earth's axis.
- Apparent motion.
- Shadow.
- Succession of the seasons.
- Day.
- Night.

Included Skills, Values and Issues :

- **Skills** : Data analysis - Observation - Conclusion.
- **Values** : Collaboration - Appreciation of the greatness of God the creator.
- **Issue** : Electricity conservation.

Cross-Cutting Concepts :

- Patterns.

Lesson Objectives :

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

1. Conclude the similarities and differences among the planets in the solar system.
2. Recognize some of the consequences of Earth's axis tilt.
3. Conclude the relation between the apparent motion of the sun and the lengths of shadows cast by objects.
4. Conclude the relation between the tilt of Earth's axis and its orbiting around the sun with changing seasons.
5. Conclude the relation between the number of the daylight hours and the four seasons.

Lesson Preparation :

The figure here shows two seasons of the year.
This lesson explores ideas that help you answer the following questions :



- Is it possible to farm on other planets besides Earth ?
- Why do summer and winter alternate ?
- Does the shadow of a tree change from one season to another ?

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Characteristics of The Components of The Planets of The Solar System

The solar system (Figure 1) consists of a star, the sun, and 8 planets that orbit the sun in elliptical paths on different distances from it, ensuring that the planets do not collide during their movement.

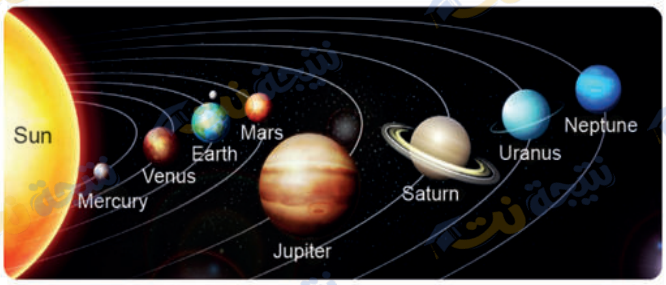


Figure (1) The solar system

Activity 1 Data analysis

Table (1) exhibits data from monitoring devices about some characteristics of the planets in the solar system.

	Planets	Crust	Atmosphere	Diameter	Volcanic activity
Inner planets	**Mercury**	Very thin, full of craters caused by meteor impacts	Very thin, composed of hydrogen and helium gases	4878 km	No active volcanoes
	Venus	Thick compared to Mercury's crust	Very dense, composed mainly of carbon dioxide gas	12120 km	Many active volcanoes
	Earth	Thicker than Venus's crust	Composed mainly of nitrogen and oxygen gases, where it is the planet of human life	12756 km	Many active volcanoes
	Mars	Thick crust, relatively similar to Earth's crust, it is known as the Red Planet	Composed mainly of carbon dioxide gas	6787 km	There are indications of volcanoes, but no current volcanic activity
Outer planets	**Jupiter**	Gaseous planet, no crust, composed of gases only	Composed of hydrogen and helium gases	142948 km	No volcanoes
	Saturn	Similar to Jupiter	Same Jupiter atomspheric components	120536 km	No volcanoes
	Uranus	Gaseous planet, no crust, composed of gases and ice	Composed of hydrogen, helium gases, and methane gas which has greenish blue color	51118 km	No volcanoes
	Neptune	Similar to Uranus	It has the same components of Uranus atmosphere, and known as the blue planet	49660 km	No volcanoes

Table (1)

"The planet diameters are for comparison purposes only"

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Team up with one of your classmates to analyze the data in Table (1), then compare the characteristics of the planets.
by answering the following questions :

1. **Arrange** the planets of the solar system **ascendingly** according to their diameters.

.....

2. **Which** group of planets is described as rocky planets ?

.....

3. **Which** group of planets is characterized by active volcanoes ?

.....

4. **What is the similarity between** the atmospheres of Mercury **and** Jupiter ?

.....

5. **What is the difference between** the atmospheres of Saturn **and** Uranus ?

.....

The Sun-Earth System

- The Earth completes a full rotation every 24 hours around its axis, which is an imaginary straight line runs through the North pole and the South pole, passing through Earth's center.
- Earth's axis tilts at an angle of 23.5° from the imaginary perpendicular line to its orbit around the Sun. The tilt of Earth's axis causes variations in the angle at which sunlight falls on the different areas of Earth's surface, leading to differences in the intensity of sunlight that falls on unit area (Figure 2).

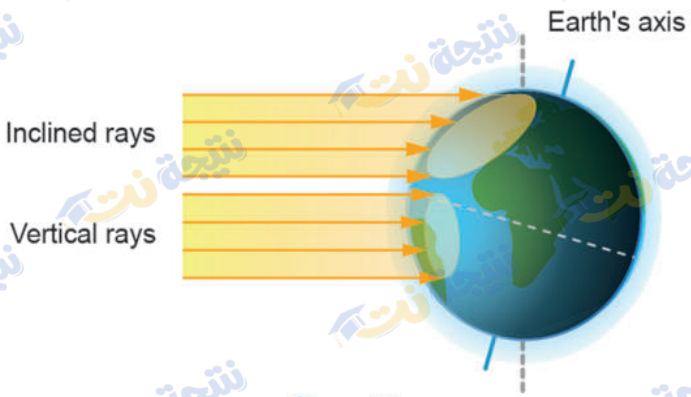


Figure (2)

As Earth rotates around its axis in front of the Sun, day and night cycle occurs, and also the apparent motion of the sun, while the tilt of Earth's axis and its revolving around the sun every 365 $\frac{1}{4}$ days result in the alternation of the four seasons.

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The Apparent Motion of The Sun

It is known that Earth orbits the Sun, but during Earth's rotation around its own axis from west to east, the Sun appears in the sky throughout the day or the year as if its position is shifting from east to west, a phenomenon known as The apparent motion of the Sun (Figure 3)

Activity 2 Observation

Figure (3) The apparent motion of the Sun :

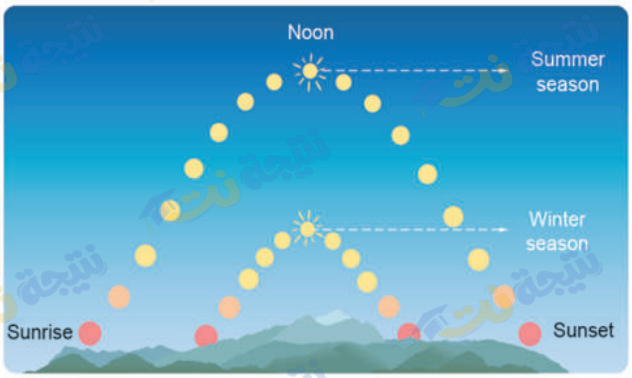


Figure (3) The apparent motion of the sun

(1) **At what time of the year:**

- Does the sun's apparent height increase ?

.....

- Does the sun's apparent height decrease ?

.....

(2) In which season is the sun's apparent height :

- The highest ? ..... - The lowest ? .....

Compare the lengths of the shadows cast by the stick in (Figure 4), Then answer the following questions:

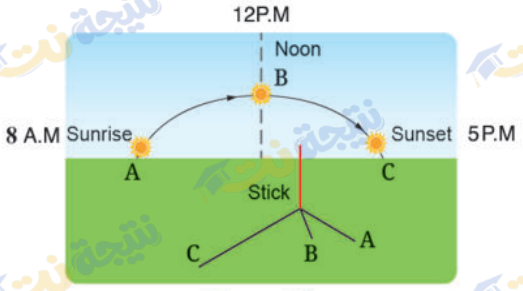


Figure (4)
Change in shadow length throughout the day

(3) When is the shadow of the stick the longest, and when is it the shortest ?

.....

.....

(4) Which is longer : the shadow of the stick at sunrise **or** sunset ?

.....

(5) What is the relation between the apparent height of the sun during the day **and** the length of the cast shadows ?

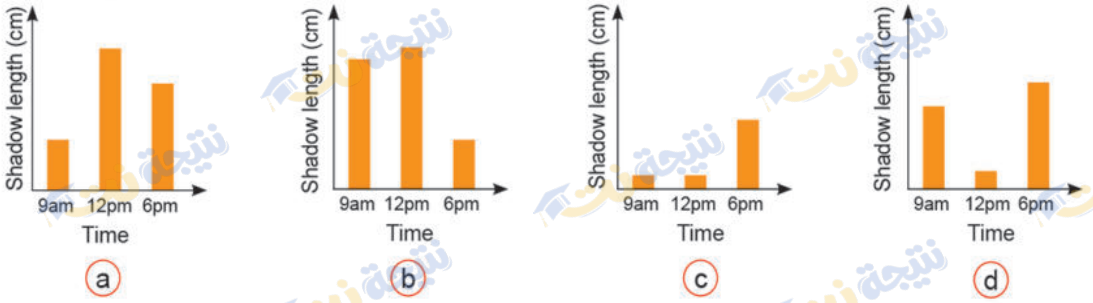
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From the previous, it can be observed that the shadow length at noon is the shortest because the sun's apparent height is the highest at noon.

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Evaluate Your Understanding:

A student observed the length of the shadow of a stick placed at a fixed position in the ground from 9 am to 6 pm, Which of the following graphs represents the relative lengths of the shadows formed? Explain.



.....

.....

Technological Application

A sundial : An ancient solar clock (Figure 5) that was used to determine the time based on the length and direction of the shadow resulting from the apparent motion of the sun.

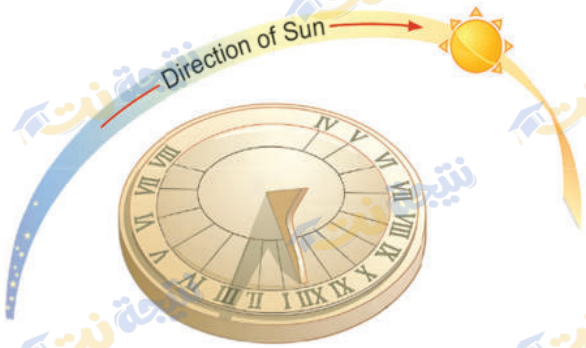


Figure (5) Sundial

The Cycle of The Seasons

The tilt of Earth's axis and its orbit around the Sun cause sunlight to fall on Earth's surface at different angles, leading to variations in the amount of sunlight received by Earth's hemispheres (the two halves of Earth's sphere) throughout the year.

This results in the alternation of the four seasons across $365\frac{1}{4}$ days.

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Activity 3 Conclusion

Observe Figure (6) to determine the relation between Earth's axis direction relative to the Sun in the four seasons, by answering the following questions :

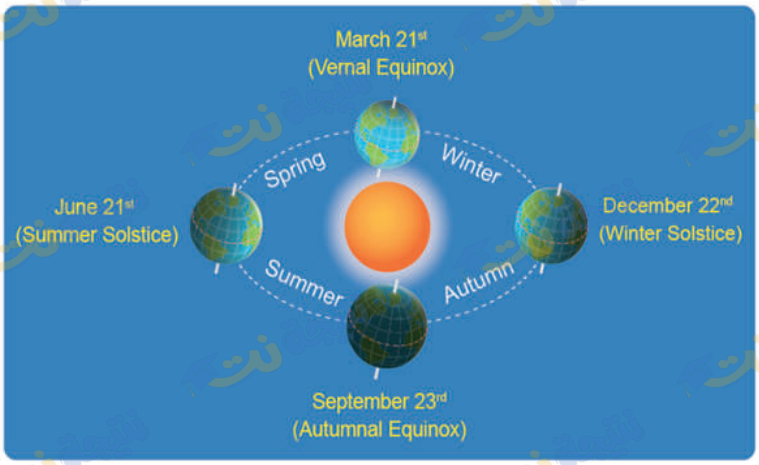


Figure (6) Sequence of the seasons

1. **Where** does the northern end of Earth's axis lean on June 21st, and what is the extent of this leaning ?

.....

2. **Where** does the northern end of Earth's axis lean on December 22nd, and what is the extent of this leaning ?

.....

From Activity (3), it is clear that :

- The northern end of Earth's axis leans closest to the sun in summer and away from it in winter.
- In spring and autumn, the northern end of Earth's axis neither leans close to nor away from the sun.
- The tilt of Earth's axis results in variations in daylight hours throughout the seasons, leading to changes in weather conditions (Figure 7).



Spring (21 March - 20 June)	Summer (21 June - 22 September)	Autumn (23 September - 21 December)	Winter (22 December - 20 March)

Figure (7)

Cross-Cutting Concepts : Patterns

The alternation of the four seasons follows specific patterns can be observed throughout the year, leading to changes in weather, temperature, and the day length.

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Activity 4 Conclusion

Table (2) shows the sunrise and sunset times in Egypt on four different days of the year 2024

Day	Sunrise		Sunset		Number of day hours		Relation between day hours and night hours
	Hour	Min	Hour	Min	Hour	Min	
21/3/2024	05	57	18	07	.....		Day hours ..... Night hours
			(6 : 07) pm				
13/7/2024	06	03	19	58	.....		Day hours ..... Night hours
			(7 : 58) pm				
23/9/2024	06	44	18	49	.....		Day hours ..... Night hours
			(6 : 49) pm				
22/12/2024	06	47	17	00	.....		Day hours ..... Night hours
			(5 : 00) pm				

Table (2)

1. **Record** the number of daylight hours for each day in the table by subtracting the sunrise time from the sunset time.
2. **Choose** the appropriate mathematical symbol (> / = / <) to represent the approximate relation between the length of day time and night time on each day.
3. **Conclude** the relation between the length of day and night (the day length) in the four seasons.
   - In summer : .....
   - In winter : .....
   - In spring and autumn : .....

Combination with Agricultural Science

The times of planting and harvesting the different crops in Egypt vary with the seasons of the year. For example, watermelon, cucumber, and zucchini, are summer crops, while orange, wheat and lettuce are winter crops

Information and Communication Technology

Search reliable digital sources to find out the sunrise and sunset times and the day length in different cities.

Topic for Discussion

Changes in electricity consumption in different seasons.

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Evaluation Questions on Lesson one

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

(1) All the following are correct, except .....

(a) Venus is a rocky planet, while Neptune is a gaseous planet.

(b) the atmospheric composition of Venus and Mars are similar.

(c) there are volcanoes on both Earth and Uranus.

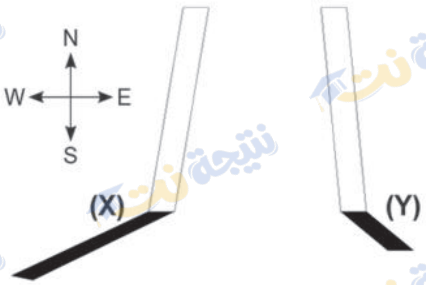
(d) Saturn's diameter is larger than Uranus's diameter.

(2) The day length can reach 13 hours and 40 minutes in .....

(a) March. (b) July.

(c) September. (d) December.

(3) The following figure shows the length and direction of the shadow of a pole fixed in the ground at two different times of the day :



If shadow (X) formed at 10 am, shadow (Y) forms at .....

(a) 9 am (b) 11 am

(c) 2 pm (d) 6 pm

(4) All the following describe spring, except .....

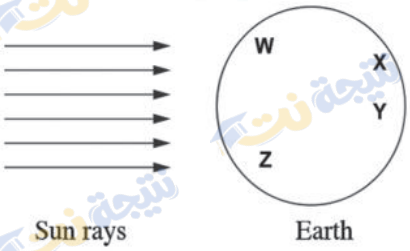
(a) daylight hours are equal to night hours.

(b) the apparent height of the sun in it is lower than in summer.

(c) Earth's axis does not lean to the sun.

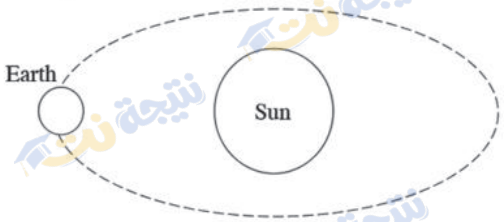
(d) the cast shadows in it are longer than in winter.

2 From the following figure:



(1) Identify the letters indicating the areas of the Earth where it is daytime.

(2) Draw the Earth's approximate position 9 months after the position which is shown in the following figure:



3 Compare between Mercury and Earth in terms of :

(1) Atmospheric composition.

(2) Volcanic activity.

4 The summer solstice begins after the vernal equinox ends :

(1) What is the start date of the summer solstice?

(2) Which season begins after the end of summer?

5 Explain the effect of Earth's axis tilt during its orbiting around the Sun on the variation in agricultural crops in Egypt.

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Lesson **Two**

Lunar Eclipse



Lesson Terminology :

- Moon phases.
- Full moon.
- Lunar eclipse.
- Penumbral lunar eclipse.
- Penumbra.
- Total eclipse.
- Partial eclipse.

Included Skills, Values and Issues :

- **Skills** : Discovery, Practical skills, Observation and Conclusion.
- **Values** : Appreciation of the greatness of God the Creator.
- **Issue** : Ethics of science.

Cross-Cutting Concepts :

- Cause and Effect.

Lesson Objectives :

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

1. Distinguish between the phases of the moon.
2. Identify the full moon phase.
3. Understand the formation of shadows and penumbra for dark objects.
4. Explain the phenomenon of lunar eclipse.
5. Write a report on solar eclipse.

Lesson Preparation :

The image here shows eight pictures of the Moon during one of the Arabic months :



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

- Does the shape of the Moon change during the Arabic month ?
- What is meant by the phases of the moon?
- Where is the Moon located in its full moon phase in relation to the Sun and Earth ?
- Does lunar eclipse occur every time the Moon is full ?

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Moon

The Moon is a dark body that orbits Earth and is the closest celestial body to Earth. It appears illuminated as it reflects sunlight. Its revolution around Earth takes approximately 29.5 days (Figure 1), which is the same time it takes to rotate on its axis. Therefore, an observer on Earth always sees one side of the moon (Figure 2).

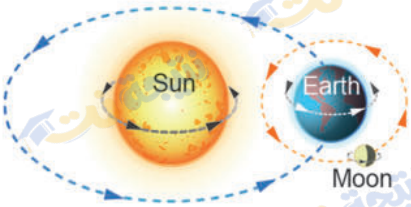


Figure (1)

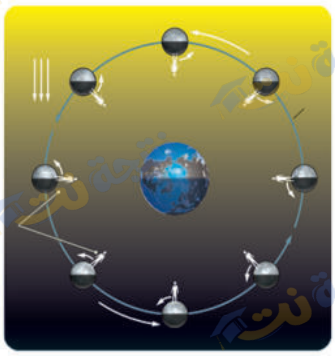


Figure (2)

Phases of The Moon

The moon appears to change shape throughout the Arabic (lunar) month, but in reality, it does not change. What changes is the size of the part that can be seen from the illuminated part which reflects sunlight. The different stages the moon goes through during its orbit around Earth are called **the phases of the Moon.**

Activity 1 Discovery

Examine (Figure 3) to learn about the phases of the Moon during its orbit around Earth from east to west, **then answer the following questions :**

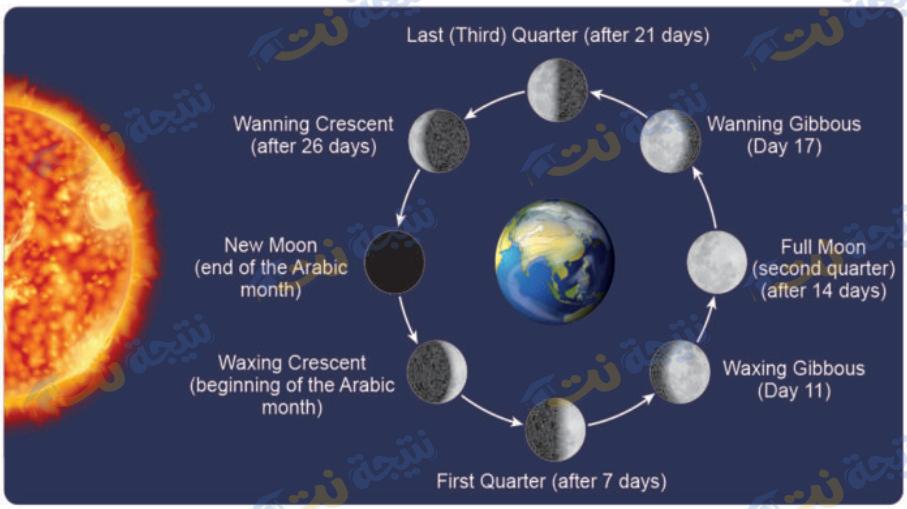


Figure (3) Phases of the moon

1. **What phase** follows the Waxing Gibbous? .....
2. **How** does the moon appear in this phase? .....
3. **What ratio** of the moon's orbit around Earth has been completed by this phase ?

.....

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It is clear from the previous that :

When Earth is positioned between the moon and the sun in the middle of the Arabic (lunar) month, the moon appears as a complete disc, and it is said to be in the Full Moon phase. It is observed once or twice a year that the Full Moon gradually darkens until it completely disappears in the same period of the lunar month, this phenomenon is known as **The Lunar eclipse.**

Lunar Eclipse

To understand the lunar eclipse, it is necessary to grasp some concepts explained in Activity 2

Activity 2 Practical

1. Place a light source such as an electric lamp in a dark room and direct it toward a white movable screen.
2. Place an opaque ball - like - object between the lamp and the screen.
3. Move the ball closer to or farther from the lamp Figure (4) .. **What do you observe ?**

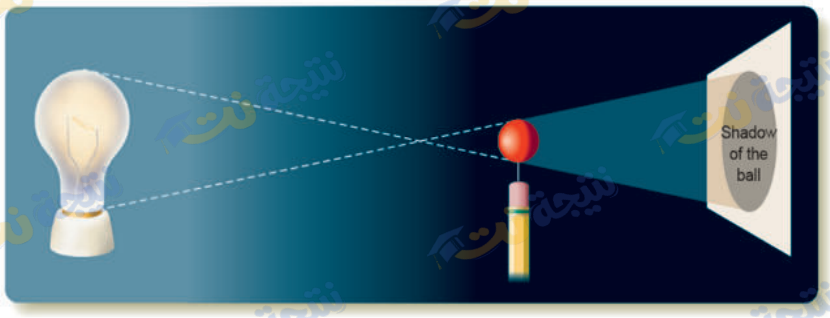


Figure (4)

- **What does form** on the white screen ? .....
- **What happens to the ball's shadow** as the ball approaches the lamp ? .....

4. Move the screen toward the ball Figure (5).. **What do you observe ?**

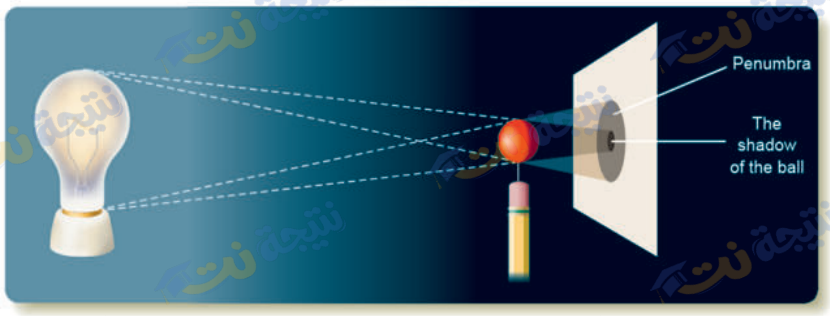


Figure (5)

- **What is the name of the dark area** formed on the white screen ? .....
- **What is the name of the partially lit area** which surrounds the shadow of the ball ?

.....

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It is clear from the previous that :

The presence of an opaque object in the path of light rays leads to the formation of a dark area known as a shadow, surrounded by a partially illuminated area known as the penumbra.

Cross-Cutting Concepts : Cause and Effect

Transparent objects allow light to pass through them, so they do not cast shadows , whereas opaque objects block light and therefore they cast shadows .

If we consider the lamp used in Activity (2) to represent the Sun, the ball to represent the Earth, and the white screen to represent the Moon in the Full Moon phase, then when Earth, during its orbit around the Sun, aligns itself between the Sun and the Moon, it partially or completely blocks sunlight from reaching the Moon, resulting in **the lunar eclipse**

Activity 3 Observation and Conclusion

Figure (6) shows two types of lunar eclipses :

Total Eclipse : The Full Moon appears as a dark disc because no sunlight reaches it .

Partial Eclipse : The Full Moon appears partially dark .

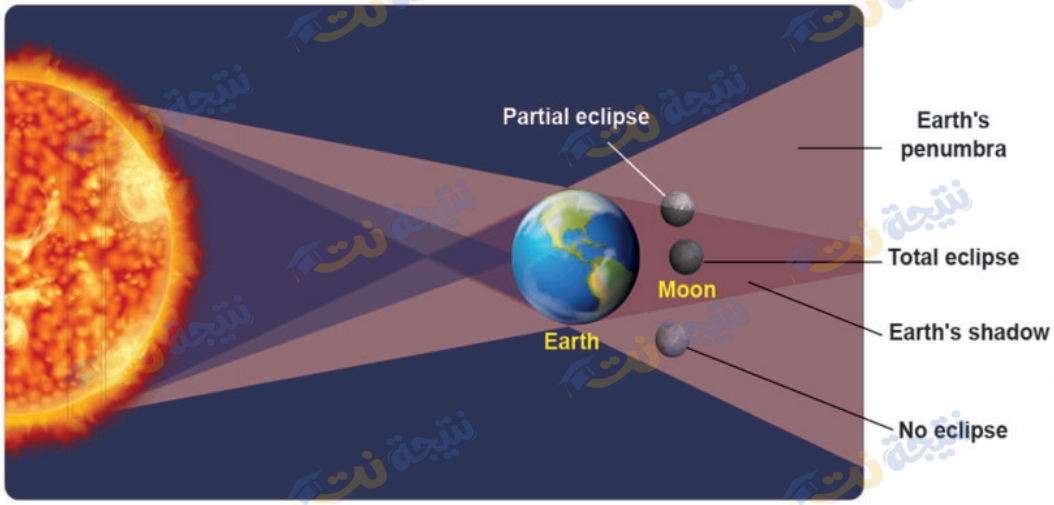


Figure (6) Lunar eclipses

- Where is the moon located during : • Total eclipse : .....

• Partial eclipse : .....

- When the Moon is completely within Earth's penumbra, The full moon phase appears as a red disc which is dimly lit, which is **not considered an eclipse.**

- You may wonder .. Why doesn't the lunar eclipse occur every time the moon is full ?

• Due to the 5-degree tilt of the Moon's orbit around Earth relative to Earth's orbit around the sun, the moon does not always align on the line between the sun and Earth during every full moon. Therefore, it is not necessarily for the moon to undergo an eclipse during every full moon.

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Evaluate Your Understanding:

Three wooden blocks were placed between a flashlight and a screen (Figure 7) :

1. On (Figure 7), **mark** the area where the shadow of the blocks will form.
2. **What happens** to the size of the shadow when the screen is moved away from the blocks ?

.....

3. **How** can you increase the size of the shadow without changing the positions of the blocks and the screen ?

.....

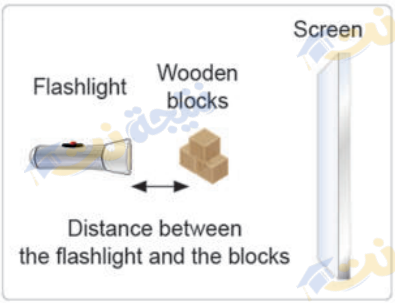


Figure (7)

Combination with History

During **Christopher Columbus's** fourth voyage to the Americas in 1504, the native people of Jamaica refused to continue supplying him with food. Columbus, knowing the date of an upcoming lunar eclipse, threatened the leaders that the gods' wrath would descend upon them if they continued to refuse his requests. When the eclipse occurred, the leaders believed his story of the gods' anger and obeyed his orders.

Issue for Discussion

The exploitation of science to deceive the unwise people.

Scientific Skills Writing scientific report

Search the various sources of knowledge about **solar eclipses**, then write a scientific report on the subject using accurate scientific terms.

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Evaluation Questions on Lesson Two

1 Choose the correct answer to questions (1) : (5).

(1) The following shapes show the appearance of the Moon at four different days in the same country :



1 June | 8 June | 15 June | 23 June

What is the appearance of the moon on June 3rd ?



(a) (b) (c) (d)

(2) What is the time interval between the Full Moon and New Moon phases ?

(a) 11 days. (b) 15 days.
(c) 17 days. (d) 29 days.

(3) When the Moon completes the second quarter of its orbit, it is in the ..... phase

(a) Waxing Gibbous (b) New Moon
(c) Full Moon (d) First Quarter

(4) The main reason for the lunar eclipse is .....

(a) the Moon's orbit around Earth.
(b) Earth's orbit around the sun.
(c) the Moon being between the sun and Earth.
(d) Earth being between the sun and the moon.

(5) The partial lunar eclipse occurs when .....

(a) the moon is in both Earth's shadow and penumbra.
(b) the moon is in Earth's penumbra.
(c) the moon is in the Waxing Crescent phase.
(d) the moon is in the New Moon phase.

2 In the following figure:

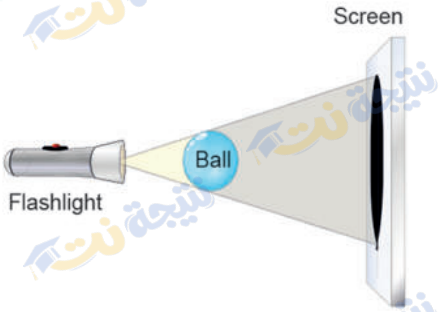


(1) What is the name of the region where the moon is located ?

(2) What phenomenon is represented by the figure ?

3 What is the result of the fact that the Moon's rotation period around its axis equals its revolution period around Earth ?

4 In the following figure :



(1) Is the ball transparent or opaque ? Explain.

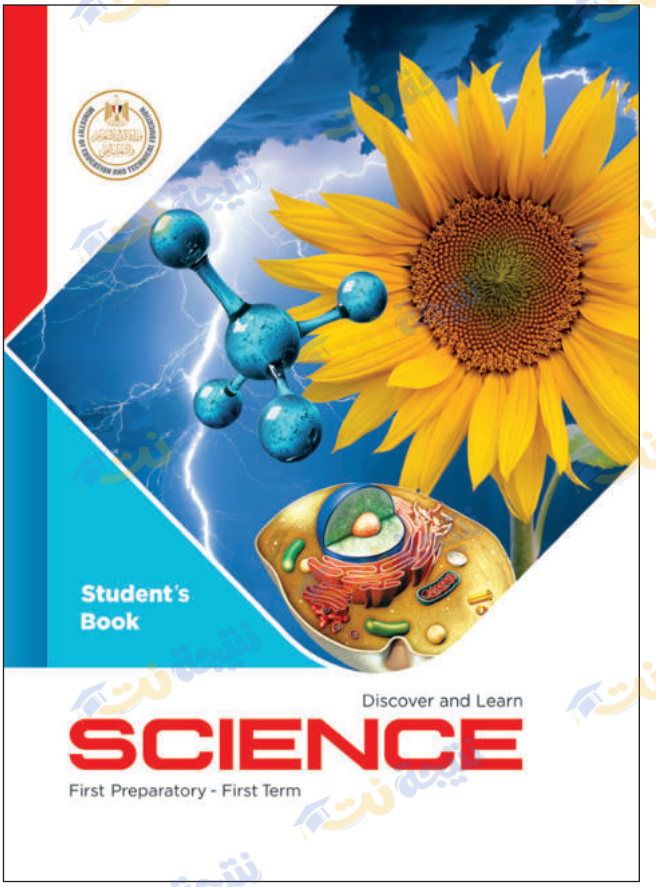
(2) How can the shadow area be increased in two different ways ?

5 Explain the difference between the New Moon phase and the Full Moon phase.

6 Why doesn't an eclipse occur every month during the Full Moon phase ?

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