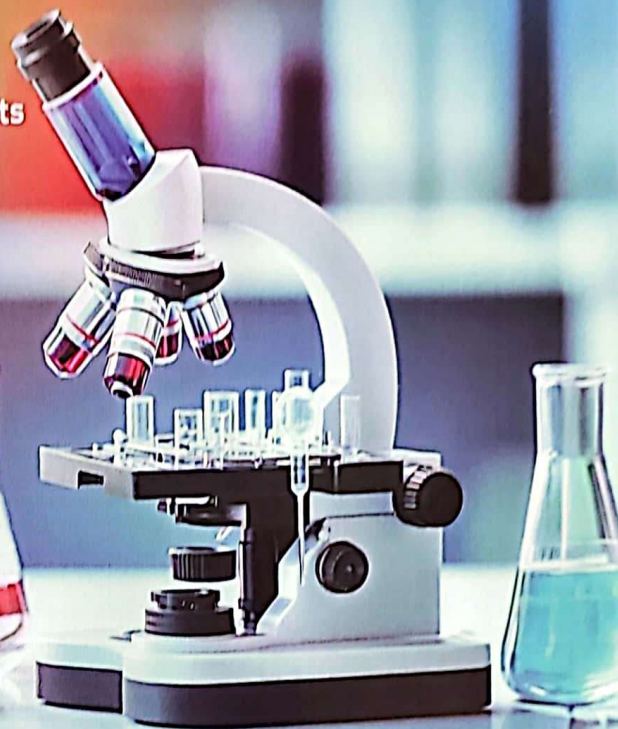


The Matter

| | |
|---------------------|---------------------------------------|
| 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.

Lesson ONE

Structure of The Atom



Unit

Unit

Unit

Unit

Lesson Terminology :

- Matter
- Molecule
- Atom
- Proton
- Neutron
- Electron
- Nucleus
- Subatomic particles
- Energy level
- Atomic number
- Mass number
- Nucleones
- Isotopes

Included Skills, Values and Issues :

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

Cross-cutting concepts :

- Measurement and Proportions.

Lesson Objectives :

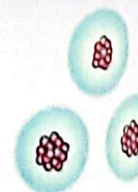
By the end of the lesson, the student should be able to :

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 subatomic components of the atom.
4. Recognize the charges and masses of 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 relation 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 help you answer these questions :

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



- Every non-living thing around us, anywhere on Earth, is **matter**

Matter

Anything that has mass and volume and occupies space.



Take care:

Some may think gases are not matter because they are invisible. In fact, matter exists in three different states, which are : Solid state, liquid state and gaseous state.

Building Units

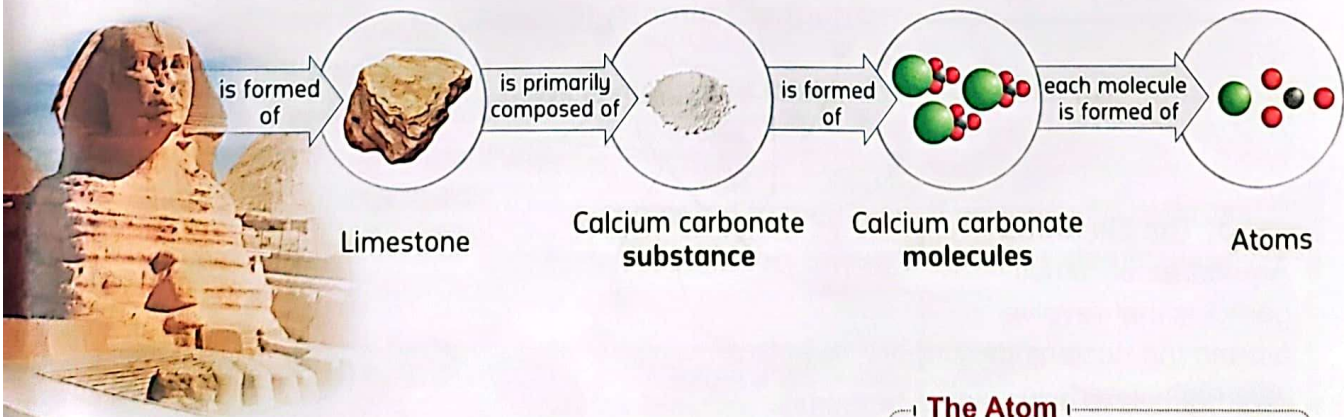
Just as a house is formed of several floors, each floor consists of several apartments, each apartment consists of walls, and each wall is formed of bricks so each brick considers a building unit of the house. Similarly, the atom is the building and structure unit of matter.



Walls are made of bricks for protection and division

The Atom is the Building unit of Matter

The Sphinx statue



∴ The building unit of the sphinx statue is the atom.

The Atom Is the building and structure unit of any matter.

Structure of the Atom

Attempts to discover the atomic structure have been numerous throughout the ages, as detailed below :

- **In Ancient Times** : The Greek philosophers believed that the matter was formed of small, indivisible parts called atoms.
- **In the Early 19th Century** : The scientist Dalton proposed the first scientific atomic theory, stating that atoms are indivisible.
- **In 1909** : The scientist Rutherford proposed the first model of the atom based on experimental basis.



The scientist Dalton

The scientist
**Ernest
Rutherford**

He is a New Zealand physicist, born in 1871, he won the Nobel Prize in Chemistry in 1908, and died in 1937. New Zealand honored him by featuring his image on its largest currency note for his contributions to discovering the atomic structure



Scientists have discovered the following :

1. The Atom

Despite its tiny size, the structure of the atom is complex, where it consists of a central nucleus which is surrounded by electrons.

2. The Nucleus

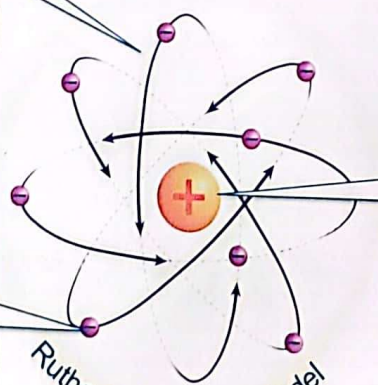
Occupies a tiny space in the atom and contains two types of particles: protons and neutrons.

The nucleus is very very small compared to size of the atom.

If we imagine the atom as the size of a baseball field, the nucleus would be the size of a pinhead in the center of the field.

3. The Electrons

Are extremely small particles that revolve around the nucleus at very high speeds in certain energy levels.



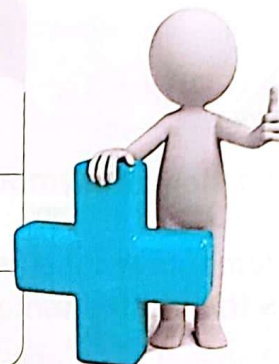
Rutherford's Atomic Model



Properties of Atomic Components (The Subatomic Particles)

Protons, neutrons and electrons are subatomic particles, the following table illustrates their properties :

| Particle | Symbol | Relative Electrical Charge | Mass |
|----------|----------------|----------------------------|--------------------|
| Proton | p | +1 | 1 u |
| Neutron | n | 0 | 1 u |
| Electron | e ⁻ | -1 | $\frac{1}{1836}$ u |



The relative electrical charge of atomic components :

Proton **p**

Positively charged particle (+)

Neutron **n**

Neutrally charged particle (±)

Electron **e⁻**

Negatively charged particle (-)

▶ Proton charge is equal to the electron charge in the magnitude but opposite in the type.

G.R.? The nucleus of the atom is positively charged.

Because it contains positively charged protons and neutrally charged neutrons.

Mass of Atomic Components :

- ▶ The mass of subatomic particles is measured in atomic masses unit (u).
- ▶ Proton mass (=) Neutron mass.
- ▶ The mass of electrons is **very tiny** compared to the mass of protons and neutrons, so the electrons mass is usually neglected in the calculations of the atomic mass.

G.R.? The mass of the atom is concentrated in the nucleus.

Because the mass of electrons is negligible compared to the mass of both protons and neutrons that are found inside the atom nucleus.

Chemical Symbols of Elements

Scientists agreed to represent elements with symbols to simplify their representation, especially in chemical equations.



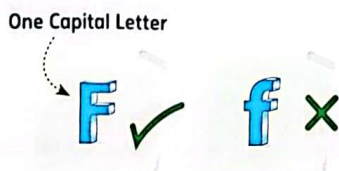
Rules for Selecting and Writing Element Symbols :

① The element symbol represents a single atom of it.

② Elements whose names in English are the same as their Latin names may be symbolized by :

- The first letter of the name, written Capital (upper-case).

⚠ Take care:
Fluorine symbol



Element name in the language of

| Element symbol | Element name in the language of | |
|----------------|---------------------------------|-------------|
| | English | Latin |
| C | Carbon | Carbo |
| N | Nitrogen | Nitrogenium |
| Cl | Chlorine | Chlorum |
| Cr | Chromium | Chromium |

- Two letters , from the name :
 - The first is Capital (upper-case).
 - The second is Small (lower-case).

⚠ Take care:
Calcium symbol



③ Elements whose English names are not the same as their Latin names are symbolized according to the letters of their Latin names, following the same previous rules.

Element name in the language of

| Element symbol | Element name in the language of | |
|----------------|---------------------------------|---------|
| | English | Latin |
| Na | Sodium | Natrium |
| K | Potassium | Kalium |
| Cu | Copper | Cuprum |
| Fe | Iron | Ferrum |



Examples of Symbols of Some Famous Elements

| Element | Symbol | Element | Symbol | Element | Symbol |
|------------|--------|-----------|--------|----------|--------|
| Hydrogen | H | Potassium | K | Iodine | I |
| Helium | He | Magnesium | Mg | Carbon | C |
| Mercury | Hg | Lithium | Li | Calcium | Ca |
| Oxygen | O | Zinc | Zn | Chlorine | Cl |
| Fluorine | F | Nitrogen | N | Copper | Cu |
| Iron | Fe | Neon | Ne | Chromium | Cr |
| Phosphorus | P | Sodium | Na | Argon | Ar |
| Lead | Pb | Boron | B | Aluminum | Al |
| Sulphur | S | Beryllium | Be | Gold | Au |
| Silicon | Si | Bromine | Br | Silver | Ag |

Life Application

The Fertilizers

Chemical compounds that are used to improve the agricultural production.



Fertilizer NPK

The most important types of fertilizers is : **NPK Fertilizer**

Composed of three compounds containing the elements :

Nitrogen (N), Phosphorus (P) and Potassium (K).

N 

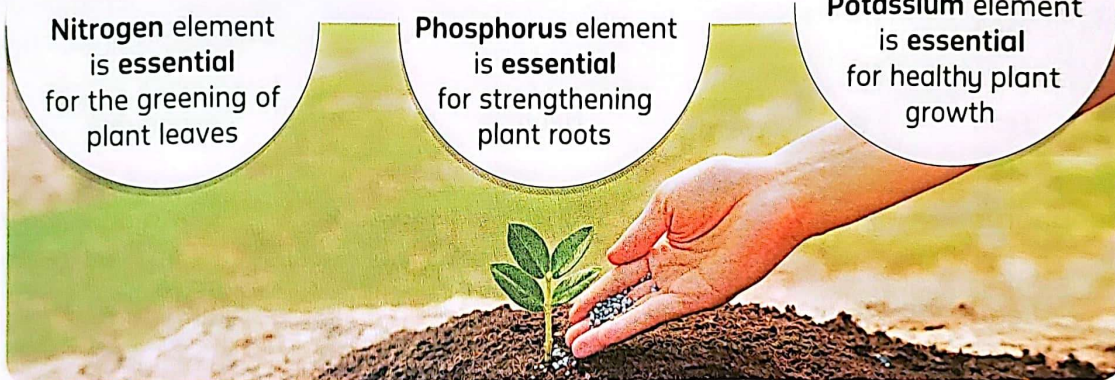
Nitrogen element is essential for the greening of plant leaves

P 

Phosphorus element is essential for strengthening plant roots

K 

Potassium element is essential for healthy plant growth

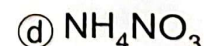
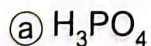


Note

Excessive use of fertilizers is harmful to the plants, the soil, human health, animals health and the environment in general.

Question ? Answer

Q Which of these substances contains the three essential elements for plant growth ?



A \therefore Nitrogen (N), phosphorus (P) and potassium (K) are essential for plant growth.

\therefore The correct choice is : c

Test ? Your Understanding 1

Choose the correct answer :

- (1) The building and structure unit of any matter is
- (a) the brick. (b) the molecule. (c) the atom. (d) the cell.
- (2) The scientist who proposed the first scientific theory about the atom is
- (a) Rutherford. (b) Dalton. (c) Thomson. (d) Mendeleev.
- (3) The subatomic particles that compose the nucleus of a neon atom are
- (a) protons and electrons. (b) neutrons and electrons.
(c) protons and neutrons. (d) protons, neutrons and electrons.
- (4) Which of the following represents the properties of a proton?

| Choices | Mass | Relative charge |
|---------|-----------------------------|-----------------|
| (a) | $\frac{5}{10000} \text{ u}$ | +1 |
| (b) | $\frac{5}{10000} \text{ u}$ | -1 |
| (c) | 1 u | -1 |
| (d) | 1 u | +1 |

- (5) Which of the following represents one of the elements and its correct symbol ?
- (a) Sodium S (b) Iron Fe (c) Neon N (d) Chlorine Ch

- (6) From the opposite table :

The three elements which are essential for plant growth are found in the two compounds

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

| The compound | The chemical formula |
|--------------|------------------------------|
| (1) | FeSO_4 |
| (2) | $(\text{NH}_4)_3\text{PO}_4$ |
| (3) | KNO_3 |
| (4) | NaCl |

Energy Levels

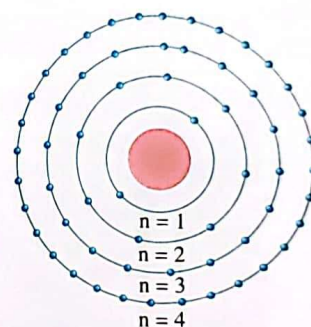
* Electrons revolve - each according to its energy - around the nucleus in 7 main energy levels, the number of each of them is referred to by the symbol (n).

| | | | | |
|-------------------------|---|---|---|---|
| Energy level number (n) | 1 | 2 | 3 | 4 |
| Energy level symbol | K | L | M | N |

The opposite table shows the symbols for the first four energy levels.

- * Each main energy level consists of a number of energy sublevels, in which the electrons revolve in different shapes.
- * Each of the first four energy levels can be saturated with a definite number of electrons, determined by the mathematical relation $(2n^2)$, where (n) represents the number of the main energy level.

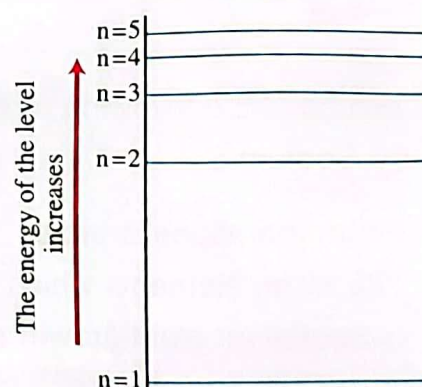
| Energy level | Number of energy level (n) | Number of electrons which saturate the energy level |
|--------------|----------------------------|---|
| K | 1 | $2 \times (1)^2 = 2 \times 1 = 2e^-$ |
| L | 2 | $2 \times (2)^2 = 2 \times 4 = 8e^-$ |
| M | 3 | $2 \times (3)^2 = 2 \times 9 = 18e^-$ |
| N | 4 | $2 \times (4)^2 = 2 \times 16 = 32e^-$ |



The number of electrons required to saturate the first four energy levels

Note :

- 1 The energy of an electron increases as the energy level that revolved in moves farther from the nucleus, as the electron's energy equals the energy of the level it revolves in.
- 2 The energy difference between each level and the next one decreases as the distance from the nucleus increases. For example, the energy difference between level L (n = 2) and level M (n = 3) is less than that between level K (n = 1) and level L (n = 2).



The energy of some levels around the nucleus in which the electrons revolve

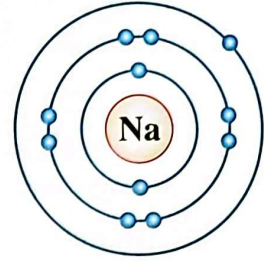
Question ? Answer

Q Which is greater: The difference in energy between the levels L and M or that between the levels M and N ?

A ∴ The energy difference between each level and the next one decreases as the distance from the nucleus increases.
 ∴ Therefore, the energy difference between the levels L and M is greater than that between the levels M and N

Rules for Electron configuration in Energy Levels :

- 1 The first energy level is filled with electrons first, followed by the higher energy levels successively according to the number of the electrons in each element's atom.
- 2 The last (outermost) energy level in any atom does not contain more than 8 electrons, whatever its number is, except the first energy level (K) cannot contain more than 2 electrons only.



And this is the explanation

of the electron configuration in the different energy Levels :

The level (K) is filled with one or two electrons

1 2

After filling the first level (K) with 2 electrons, the next step is to fill the second energy level (L) with electrons

The level (L) is filled with one electron and up to 8 electrons

2,1 2,2 2,3 2,4 2,5 2,6 2,7 2,8

After The level (L) is filled with up to 8 electrons. the next step is to fill the third energy level (M) with electrons

Filling the level (M) with one electron and up to 8 electrons, based on the number of electrons in the atom of each element

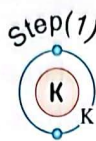
2,8,1 2,8,2 2,8,3 2,8,4 2,8,5 2,8,6 2,8,7 2,8,8

Application Electron configuration in potassium atom (K)

19 electrons revolve around the nucleus of a potassium atom, distributed as follows:

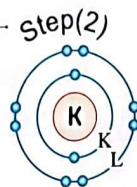
Step 1

The first level (K) is filled with 2 electrons, the remaining is $19 - 2 = 17e^-$



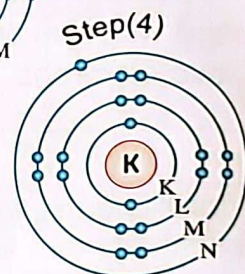
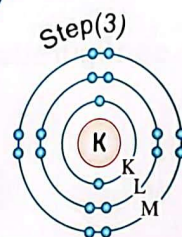
Step 2

The second level (L) is filled with 8 electrons, the remaining is $17 - 8 = 9e^-$



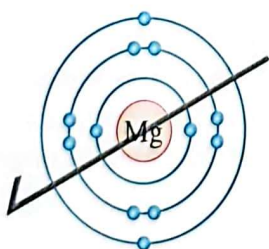
Steps 3, 4

Although the third level (M) can hold 18 electrons, the last energy level in any atom cannot hold more than 8 electrons. Thus, 8 electrons are distributed in the third level, and the remaining electron in the fourth level.

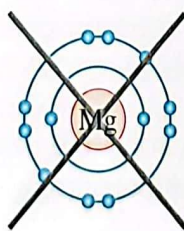


Take care:

The electron configuration of a magnesium atom (Mg), which has 12 electrons revolving around its atom nucleus is :

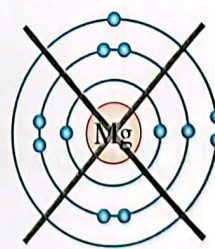


Correct



Wrong

As the outermost energy level of any atom cannot hold more than 8 electrons



Wrong

Because the lower energy level (L) must be filled first with 8 electrons, and then the higher energy level (M) is filled

The Relationship Between the Numbers of Subatomic Particles

The following table shows the numbers of subatomic particles in the atoms of several elements:

| Element | Hydrogen | Helium | Lithium | Beryllium | Boron | Carbon |
|---------------------------|----------|--------|---------|-----------|-------|--------|
| | H | He | Li | Be | B | C |
| Number of protons p | 1 | 2 | 3 | 4 | 5 | 6 |
| Number of neutrons n | 0 | 2 | 4 | 5 | 6 | 6 |
| Number of electrons e^- | 1 | 2 | 3 | 4 | 5 | 6 |
| Total number of $n + p$ | 1 | 4 | 7 | 9 | 11 | 12 |

Observations from the previous table :

- ① The number of positive protons p \equiv The number of negative electrons e^-
 "In any element's atom"

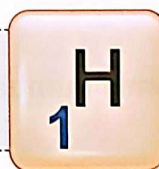
Therefore, the atom is electrically neutral.

- ② The number of protons is called the atomic number and is symbolized by the symbol Z

The atomic number Z

Is the number of the positive protons found inside the nucleus in the element atom.

It is written at the lower left side of the element symbol



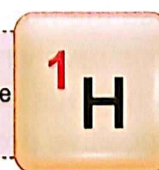
- ③ Neutrons number \equiv Protons number ④ Neutrons number $>$ Protons number
 inside the nuclei of the atoms of some elements such as He, C atoms inside the nuclei of the atoms of some elements such as B, Be and Li atoms

- ⑤ The sum of number of protons and neutrons inside the nucleus of any element atom is called **the number of the nucleons** or **the mass number**, symbolized by the symbol A

The mass number A

The sum of number of the protons and the neutrons found inside the nucleus in the element atom.

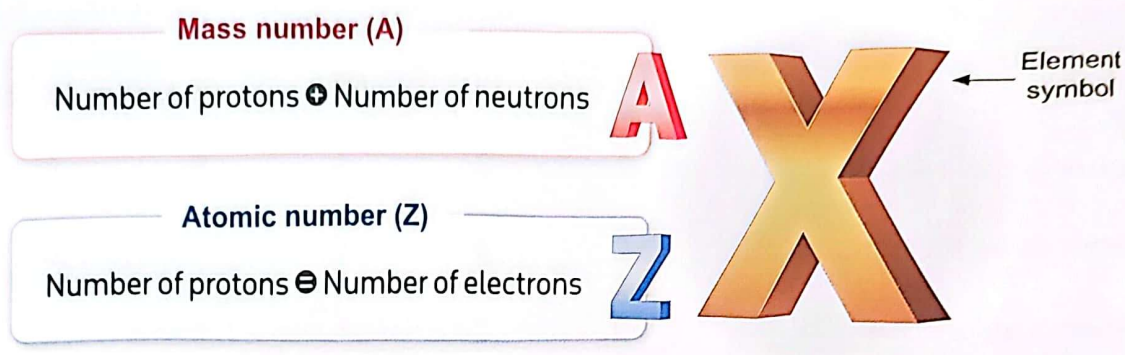
It is written at the upper left side of the element symbol



⑥ The difference between the mass number A and the atomic number Z equals the number of neutrons.

• Number of neutrons \ominus Mass number A \ominus Atomic number Z

* In general, the element symbol is represented as follows :



Evaluate Your Understanding

The nucleus of a chlorine atom contains 17 protons and 18 neutrons.

Write the symbol of the chlorine atom in the opposite box, including the numbers Z , A

What is the meaning of ?

► The atomic number of chlorine equals 17

► The mass number of chlorine equals 35

It means that

The number of the positive protons inside the nucleus of the chlorine atom equals 17

The sum of number of the protons and neutrons (the nucleons) inside the nucleus of the chlorine atom equals 35

G.R.?

(1) The atom is electrically neutral in its normal state.

Because the number of the negative electrons revolving around the atom's nucleus equals the number of the positive protons found inside the atom's nucleus.

(2) The mass number is usually greater than the atomic number.

Because the mass number equals the sum of number of protons and neutrons found inside the atom's nucleus, while the atomic number equals the number of the protons only.

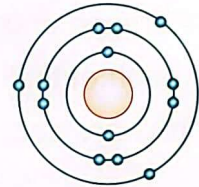
How to Determine the Atomic Number of an Element by Knowing Its Electron configuration

The atomic number of an element \ominus The total number of electrons revolving in its atom's energy levels.

Application

Calculation of the atomic number of an element's electrons revolve in 3 energy levels, and its outermost energy level contains 3 electrons.

- \therefore The electrons of this element atom revolves in 3 energy levels.
- \therefore The first energy level is filled with $2e^-$,
the second energy level is filled with $8e^-$
- \therefore The outermost energy level contains 3 electrons.
- \therefore The atomic number of the element equals $= 2 + 8 + 3 = 13$



Question ? Answer

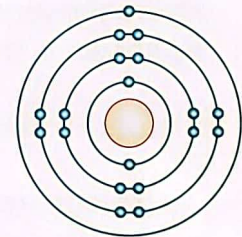
Q A certain element's atom contains 39 nucleons, and its electrons revolve in 4 energy levels, the outermost energy level contains one electron,

Calculate :

- (1) The atomic number.
- (2) The number of the neutrons in the atom's nucleus.

A (1) The atomic number of the element =
The sum of number of electrons revolving in its atom's energy levels
 $= 2 + 8 + 8 + 1 = 19$

- (2) The number of neutrons = Number of nucleons – Atomic number
 $= 39 - 19 = 20$ neutrons.



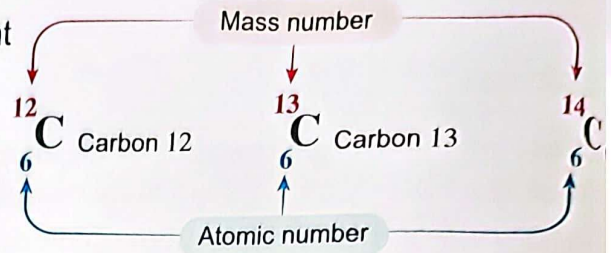
Evaluate Your Understanding

Complete the following table :

| Element symbol | Mass number | Atomic number \ominus | Number of protons \ominus | Number of electrons \ominus | Number of neutrons (Mass number \ominus Atomic number) |
|-------------------------|-------------|-------------------------|-----------------------------|-------------------------------|--|
| ${}^{12}_6\text{C}$ | | 6 | ..... | ..... | ..... |
| ${}^{23}_{11}\text{Na}$ | | | | 11 | $12 = \text{.....} - \text{.....}$ |
| ${}^{40}_{20}\text{Ca}$ | | | 20 | ..... | ..... |

Isotopes

The scientists noticed that atoms of the same element could have different forms that have **the same atomic number** due to having the same number of protons in their nuclei but **differ in mass number** due to the difference of the number of neutrons in each of their nuclei. These different forms are described as isotopes.



Isotopes :

Are different forms of the same element's atoms that have the same *atomic number* but differ in mass number.

Application 1 Isotopes of Hydrogen

Hydrogen element, the simplest element in nature, has three isotopes, as shown in the following table :

| Isotope symbol | ${}^1_1\text{H}$ | ${}^2_1\text{H}$ | ${}^3_1\text{H}$ |
|--------------------------------------|------------------|------------------|------------------|
| Isotope name | Protium | Deuterium | Tritium |
| Components of isotope atom | | | |
| Atomic number (Z) | 1 | 1 | 1 |
| Mass number (A) (Nucleons number) | 1 | 2 | 3 |
| Protons number (p) | 1 | 1 | 1 |
| Neutrons number (n) | $1 - 1 = 0$ | $2 - 1 = 1$ | $3 - 1 = 2$ |

Observations from the previous table :

- The atomic number of protium atom equals its mass number.
- **The number of neutrons :**
 - Equals the number of protons in the nucleus of deuterium atom.
 - Is twice the number of protons in the nucleus of tritium atom.

What is the result of ?

Protium nucleus does not contain neutrons.

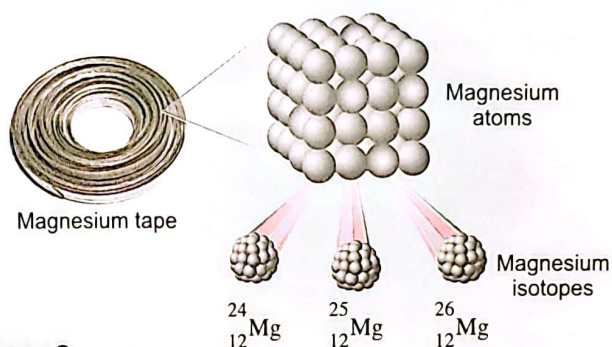
The atomic number of protium atom equals its mass number.

Application 2 Isotopes of Magnesium Mg

Magnesium Mg has 3 isotopes :

- Magnesium – 24 , It's symbol ${}^{24}_{12}\text{Mg}$
- Magnesium – 25 , It's symbol ${}^{25}_{12}\text{Mg}$
- Magnesium – 26 , It's symbol ${}^{26}_{12}\text{Mg}$

How many nucleons are found in the nucleus of each magnesium atom isotope?



Question ? Answer

Q The following table shows the number of protons and neutrons in the nuclei of some elements :

| Element atom | (1) | (2) | (3) | (4) | (5) |
|----------------------|-----|-----|-----|-----|-----|
| Number of protons p | 20 | 16 | 16 | 7 | 8 |
| Number of neutrons n | 20 | 20 | 18 | 8 | 9 |

Which two atoms are isotopes of the same element ?

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

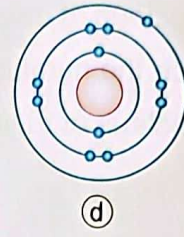
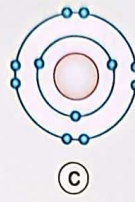
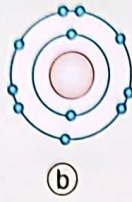
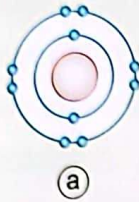
A ∴ The isotopes of the same element have the same atomic number (number of protons).

∴ The correct choice is : (c)

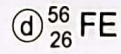
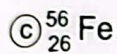
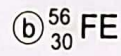
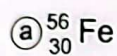
Test ? Your Understanding 2

Choose the correct answer :

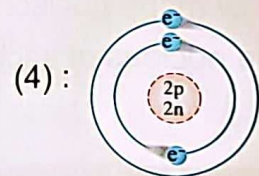
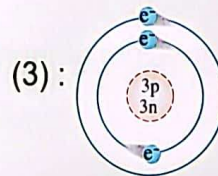
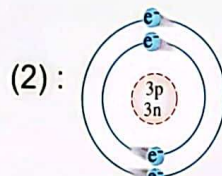
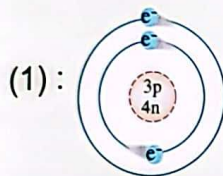
(1) Which of the following represents the electron configuration of sodium atom ${}_{11}\text{Na}$?



(2) What is the chemical symbol of iron, knowing that its nucleus contains 26 protons and 30 neutrons ?



(3) Which two atoms are isotopes of the same element ?



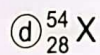
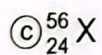
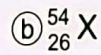
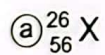
(a) (1), (2).

(b) (1), (3).

(c) (2), (3).

(d) (2), (4).

(4) Which of the following represents the symbol of an isotope of element ${}_{26}^{56}\text{X}$?



(5) An element atom its electrons are distributed in three energy levels, the outermost energy level contains 3 electrons, and it's nucleus contains 14 neutrons.

What are the values of (Z), (A) of this element ?

(a) (Z) = 14, (A) = 27

(b) (Z) = 13, (A) = 27

(c) (Z) = 18, (A) = 14

(d) (Z) = 3, (A) = 17

Questions ?

UNIT 1

Lesson 1

First

School Book Questions

Answered

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

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

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

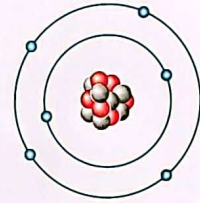
(2) Which of the following subatomic components has a mass of 1 u ?

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

(3) The opposite figure shows the structure of the atom (X).

What is the symbol that represents this atom ?

- (a) ${}^{13}_7\text{X}$ (b) ${}^{13}_6\text{X}$
(c) ${}^6_7\text{X}$ (d) ${}^7_6\text{X}$



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

- (a) ${}^1_1\text{H}$ (b) ${}^3_1\text{H}$ (c) ${}^4_2\text{He}$ (d) ${}^7_2\text{He}$

(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 :

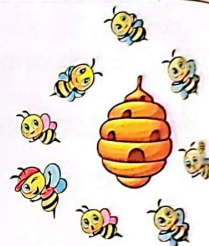
- (1) What is the number of negatively charged particles in this atom ?
 (2) Write the symbol of this element, including the numbers of Z and A

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 ?



Second

Questions Bank of EL-MOASSER

Answered

1 Write the scientific term of each of the following statements :

From building units to chemical symbols of elements

- (1) Anything that has mass and volume, and occupies space. (5)
 (2) The building and structure unit of any matter.
 (3) The first scientific theory about the atom. (6)
 (4) The first model of the atom based on experimental basis.
 (5) A New Zealand physicist who won the Nobel Prize in Chemistry in 1908
 (6) Positively charged particles found inside the nucleus of the atom.
 (7) A subatomic particle whose charge can be neglected, but its mass cannot be neglected.
 (8) Negatively charged particles in the atom with very tiny mass, revolving around the nucleus. (7)
 (9) A subatomic particle whose mass equals $\frac{1}{1836} u$
 (10) Chemical compounds that are used to improve agricultural production.

From energy levels to isotopes

- (11) Regions where electrons revolve around the nucleus according to their energy. (8)
 (12) A number written at the lower left side of an element's symbol, representing the number of the positive protons found inside the nucleus of the element.
 (13) The sum of the number of protons and neutrons that compose the nucleus atom.
 (14) Different forms of the same element's atoms that have the same atomic number but differ in mass numbers.

2 Choose the correct answer :

— From building units to chemical symbols of elements

- (1) Each of the following is matter, except
- (a) air. (b) light. (c) sand. (d) table salt.
- (2) Which of the following is a characteristic of the nucleus of an atom ?
- (a) Positively charged. (b) Negatively charged.
- (c) Contains negatively charged electrons.
- (d) Contains negatively charged protons.
- (3) The mass of a proton equals
- (a) 1 g (b) 1 kg (c) 1 u (d) 1 mg
- (4) Which of the following choices expresses the relative charges of the components of the atom?

| Choices | Proton | Electron | Neutron |
|---------|--------|----------|---------|
| (a) | -1 | +1 | 0 |
| (b) | 0 | -1 | +1 |
| (c) | +1 | -1 | 0 |
| (d) | +1 | 0 | -1 |

- (5) The mass of the atom is approximately equal to the sum of masses of
- (a) the electrons and the protons. (b) the protons and the nucleons.
- (c) the neutrons and the electrons. (d) the protons and the neutrons.
- (6) On comparing the charge of protons to the charge of electrons in an atom of any element, the charge of the protons is
- (a) Greater than the charge of the electrons and of the same type.
- (b) Greater than the charge of the electrons and of an opposite type.
- (c) Equal to the charge of the electrons in magnitude and of the same type.
- (d) Equal to the charge of the electrons in magnitude and of an opposite type.
- (7) Which of the following groups of elements has chemical symbols starting with the letter A?
- (a) Aluminum, Silver and Lithium. (b) Gold, Mercury and Silver.
- (c) Gold, Aluminum and Sodium. (d) Aluminum, Silver and Gold.

- (8) The apposite table lists two elements :
What are the symbols of the first and the second elements respectively ?

- (a) C , C (b) C , Co
- (c) Ca , Co (d) C , Cu

| Element name in language | | |
|--------------------------|---------|--------|
| | English | Latin |
| First element | Carbon | Carbo |
| Second element | Copper | Cuprum |



- (9) Which of the following represents an element and its correct symbol ?
(a) Potassium P (b) Phosphorus F (c) Nitrogen Ni (d) Chromium Cr
- (10) What are the elements which compose glucose $C_6H_{12}O_6$?
(a) Carbon, Helium and Water. (b) Carbon, Hydrogen and Oxygen.
(c) Calcium, Hydrogen and Oxygen. (d) Copper, Hydrogen and Oxygen.
- (11) Which two compounds do contain the three essential elements required for plant growth ?
(a) $(NH_4)_2SO_4$, $Ca(NO_3)_2$ (b) $(NH_4)_3PO_4$, $Ca(NO_3)_2$
(c) $(NH_4)_2SO_4$, KNO_3 (d) $(NH_4)_3PO_4$, KNO_3
- (12) A fertilizer package contains the two compounds $(NH_4)_2SO_4$ and K_2SO_4 . What are the elements essential for plant growth in this package?
(a) Nitrogen and Hydrogen. (b) Sulphur and Oxygen.
(c) Potassium and Nitrogen. (d) Potassium and Sulphur.

From energy levels to isotopes

- (13) The number of electrons that can saturate each energy level in an atom equals
(a) three times the energy level number.
(b) twice the square of the energy level number.
(c) twice the energy level number.
(d) twice the cube of the energy level number.
- (14) In the relation $(2n^2)$, the symbol (n) refers to
(a) energy level number. (b) number of electrons.
(c) number of protons. (d) element's symbol.
- (15) In the atom of ${}^{24}_{12}Mg$ has
(a) an atomic number equal to its mass number.
(b) a mass number equal to its number of neutrons.
(c) a number of protons equal to its number of neutrons.
(d) a number of energy levels equal to its number of electrons.
- (16) The number of negatively charged particles in aluminum atom ${}^{27}_{13}Al$ is
(a) 13 (b) 14 (c) 20 (d) 27
- (17) The energy level L in silicon atom ${}_{14}Si$ contains
(a) $2e^-$ (b) $3e^-$ (c) $8e^-$ (d) $18e^-$
- (18) Which figure represents the outermost energy level of sulphur atom ${}^{32}_{16}S$?



(19) The last energy level contains 7 electrons in the atom of

- (a) ${}_{7}\text{N}$ (b) ${}_{9}\text{F}$ (c) ${}_{11}\text{Na}$ (d) ${}_{15}\text{P}$

(20) Which of the following choices expresses the number of components in the nucleus of the atom of ${}_{26}^{56}\text{Fe}$?

| Choices | Neutron | Nucleon | Proton |
|---------|---------|---------|--------|
| (a) | 56 | 30 | 30 |
| (b) | 56 | 26 | 26 |
| (c) | 26 | 56 | 30 |
| (d) | 30 | 56 | 26 |

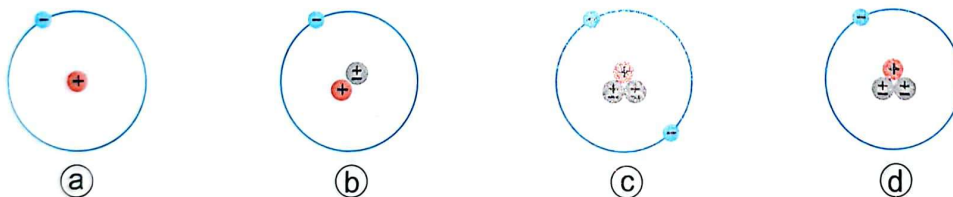
(21) What is the symbol of element (X) whose atom contains 18 protons, 18 electrons and 22 neutrons ?

- (a) ${}_{18}^{36}\text{X}$ (b) ${}_{22}^{36}\text{X}$ (c) ${}_{18}^{40}\text{X}$ (d) ${}_{22}^{40}\text{X}$

(22) The isotopes of the same element have all the following in common, except

- (a) the atomic number. (b) number of protons.
 (c) number of neutrons. (d) number of electrons.

(23) Which of the following figures represents the structure of a tritium atom ?



(24) Which of the following is an isotope for the element ${}_{8}^{16}\text{O}$?

- (a) Oxygen – 8 (b) Oxygen – 18 (c) Sulphur – 16 (d) Sulphur – 18

(25) From the following hypothetical element symbols :

- (1) : ${}_{17}^{35}\text{X}$ (2) : ${}_{17}^{37}\text{X}$ (3) : ${}_{18}^{38}\text{X}$ (4) : ${}_{35}^{81}\text{X}$ (5) : ${}_{37}^{81}\text{X}$

Which two symbols represent isotopes of the same element ?

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

(26) Three atoms with the symbols : ${}_{19}^{40}\text{X}$, ${}_{19}^{39}\text{X}$, ${}_{20}^{40}\text{X}$

Which of the following is correct ?

- (a) ${}_{19}^{40}\text{X}$, ${}_{19}^{39}\text{X}$ are isotopes of the same element.
 (b) ${}_{19}^{40}\text{X}$, ${}_{20}^{40}\text{X}$ are isotopes of the same element.
 (c) The number of protons in the nucleus of ${}_{19}^{40}\text{X}$ atom is greater than that in the nucleus of ${}_{19}^{39}\text{X}$ atom.
 (d) The number of neutrons in the nucleus of ${}_{20}^{40}\text{X}$ atom is greater than that in the nucleus of ${}_{19}^{39}\text{X}$ atom.



- (27) The atomic number of an element equals the mass number when the atom does not contain
- (a) electrons. (b) protons. (c) neutral particles. (d) positive particles.
- (28) What is the number of nucleons in the nucleus of the element ${}^{235}_{92}\text{U}$ atom ?
- (a) 92 (b) 143 (c) 235 (d) 327
- (29) Which of the following is correct about the two atoms ${}^{52}_{23}\text{X}$, ${}^{52}_{24}\text{Y}$?
- (a) They are two different elements due to the difference in the number of neutrons.
 (b) They are two different elements due to the difference in the number of protons.
 (c) They are isotopes of the same element because the number of nucleons is the same.
 (d) They are isotopes of the same element because the number of protons is the same.

(30) The following figures represent the nuclei of some element's atoms :



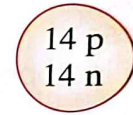
(1)



(2)



(3)



(4)

Which two figures represent the nuclei of atoms of the same element ?

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

(31) From the opposite table :

Which of the following atoms are isotopes of the same element ?

- (a) (W) and (X) only.
 (b) (W) and (Y) only.
 (c) (W) and (Z) only.
 (d) (W) and (X) and (Y) only.

| Atom | Number of electrons | Number of protons | Number of neutrons |
|------|---------------------|-------------------|--------------------|
| (W) | 19 | 19 | 20 |
| (X) | 19 | 20 | 20 |
| (Y) | 20 | 20 | 20 |
| (Z) | 19 | 19 | 22 |

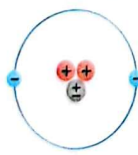
(32) Among the isotopes of carbon are : Carbon-12 and Carbon-14

Which of the following is correct ?

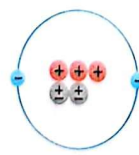
- (a) The two isotopes have the same number of neutrons.
 (b) The two isotopes differ in the number of nucleons.
 (c) The two isotopes have the same mass number.
 (d) The two isotopes differ in the number of protons.

(33) The opposite figure shows the structure of an element's atom.

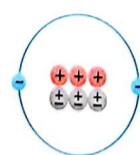
Which of the following figures represents the structure of an isotope of this element ?



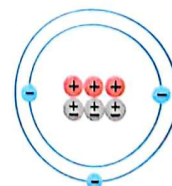
(a)



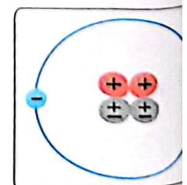
(b)



(c)



(d)



3 Choose from column (B) what suits it in column (A) :

| (A) | (B) |
|-----------------------|--|
| (1) Potassium | (1) An element whose nucleus of its isotope does not contain neutrons. |
| (2) NPK | (2) A substance from which limestone is made. |
| (3) Calcium carbonate | (3) An element essential for strengthening plant roots. |
| (4) Phosphorus | (4) A substance used to improve agricultural production. |
| | (5) An element essential for healthy plant growth. |

4 Complete the following sentences :

From building units to chemical symbols of elements

- (1) Limestone is composed of molecules, which in turn are made of smaller units called
- (2) The atom is the and unit of any matter.
- (3) The scientist proposed the first scientific theory about the atom, while the scientist proposed the first model of the atom based on experimental basis.
- (4) Electrons revolve around the at very high speeds in regions known as
- (5) Protons are charged particles, while electrons are charged particles.
- (6) Neutrons are charged particles found inside the of the atom.
- (7) The chemical symbol of phosphorus is , while the chemical symbol of fluorine is
- (8) The chemical symbol of element is Cu, while the chemical symbol of element is Fe
- (9) The element is essential for the greening of plant leaves, while the element is essential for strengthening its roots.

From energy levels to isotopes

- (10) In any atom, the energy level M precedes directly the energy level and follows directly the energy level
- (11) The energy of a level decreases as it to the nucleus, hence the energy of the level is less than the energy of the energy level (L).
- (12) The energy level (L) is saturated with electrons, while the energy level (N) is saturated with electrons.
- (13) The atom is charged in its normal state, while the nucleus is charged.
- (14) The atom does not have neutrons when the equals the



5 Complete the following sentences using the given words (or phrases) :

Greater than , Equal to , Less than , Greater than or equal to

«the same word or phrase can be used more than once»

- (1) The mass of the proton is the mass of the neutron.
- (2) The mass of the electron is the mass of the atom's nucleus.
- (3) The energy of the electron in the energy level N is the energy of the electron in the energy level M
- (4) The difference in energy between the energy levels M and N is the difference in energy between the energy levels K and L
- (5) In the nuclei of elements, the number of neutrons is the number of protons

6 Complete the following tables :

| ① Element atom | Atomic number | Mass number | Number of neutral particles | Number of positively charged particles | Number of negatively charged particles |
|--------------------------------------|---------------|-------------|-----------------------------|--|--|
| (1) Nitrogen ${}^{14}_7\text{N}$ | ..... | 14 | ..... | 7 | ..... |
| (2) Chlorine ${}^{35}_{17}\text{Cl}$ | 17 | ..... | 18 | ..... | ..... |

| ② Element atom | Chemical symbol | Atomic number | Number of nucleons | Number of neutrons | Number of protons | Electron configuration | | |
|----------------|-------------------------|---------------|--------------------|--------------------|-------------------|------------------------|-------|-------|
| | | | | | | K | L | M |
| (1) | ${}^2_2\text{He}$ | ..... | 4 | ..... | 2 | ..... | - | - |
| (2) Aluminum | ..... | ..... | 27 | ..... | ..... | ..... | ..... | 3 |
| (3) | ${}^{40}_{20}\text{Ca}$ | ..... | ..... | 20 | ..... | ..... | ..... | ..... |

7 Correct the underlined words :

From building units to chemical symbols of elements

- (1) The Sphinx statue is made of sandstone.
- (2) Matter is composed of atoms, which in turn are composed of smaller units called molecules.
- (3) The Greek philosophers believed that matter was made of indivisible parts called molecules.
- (4) The masses of subatomic particles are measured in milliliters.
- (5) The proton is the subatomic particle which has the smallest mass.
- (6) The chemical symbol of magnesium is MG

— From energy levels to isotopes

- (7) The nucleus of the element ${}_{13}^{27}\text{X}$ contains 13 **neutrally** charged particles and ,
14 **negatively** charged particles.
- (8) The nucleus of **tritium** atom contains one proton and one neutron.
- (9) Chlorine -37 differs from chlorine -35 in having a greater number of **protons**.

8 Mark (✓) or (X) for each statement with correction :

— From building units to chemical symbols of elements

- (1) Calcium carbonate is the building unit of the Sphinx statue. ()
- (2) Rutherford proposed the first scientific theory about the atom, explaining its indivisibility. ()
- (3) The charge of the proton is similar to the charge of the electron in magnitude and type. ()
- (4) Elements whose English name differs from their Latin name are symbolized by the letters of their English names. ()
- (5) NPK fertilizer contains nitrogen, potassium and calcium elements. ()

— From energy levels to isotopes

- (6) Electrons revolve inside the nucleus in energy levels. ()
- (7) Each main energy level is composed of a number of energy sublevels in which the electrons revolve in the same shape. ()
- (8) The energy of the level increases as it gets closer to the nucleus. ()
- (9) The third energy level in the atom is located between levels K and M and can be saturated by 8 electrons. ()
- (10) The higher energy levels are filled with electrons first. ()
- (11) The elements ${}_{11}\text{Na}$ and ${}_{13}\text{Al}$ have the same number of electrons in the energy level (L). ()
- (12) The atomic number is written at the upper left side of the element's symbol. ()
- (13) The atom containing 13 protons, 14 neutrons and 13 electrons is electrically neutral. ()
- (14) The number of neutrons is twice the number of protons in the nucleus of tritium isotope. ()
- (15) Magnesium-24 and magnesium-25 isotopes have the same number of protons. ()

9 State the number which indicates each of the following :

- (1) Neutron mass. (2) Electron mass. (3) The number of energy levels in an atom.
- (4) The number of electrons that can fill the energy level M
- (5) The number of electrons in the outermost energy level of nitrogen atom ${}_{7}\text{N}$
- (6) The number of occupied energy levels in the atom of an element which has 5 protons in its nucleus.
- (7) The smallest atomic number of an element whose electrons revolve in three energy levels in its normal state.

10 What is meant by each of the following :

- (1) Matter. (2) Atom. (3) Fertilizers.
- (4) Atomic number. (5) Mass number. (6) Isotopes.



11 What is the meaning of :

- (1) The atomic number of aluminum = 13
- (2) The number of positively charged particles in the nucleus of an element atom =
- (3) The number of protons in the nucleus of an element atom = 7
- (4) The mass number of calcium = 40
- (5) The number of nucleons in the nucleus of an element atom = 23

12 State one importance for each of the following :

- | | |
|-----------------------------------|-------------------------|
| (1) Chemical symbols of elements. | (2) Fertilizers. |
| (3) Nitrogen element. | (4) Phosphorus element. |
| (5) Potassium element. | |

13 Give reasons for each of the following :

— From building units to chemical symbols of elements

- (1) The nucleus of the atom is described as positively charged.
- (2) The mass of the atom is concentrated in the nucleus.
- (3) The symbol of potassium is K not P as expected.
- (4) NPK is one of the most important types of agricultural fertilizers.
- (5) It is advised not to excessively use of agricultural fertilizers.

— From energy levels to isotopes

- (6) The energy of the electron differs in the different energy levels.
- (7) The energy level L is filled with electrons before the energy level M
- (8) The third energy level is saturated with $18 e^-$
- (9) Carbon atom is electrically neutral in its normal state.
- (10) The mass number is usually greater than the atomic number.
- (11) The atoms of the isotopes of the same element have the same atomic number but different mass number.
- (12) The number of neutrons in the nucleus of an isotope atom cannot be determined by knowing its mass number only.
- (13) The atomic number equals the mass number for protium.
- (14) Protium, deuterium and tritium are isotopes of the same element.

14 What are the results of the following :

- (1) Excessive use of fertilizers.
- (2) The absence of neutrons in the nucleus of a protium atom.

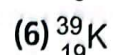
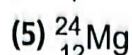
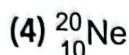
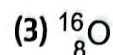
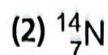
15 Choose the odd word (or symbol) out, and mention the relation between the rest :

- | | |
|---|---|
| (1) Protons / Neutrons / Electrons / Quantum. | (2) K / B / L / M |
| (3) ${}_{11}^{23}\text{Na}$ / ${}_{14}^{28}\text{Si}$ / ${}_{17}^{35}\text{Cl}$ / ${}_{20}^{40}\text{Ca}$ | (4) ${}_3\text{Li}$ / ${}_{11}\text{Na}$ / ${}_{12}\text{Mg}$ / ${}_{19}\text{K}$ |
| (5) Protium / Thorium / Deuterium / Tritium. | |

16 Illustrate with diagrams the electron configuration of the following atoms, with identifying :

• Number of protons.

• Number of neutrons.



17 Compare between each of the following :

— From building units to chemical symbols of elements

(1) Electron and proton “In terms of: Relative electric charge - Position in the atom - Mass”.

(2) Phosphorus and Potassium “In terms of : Chemical symbol - Importance”.

— From energy levels to isotopes

(3) Energy level (L) and energy level (M) “In terms of: Energy level number - Number of electrons it can saturated with”.

(4) Atom of ${}^{27}_{13}\text{X}$ and atom of ${}^{32}_{16}\text{Y}$ “In terms of : Number of protons - Number of electrons - Number of neutrons - Atomic number - Number of nucleons - Electron configuration”.

(5) ${}^1_1\text{H}$, ${}^2_1\text{H}$ and ${}^3_1\text{H}$ “In terms of: Isotope name - Atomic number - Number of neutrons”.

(6) Isotope ${}^{14}_6\text{C}$ and isotope ${}^{18}_9\text{F}$ “In terms of: Atomic number - Number of nucleons”.

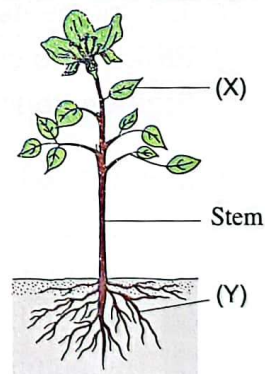
18 Study the following figures, then answer the questions :

① From the opposite figure,

Write the name and the chemical symbol of the element essential for :

(1) Greening the part (X).

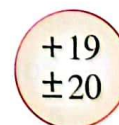
(2) Strengthening the part (Y).



② The opposite figure represents the structure of the nucleus of potassium atom :

(1) Write the chemical symbol of the element's atom, indicating the atomic number and the number of nucleons.

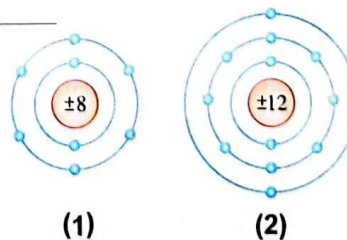
(2) State the importance of this element in agriculture.



③ Study the two opposite figures, then conclude :

(1) The atomic number of each atom.

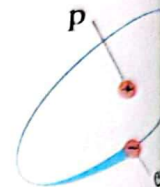
(2) The mass number of each atom.





4 The opposite figure represents the structure of one of the hydrogen isotopes :

- (1) What is the name of this isotope?
- (2) What is the number of nucleons in the nucleus of this isotope's atom?
What is their type?



19 Variant questions :

1 The following are the symbols of some energy levels around the nucleus (K , M , L ,
Arrange these levels:

- (1) Ascendingly according to the distance from the nucleus.
- (2) Descendingly according to the energy of the level.

2 The carbon atom contains 6 positively charged protons and 6 negatively charged electrons.

What can be concluded from the previous statement?

3 When does each of the following take place :

- (1) The mass number equals the atomic number.
- (2) The mass number is twice the atomic number.

4 Two elements (X) and (Y) their atomic numbers are 18 and 20 respectively.
Which one does have more electrons revolving in its outermost energy level ?
Explain your answer with the electron configuration of each atom.

5 Illustrate with diagrams the electron configuration of the atoms ${}_{10}^{20}\text{Ne}$, ${}_{11}^{23}\text{Na}$
then identify the following for each atom :

- (1) The number of neutrons.
- (2) The number of energy levels occupied with electrons.
- (3) The number of electrons in the outermost energy level.
- (4) The symbol of the outermost energy level.

6 Potassium atom is represented by the symbol ${}_{19}^{39}\text{K}$

According to the previous statement, mark (✓) or (x) next to the following statements:

- (1) The number of protons = The number of neutrons in the nucleus of potassium atom. ()
- (2) The number of protons in the nucleus of potassium atom = The number of electrons revolving around the nucleus. ()
- (3) The outermost energy level in potassium atom contains one electron. ()
- (4) The nucleus of potassium atom contains 20 neutral charge particles. ()

- 7 State the mathematical relationship used to calculate each of the following:
- (1) The mass number of the element.
 - (2) The number of neutrons in the nucleus of the element atom.
 - (3) The number of electrons that can be saturated with each of the first four energy levels.
-
- 8 If the number of nucleons and the atomic number of magnesium element are 24 and 12 respectively:
- (1) Find the number of neutrons in its atom nucleus.
 - (2) Write the chemical symbol of the element including the numbers A and Z
-
- 9 An atom of an element contains 40 nucleons in its nucleus, and its electrons revolve in 3 energy levels where the outermost energy level contains 8 electrons. Calculate :
- (1) The atomic number of the element.
 - (2) The number of neutrons in its nucleus.
-
- 10 State one similarity and one difference between the deuterium and tritium isotopes.
-
- 11 Fluorine-18 isotope is symbolized as ${}^{18}_9\text{F}$,
Find the number of each of the following in the nucleus of this isotope :
- (1) Number of protons.
 - (2) Number of neutrons.
-
- 12 Write the chemical symbols of the nuclei of the isotopes of the following elements:
- (1) Element X (Z = 8 , A = 18).
 - (2) Element Y (Z = 27 , N = 33).
 - (3) Element R (N = 48 , A = 84) .
-
- 13 An atom of one of the sodium isotopes contains 11 protons , 11 electrons and 13 neutrons :
- (1) Which of these numbers do not change in the atoms of other sodium isotopes?
 - (2) What is the number of nucleons in the nucleus of this isotope of sodium isotopes?
-
- 14 Astatine At has several isotopes, the most important of which is astatine -210 which has 85 electrons revolving around its nucleus :
- (1) What is the number of neutrons in the nucleus of this isotope?
 - (2) What is the atomic number of astatine?
 - (3) What does it mean that astatine has several isotopes?
 - (4) Write the symbol of this isotope, including the numbers A and Z



Higher-order Questions

Answered

20 Choose the correct answer:

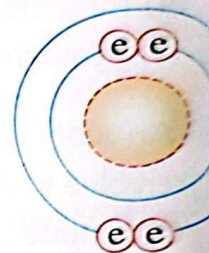
(1) An atom of an element whose electrons distributed in three energy levels, and the number of electrons in its outermost energy level is less than the number of electrons in the energy level (L) by 2, The atomic number of the element is

- (a) 8 (b) 18 (c) 16 (d) 13

(2) The opposite figure represents an atom of an element:

Which of the following expresses the number of positively charged particles and the number of neutrally charged particles, respectively, in this atom?

- (a) 4, 5 (b) 4, 3
(c) 5, 4 (d) 5, 9

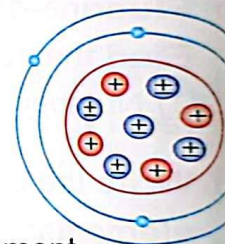


(3) An atom of an element contains 35 nucleons, if the number of neutral particles in its nucleus is 18, then the number of negatively charged particles revolving around the nucleus is

- (a) 17 (b) 18 (c) 27 (d) 35

(4) The opposite figure represents the structure of an atom of beryllium, which is symbolized by

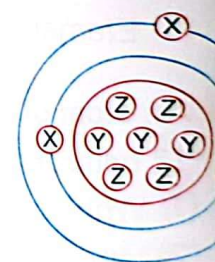
- (a) ${}^9_4\text{Be}$ (b) ${}^5_4\text{Be}$
(c) ${}^4_9\text{Be}$ (d) ${}^9_5\text{Be}$



(5) The opposite figure represents the structure of an atom of an element.

What particles are represented by the symbols (X), (Y) and (Z) respectively?

- (a) (X) : Protons , (Y) : Neutrons , (Z) : Electrons.
(b) (X) : Electrons , (Y) : Protons , (Z) : Neutrons.
(c) (X) : Neutrons , (Y) : Electrons , (Z) : Protons.
(d) (X) : Electrons , (Y) : Neutrons , (Z) : Protons.



(6) The mass of the proton is approximately equal to the mass of an atom of

- (a) protium. (b) deuterium. (c) oxygen -16 (d) oxygen -18

(7) The nucleus of radon -222 contains 136 neutrons.

What is the number of neutrons in the nucleus of the isotope radon -220 ?

- (a) 86 (b) 134 (c) 136 (d) 220

(8) Which of the following expresses the number of protons and neutrons, respectively, in the nucleus of iodine -131 ?

- (a) 131, 131 (b) 78, 53 (c) 53, 131 (d) 53, 78

21 Correct the underlined : The atom of the element whose nucleus contains 12 neutrons, and one electron revolves in the energy level M , has 13 nucleons inside its nucleus.

22 Give reason : The mass of the proton is equal to the mass of the nucleus of protium, but not the mass of the nucleus of tritium.

23 An atom of an element has one electron in the energy level N and its nucleus contains 20 neutrons.

Calculate:

- (1) The atomic number of the element.
- (2) The mass number of the element.
- (3) The number of energy levels occupied with electrons.

24 An element has its electrons distributed in three energy levels, and the number of electrons in its outermost energy level equals the number of electrons in its first energy level, the number of protons equals the number of neutrons.

Determine :

- (1) Its atomic number.
- (2) Its mass number.

25 An element its atomic number is half its mass number and its electrons revolve in 4 energy levels, with the same number of electrons in both the first and the last energy levels.

Calculate :

- (1) The atomic number of the element.
- (2) The number of neutrons in the nucleus of its atom.

26 Among the isotopes of Americium are Americium-241 and Americium-242:

- (1) **What is the difference** in the composition of the nucleus of each of these isotopes ?
- (2) Another element (X) atom contains 241 nucleons in its nucleus.

Identify two differences between the nucleus of element (X) atom and the nucleus of Americium-241 isotope.

27 The opposite table shows four different atoms,

What are the two atoms which contain the same number of :

- (1) Protons.
- (2) Nucleons.
- (3) Neutrons.

| | |
|-----------------|--------------------------|
| Uranium – 234 | ${}_{92}^{234}\text{U}$ |
| Uranium – 235 | ${}_{92}^{235}\text{U}$ |
| Plutonium – 238 | ${}_{94}^{238}\text{Pu}$ |
| Americium – 238 | ${}_{95}^{238}\text{Am}$ |

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 the 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?

Attempts to Classify Elements

- The scientists have made multiple attempts to classify elements ... **G.R.?**

To facilitate their study and conclude relationships between elements and their physical and chemical properties.



First Mendeleev's Periodic Table

- Mendeleev's periodic table is the first true periodic table for classifying elements.

Dmitri Mendeleev, a Russian chemist, published his periodic table of elements in 1869 and later modified it. He was honored 48 years after his death by naming one of the newly discovered elements after him, called Mendeleevium ${}_{101}\text{Md}$



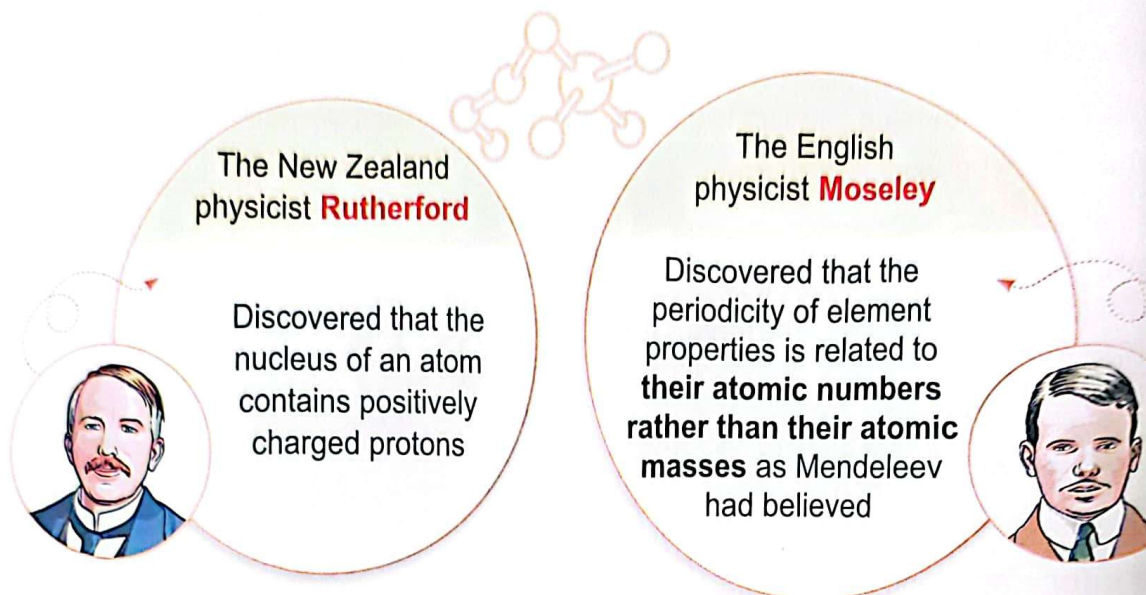
Dmitri Mendeleev

Mendeleev arranged the elements in his table in ascending order according to their atomic masses without a consistent gradation (regular pattern) upon moving from the left of the table to the right in horizontal rows, "which later were called periods".

Mendeleev discovered that the properties of elements repeat periodically with the start of each new row.

| | | |
|----------|--|------------|
| Li 7 | Be 9.4 | B 11 |
| Na 23 | Mg 24 | Al 27.3 |
| K 39 | Mendeleev's classification of elements | |

Second Moseley's Periodic Table



Moseley's key modifications to Mendeleev's table

- 1 Arranging elements in ascending order according to **their atomic numbers**, where the atomic number of each element exceeds the atomic number of the preceding element in the same period by 1
- 2 He added to the table :
 - The group of inert gases.
 - Other elements discovered after Mendeleev's table was designed.

Third The Modern Periodic Table

- Some inadequacies (limitations) in Mendeleev's table led scientists to try to modify it further.

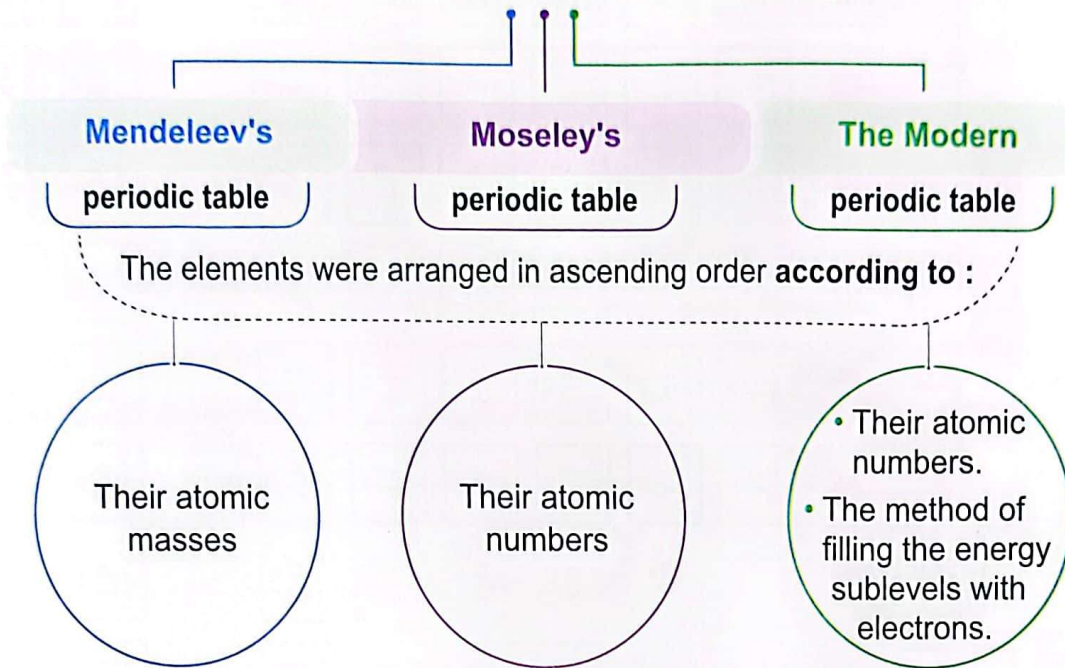
As a result The elements were rearranged in a new table known as **the modern periodic table**, in a regular **ascending order**

based
on

- Their atomic numbers.
- The method of filling the energy **sublevels** with electrons.



• We can summarize the scientific basis for classifying elements in the following diagram :



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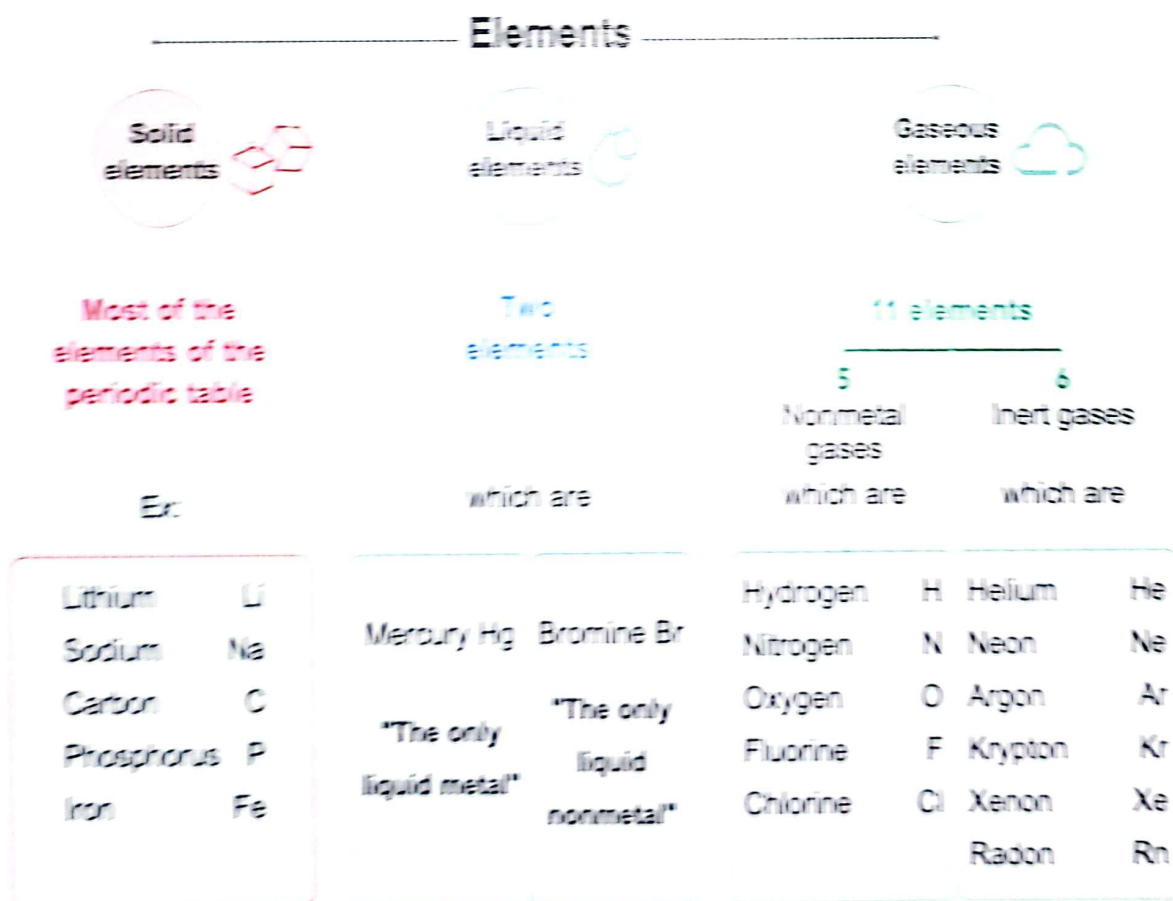
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Description of the Modern Periodic Table

- ▶ The modern periodic table shown in the previous page consists of :
 - 7 periods (horizontal rows), each starting with a new energy level.
 - 18 vertical groups, each with a traditional numbering as well as a modern numbering.
- ▶ The modern periodic table includes **118 elements**, and the opposite table shows the distribution of elements in the first four periods.
- ▶ Elements of the periodic table are classified according to **the physical state** into:

| Period | (1) | (2) | (3) | (4) |
|--------------------|-----|-----|-----|-----|
| Number of elements | 2 | 8 | 8 | 18 |

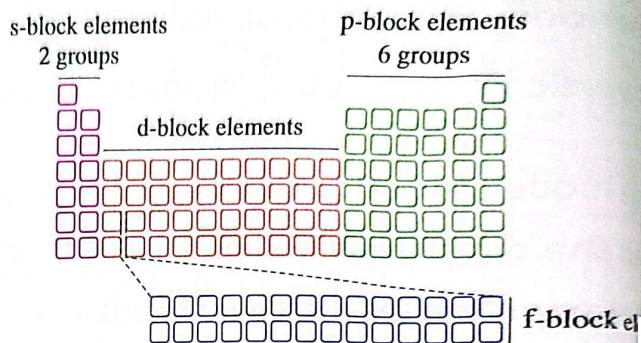


Main blocks of Modern Periodic Table Elements

The Modern Periodic Table is divided into :

Four main blocks :

- (1) s block.
- (2) p block.
- (3) d block.
- (4) f block.



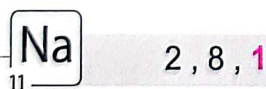
Modern Periodic Table blocks

1 (s)-block

- ▶ It is located on the **left side** of the periodic table.
- ▶ It consists of **two groups** labeled with **the letter A**, which are :

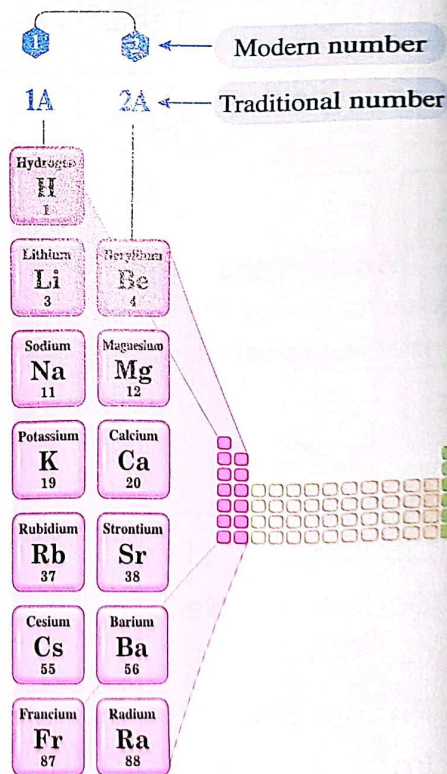
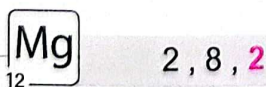
Group 1A elements

- They are all metals **except** hydrogen element.
- They are known as alkali metals.
- Their electron configurations end with **1** electron,
- **Example:** Sodium.



Group 2A elements

- They are all metals.
- They are known as alkaline earth metals.
- Their electron configurations end with **2** electrons,
- **Example:** Magnesium.



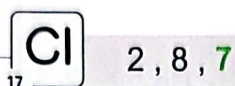
Two groups of (s)-block

2 (p)-block

- It is located on **the right side** of the periodic table.
- It consists of **6 groups** labeled with **the letter A** except group 0

Penultimate group (7A) elements (before the last)

- They are nonmetals.
- They are known as halogens.
- Their electron configurations end with **7** electrons.
- **Example** : Chlorine.



Last group (0) elements

- They are noble (Inert) gases.
- Their electron configurations end with **8** electrons, except helium, which ends with **2** electrons.
- **Example** : Argon.



It is noted that :

p-block elements include :

- All **nonmetals** whose electron configurations mostly end with **5, 6 or 7** electrons.

Example: Phosphorus. $\begin{array}{|c|} \hline \text{P} \\ \hline 15 \\ \hline \end{array} \quad 2, 8, 5$

- All **noble gases**,

Example: Neon. $\begin{array}{|c|} \hline \text{Ne} \\ \hline 10 \\ \hline \end{array} \quad 2, 8$

- Some other **metals**,

Example: Aluminum. $\begin{array}{|c|} \hline \text{Al} \\ \hline 13 \\ \hline \end{array} \quad 2, 8, 3$

- All **metalloids**, which cannot be identified solely by their electron configurations, due to the difference in the number of electrons in their outermost energy levels, as illustrated in the following table:

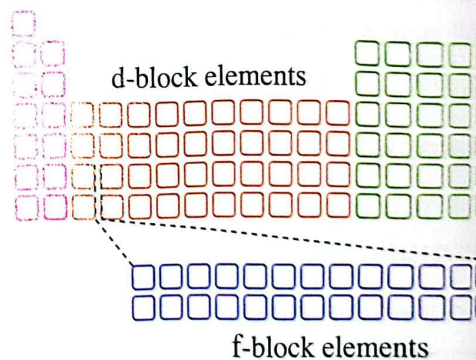
| Metalloid | Boron B | Silicon Si | Germanium Ge | Arsenic As | Antimony Sb | Tellurium Te |
|---|------------|---------------|-----------------|---------------|----------------|-----------------|
| Number of the period | 2 | 3 | 4 | 4 | 5 | 5 |
| Number of the group | 3A | 4A | 4A | 5A | 5A | 6A |
| Number of electrons in the outermost energy level | 3 | 4 | 4 | 5 | 5 | 6 |

- The following table illustrates points of comparison between some groups in the (s) and (p)-blocks:

| Points of Comparison | 1A | 2A | 7A | 0 |
|---|--------------------------------|--------------------------|-------------------------|---------------------------------------|
| Group name | Alkali metals | Alkaline earth metals | Halogens | Noble gases |
| The block of the elements | s | s | p | p |
| Number of electrons in the outermost energy level | 1 electron | 2 electrons | 7 electrons | 8 electrons except Helium 2 electrons |
| Example | ${}_{3}\text{Li} : 2, 1$ | ${}_{4}\text{Be} : 2, 2$ | ${}_{9}\text{F} : 2, 7$ | ${}_{10}\text{Ne} : 2, 8$ |
| Type of the element | All are metals except Hydrogen | All are metals | All are nonmetals | All are noble gases |

3 (d)-block elements

- ▶ It occupies **the middle** of the periodic table, where it separates between:
 - s-block elements (the left side of the periodic table).
 - p-block elements (the right side of the periodic table).
- ▶ Its elements are all **metals**.
- ▶ They begin to appear in **period (4)**, and they are called **transition metals**.

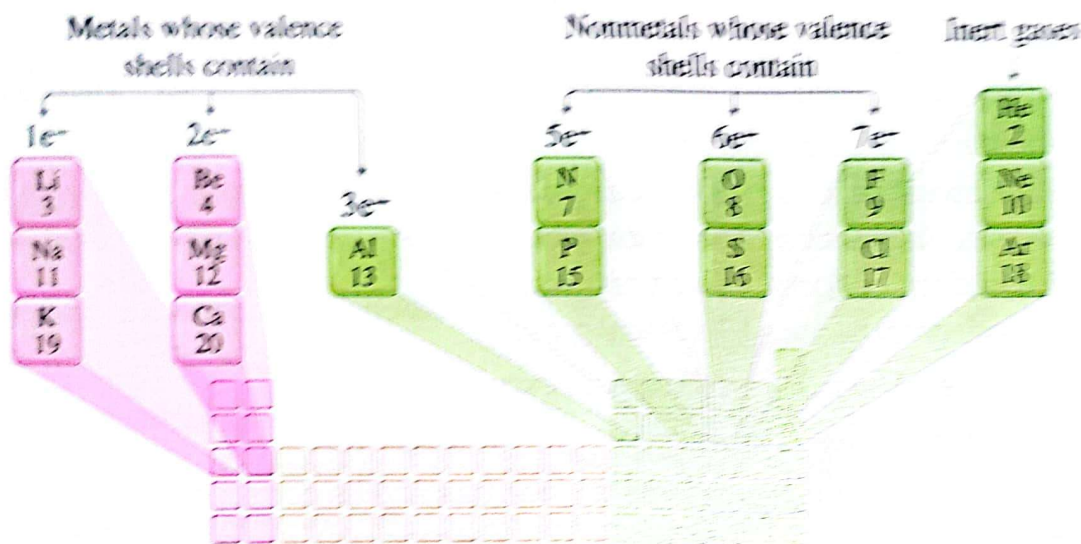


4 (f)-block

- ▶ It is located at **the bottom** of the periodic table.
- ▶ Its elements are all **metals**.

From the previous, it is clear that : The periodic table reveals the electron configuration of atoms, where:

- ① Most metals have an electron configuration that ends with 1, 2 or 3 electrons.
- ② Most nonmetals have an electron configuration that ends with 5, 6 or 7 electrons.
- ③ Noble gases have an electron configuration that ends with 8 electrons (except helium).



Question ? Answer

Q Which of the following is true for the elements of period 2 in the periodic table ?

- a) It contains two inert gases.
- b) It contains two transition metals.
- c) It starts with a metal and ends with an inert gas.
- d) It starts with an inert gas and ends with a metal.

A ∴ Each period in the periodic table ends with an inert gas located in the zero group.

∴ The choices (a) and (d) are excluded.

∴ Transition metals start appearing in period 4

∴ The choice (b) is excluded.

∴ Most periods in the periodic table start with a metal in group 1A and end with an inert gas in the zero group.

∴ The correct choice is: (c)

Test ? Your Understanding 1

1 Choose the correct answer:

- (1) The elements in the modern periodic table are arranged in
 - (a) descending order according to their atomic numbers.
 - (b) ascending order according to their atomic masses.
 - (c) ascending order according to their atomic numbers and the way the main energy levels are filled with electrons.
 - (d) ascending order according to their atomic numbers and the way the energy sublevels are filled with electrons.
- (2) The modern periodic table consists of
 - (a) 9 horizontal periods / 13 vertical groups.
 - (b) 8 horizontal periods / 15 vertical groups.
 - (c) 7 horizontal periods / 18 vertical groups.
 - (d) 18 horizontal periods / 7 vertical groups.
- (3) Each of the following is a solid metal, except
 - (a) Aluminum.
 - (b) Mercury.
 - (c) Magnesium.
 - (d) Silver.
- (4) Which of the following represents an inert gas and its correct symbol?
 - (a) Helium (H)
 - (b) Chlorine (C)
 - (c) Argon (Ar)
 - (d) Oxygen (O)
- (5) Which of the following represents the electron configuration of three metals ?
 - (a) (A) : 2,8,2 / (B) : 2,8,3 / (C) : 2,8,4
 - (b) (A) : 2,1 / (B) : 2,8,3 / (C) : 2,8,8,2
 - (c) (A) : 2 / (B) : 2,8,3 / (C) : 2,8,8,2
 - (d) (A) : 2,5 / (B) : 2,6 / (C) : 2,7
- (6) All the following are characteristics of the (d)-block elements in the modern periodic table, except that
 - (a) they occupy the middle of the periodic table.
 - (b) they start appearing in period 4
 - (c) they are called alkaline earth metals.
 - (d) all of them are metals.

2 The following figure represents a section in the modern periodic table. Select the letter which indicates:

- (1) An element belonging to the alkali metals group.
- (2) A liquid halogen.
- (3) An inert gas.
- (4) A metalloid located in period 4

| | | | | | | | | | | | |
|--|---|--|--|---|--|---|--|--|--|---|---|
| | B | | | | | | | | | | X |
| | C | | | | | | | | | Q | |
| | | | | R | | E | | | | M | |
| | | | | | | | | | | | |

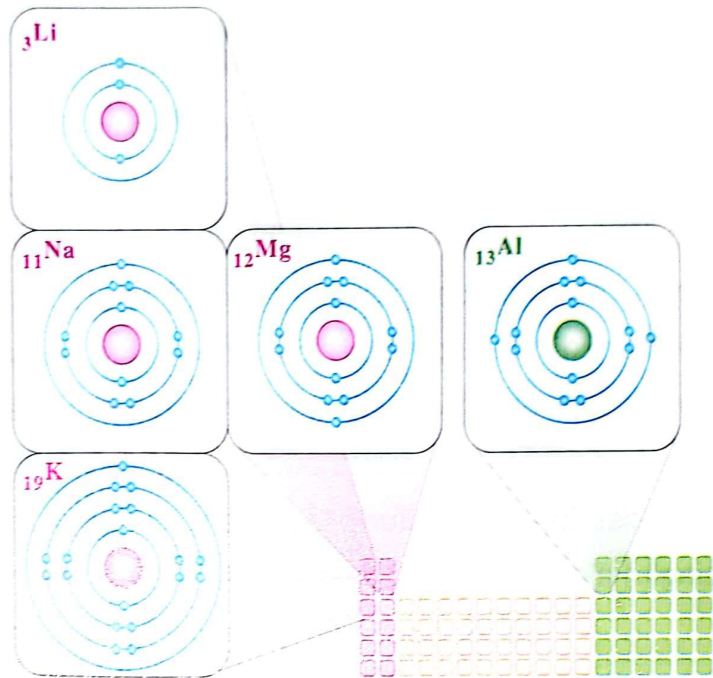
Note: The letters in the table do not represent the actual symbols of the elements

The Periodic Table and the Electron configuration of Elements

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

It is noted that :

- Elements ${}_3\text{Li}$, ${}_{11}\text{Na}$, ${}_{19}\text{K}$ are similar in the number of the electrons in the last energy level (**one electron**).
- Elements ${}_{11}\text{Na}$, ${}_{12}\text{Mg}$, ${}_{13}\text{Al}$ are similar in the number of energy levels occupied by electrons (**3 levels**).



Referring to the modern periodic table (p. 44), it is evident that:

- ▶ **Elements of the same group** are similar in the number of the electrons found in the last energy level.
- ▶ **Elements of the same period** are similar in the number of the energy levels occupied by electrons.

What do you conclude from ?

The fact that both ${}_{13}\text{Al}$, ${}_{17}\text{Cl}$ are located in the same period in the modern periodic table ? Both of their atoms have the same number of energy levels occupied by electrons (3 energy levels).

Evaluate Your Understanding

Show by drawing the electron configuration of the elements ${}_8\text{O}$ and ${}_{16}\text{S}$, then identify the similarity and the difference between them regarding their locations in the periodic table.

- **Similarity:**
- **Difference:**

| | |
|--|--|
| | |
|--|--|

Why? Do elements of the same group share similar chemical properties?

Because they have the same number of electrons in the last energy level in each of them.

Lewis Dot Structure for Valence Electrons

The scientist **Lewis** proposed a simplified method to represent the number of the electrons which are found in the last energy level around the element symbol, known as **valence electrons**, using dots (•) which are distributed on the four sides of the element symbol, individually (singly) first, and then they are paired up until they are distributed completely.

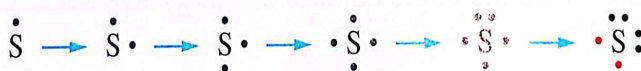
Valence electrons

They are the electrons found in the last energy level of the element atom.

It is possible to conclude the valency of an element from the number of the unpaired (single) electrons in its Lewis structure.

Application Lewis Dot Structure for Valence Electrons of Sulphur Atom $_{16}\text{S}$

- ▶ Electron configuration of sulphur atom $_{16}\text{S}$: 2 , 8 , 6
- ▶ The (6) valence electrons are represented by single dots (•) first on the four sides of the sulphur symbol, then pairing them until they are distributed completely, as follows:



∴ Number of the unpaired (single) electrons in Lewis structure = 2

∴ Sulphur is **divalent**.

Note

Each of the following represents correctly the Lewis structure of sulphur atom



The following table shows some information about the elements in period 2 in the modern periodic table, according to their Lewis dot structures:

| Period (2) elements | ${}^3\text{Li}$ | ${}^4\text{Be}$ | ${}^5\text{B}$ | ${}^6\text{C}$ | ${}^7\text{N}$ | ${}^8\text{O}$ | ${}^9\text{F}$ | ${}^{10}\text{Ne}$ |
|--------------------------------------|------------------|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------------|
| Electron configuration | 2, 1 | 2, 2 | 2, 3 | 2, 4 | 2, 5 | 2, 6 | 2, 7 | 2, 8 |
| Lewis dot structure | $\cdot\text{Li}$ | $\cdot\text{Be}\cdot$ | $\cdot\text{B}\cdot$ | $\cdot\text{C}\cdot$ | $\cdot\text{N}\cdot$ | $\cdot\text{O}\cdot$ | $\cdot\text{F}\cdot$ | $\cdot\text{Ne}\cdot$ |
| Valence according to Lewis structure | Monovalent | Divalent | Trivalent | Tetravalent | Trivalent | Divalent | Monovalent | Zero |
| Element group number | 1A | 2A | 3A | 4A | 5A | 6A | 7A | 0 |

From the previous table, it is observed that:

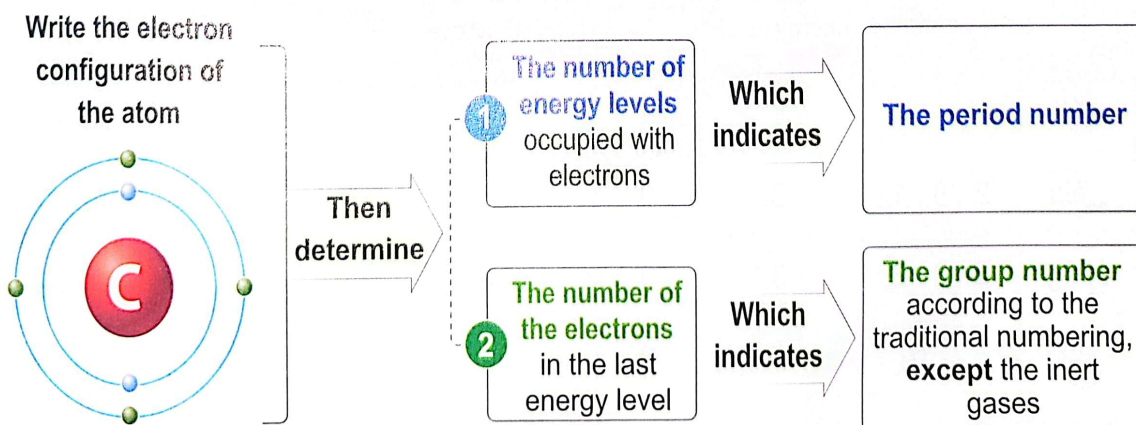
- The valencies of elements in groups **1A : 4A** equals **the group number**.
- The valencies of elements in groups **5A : 0** equals :

(8 – the number of last energy level electrons)

- The valency of the noble gases equals zero ... **G.R.?**

Because the last energy level in each of their atoms is completely filled with electrons, and thus their Lewis dot structure doesn't contain unpaired electrons.

How to Determine the Position of Group A Elements in the Periodic Table Based on Their Atomic Numbers



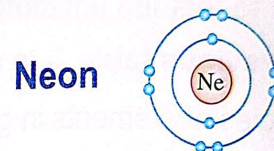
Application Determining the locations of $_{17}\text{Cl}$ and $_{19}\text{K}$ elements in the Periodic Table

| Steps | $_{17}\text{Cl}$ | $_{19}\text{K}$ |
|---|---|---|
| Write the electron configuration of the atom of the element. | 2, 8, 7 | 2, 8, 8, 1 |
| Then determine | | |
| 1 The number of occupied energy levels (period number) | 3 energy levels ∴ The element is in period 3 | 4 energy levels ∴ The element is in period 4 |
| 2 The number of the electrons in the last energy level (group number) | 7 electrons ∴ The element is in group 7A | 1 electron ∴ The element is in group 1A |

Take care:



Helium is the only noble gas with an electron configuration that ends with $2e^-$ ✓ and not $8e^-$ ✗



The inert gases like Neon is in group zero ✓ and not group 8 ✗

Examples of determining the locations of some group (A) elements in the periodic table and their valencies:

| The element | Electron configuration | Number of occupied energy levels | Period number | Number of the electrons in the last energy level | Group number | Block | Lewis structure | V |
|------------------|------------------------|----------------------------------|---------------|--|--------------|-------|------------------------------|----|
| $_{1}\text{H}$ | 1 | 1 | 1 | 1 | 1A | s | $\cdot\text{H}$ | Mo |
| $_{11}\text{Na}$ | 2, 8, 1 | 3 | 3 | 1 | 1A | s | $\cdot\text{Na}$ | Mo |
| $_{12}\text{Mg}$ | 2, 8, 2 | 3 | 3 | 2 | 2A | s | $\cdot\text{Mg}\cdot$ | D |
| $_{8}\text{O}$ | 2, 6 | 2 | 2 | 6 | 6A | p | $\cdot\ddot{\text{O}}\cdot$ | D |
| $_{18}\text{Ar}$ | 2, 8, 8 | 3 | 3 | 8 | 0 | p | $\cdot\ddot{\text{Ar}}\cdot$ | |

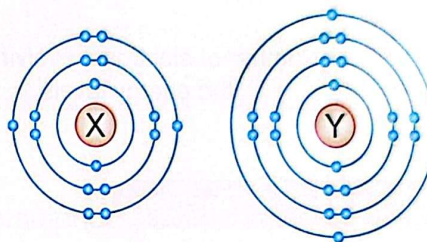
Evaluate Your Understanding

Complete the following table :

| The element | Electron configuration | Number of occupied energy levels | Period number | Number of the electrons in the last energy level | Group number | Block | Lewis structure | Valency |
|------------------|------------------------|----------------------------------|---------------|--|--------------|-------|-----------------|---------|
| $_{10}\text{Ne}$ | | | | 8 | ..... | ..... | ..... | ..... |
| $_{13}\text{Al}$ | | | | | | p | ..... | ..... |

Question ? Answer

31 The two opposite figures show the electron configurations of the atoms of elements (X) and (Y), Identify the following for each of them:



- (1) The location in the periodic table
- (2) The block it belongs to.
- (3) Its Lewis dot structure.
- (4) Its valency.

A

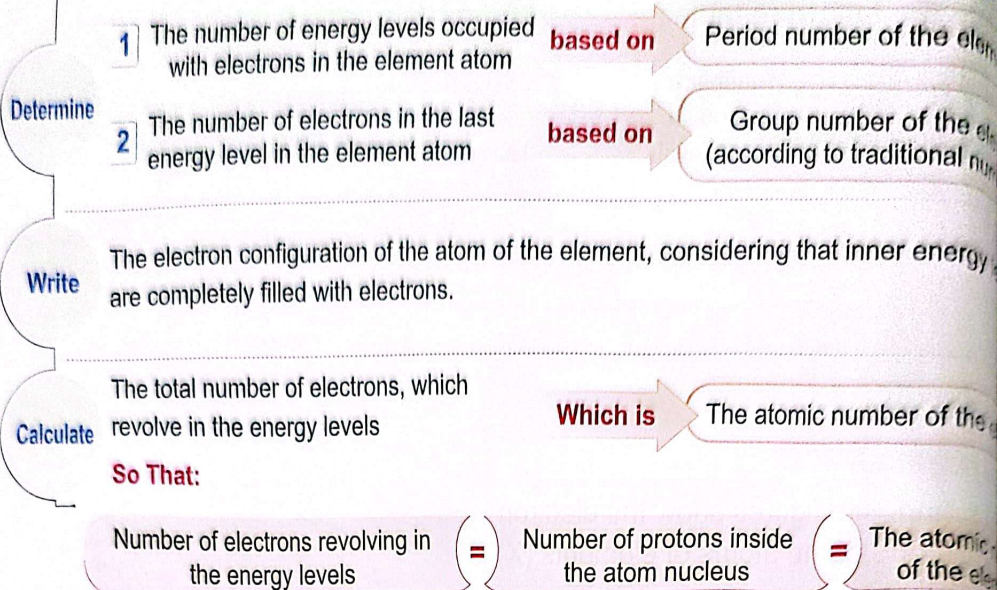
| | X | Y |
|--|-----------------------------|------------------------|
| (1) The location in the periodic table | Period 3, group 6A | Period 4, group 2A |
| (2) The block it belongs to | p | s |
| (3) The Lewis dot structure | $\cdot\ddot{\text{X}}\cdot$ | $\ddot{\text{Y}}\cdot$ |
| (4) The valency | Divalent | Divalent |

12 Classify the following elements into two vertical groups, with an explanation:



- 4 • The elements (${}_3\text{Li}, {}_{11}\text{Na}, {}_{19}\text{K}$) are in group 1A
- The elements (${}_{10}\text{Ne}, {}_{18}\text{Ar}$) are in group 0
- The explanation: **Because the elements atoms** in each group **have the same** number of electrons in the last energy level.

How to Determine the Atomic Numbers of Group A Elements Based on Their Locations in the Periodic Table



Question ? Answer

Q Calculate the atomic number of each of the following elements:

- (1) **Element (X):** Located in period (2) and group (7A).
- (2) **Element (Y):** Located in period (3) and group 0.

A (1) \therefore **Element (X) is in:**

- Period 2
- \therefore Number of energy levels in its atom is 2 energy levels.
- Group 7A
- \therefore Number of electrons in the last energy level is $7e^-$
- **Electron configuration:** 2, 7
- \therefore Atomic number = $2 + 7 = 9$

(2) \therefore **Element (Y) is in:**

- Period 3
- \therefore Number of energy levels in its atom is 3 energy levels
- Group 0
- \therefore The last energy level is completely filled with electrons (8 electrons).
- **Electron configuration:** 2, 8, 8
- \therefore Atomic number = $2 + 8 + 8 = 18$

Notes

In the same period
in the modern periodic table

The atomic number of an element **exceeds**
that of **the preceding** element by **1**

In the same group of (periods 2 and 3)
in the modern periodic table

The atomic number of an element **exceeds**
that of **the preceding** element by **8**



Scientific Prediction

Can the scientists discover a new element between sulphur $_{16}\text{S}$ and chlorine $_{17}\text{Cl}$?

(1) In the modern periodic table:

No, because the atomic number of an element is an integer number and increases by one from one element to another in the same period.

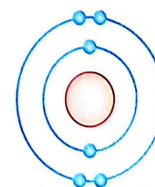
(2) In the future: If elements are reclassified in a different way other than ascending atomic number, then the scientists might discover a new element.

Question ? Answer

Q Study the opposite figure which illustrates the electron configuration of element (X) atom in the modern periodic table, then conclude the atomic number:

(1) Of the element (Y) which follows (X) in the same period.

(2) Of the element (Z) which follows (X) in the same group.



Element (X)

(1) ∴ Atomic number of element (X) = 2 + 4 = 6
 ∴ Atomic number of element (Y) = 6 + 1 = 7

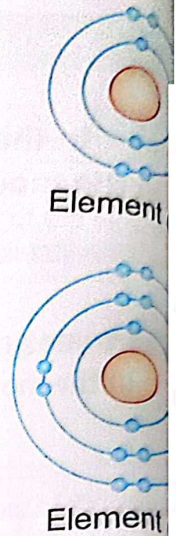
(2) ∴ Number of occupied energy levels in element (X)
 = 2 energy levels

∴ Number of occupied energy levels in element (Z)
 = 3 energy levels

∴ Element (Z) is in the same group of element (X)

∴ Number of electrons in the outermost energy level of element (Z) = Number of electrons in the outermost energy level of element (X) = 4

∴ Atomic number of element (Z) = 2 + 8 + 4 = 14



Another Solution for (2):

(2) ∴ Element (X) is located in period 2 and group 4A

∴ Element (Z) is located in period 3 and group 4A

∴ Atomic number of element (Z) = 2 + 8 + 4 = 14

The Electron Configuration of Atoms Reveals Their Properties

Chemical properties of elements depend on the number of the electrons in the outermost energy level in their atoms, while differences in the number of neutrons in their nuclei result in differences in some physical properties.

The following tables illustrate the graduation of some physical properties of some alkali metals and halogens:

| Alkali metals | Atomic radius | Melting point | Boiling point | Halogens | Atomic radius | Melting point | Boiling point |
|---|---------------|---------------|---------------|---|---------------|---------------|---------------|
| Lithium ${}^3\text{Li}$ 2, 1 | 157 pm | 181°C | 1347°C | Chlorine ${}^{17}\text{Cl}$ 2, 8, 7 | 99 pm | -101°C | -34°C |
| Sodium ${}^{11}\text{Na}$ 2, 8, 1 | 191 pm | 98°C | 883°C | Bromine ${}^{35}\text{Br}$ 2, 8, 18, 7 | 114 pm | -7°C | 59°C |
| Potassium ${}^{19}\text{K}$ 2, 8, 8, 1 | 235 pm | 64°C | 774°C | Iodine ${}^{53}\text{I}$ 2, 8, 18, 18, 7 | 133 pm | 114°C | 184°C |

↑ Increases ↓ Decreases ↓ Decreases ↓ Decreases
↑ Increases ↑ Increases ↑ Increases

By increasing the atomic number
By increasing the atomic number

From the previous tables, it is clear that:

1 The atomic radii of elements in the same group :

the atomic radii of elements in the same group **increase** as the atomic number increases (from top to bottom in the group).



2 Melting and boiling points in :

A Alkali metals :

The melting and boiling points of alkali metals **decrease** as the atomic number increases (from top to bottom in the group).

Atomic radius of Na > Atomic radius of Li
(As it follows Li in group (1A))

B Halogens:

The Melting and boiling points of halogens **increase** as the atomic number increases (from top to bottom in the group).

- The following table shows the relation between the physical state of a substance and its melting and boiling points relative to room temperature (25°C):

| The physical state of substance | Melting point °C | Boiling point °C |
|---------------------------------|------------------|------------------|
| Solid | More than 25°C | |
| Liquid | Less than 25°C | More than 25°C |
| Gas | Less than 25°C | |

Q.R.?

(1) The melting and boiling points of lithium and potassium are higher than room temperature.

Because both are solid elements at room temperature.

(2) The melting and boiling points of chlorine are lower than room temperature.

Because it is a gaseous element at room temperature.

Evaluate Your Understanding

Among the elements in the periodic table are (sodium, oxygen and bromine)

(1) Determine the physical state of each element.

(2) Compare between the melting and boiling points of them relative to room temperature.

Question ? Answer

Q From the opposite table.
Conclude the physical state of each of element (X) and (Y) at room temperature (25°C):

| | | |
|------------------|------|-----|
| | X | Y |
| Melting point °C | -7.2 | -21 |
| Boiling point °C | 58.8 | -18 |

A ∴ Melting point of element (X) is lower than room temperature, and its boiling point is higher than room temperature.

∴ Element (X) is a **liquid** at the room temperature.

∴ Both the melting and boiling points of element (Y) are lower than room temperature.

∴ Element (Y) is a **gas** at the room temperature.

3 Chemical Activity :

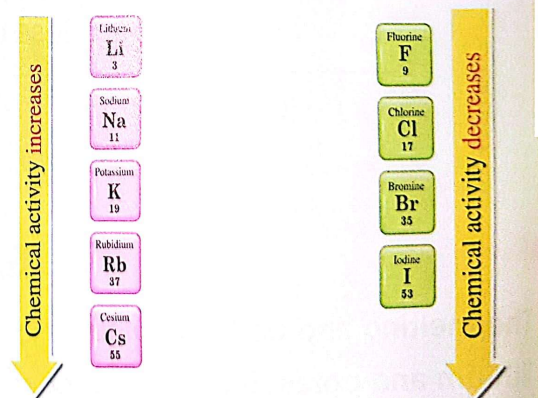
A In the two groups of Alkali and Alkaline Earth Metals:

The chemical activity of metals **increases** with increasing the atomic number (from top to bottom in the group).

Alkaline earth metals are **less active than** that of the highly active alkali metals.

B In the Group of Halogens:

The chemical activity of nonmetals **decreases** with increasing the atomic number (from top to bottom in the group).



Alkali metals activity

Halogens activity

Cesium is the most active metal,
while Fluorine is
the most active nonmetal

Test ? Your Understanding 2

1) Choose the correct answer :

- (1) Elements (X) and (Y) are in the same period in the periodic table, while elements (Y) and (Z) are in the same group. Which of the following choices represents the electron configuration of these elements?

| Choices | (X) | (Y) | (Z) |
|---------|---------|---------|---------|
| (a) | 2, 8, 7 | 2, 8, 6 | 2, 4 |
| (b) | 2, 4 | 2, 7 | 2, 8, 7 |
| (c) | 2, 4 | 2, 8, 6 | 2, 8, 7 |
| (d) | 2, 8, 4 | 2, 7 | 2, 4 |

- (2) The properties of the element whose atomic number is 2 are similar to the properties of the element whose atomic number is
 (a) 10 (b) 12 (c) 19 (d) 20
- (3) The Lewis dot structure shows 4 unpaired electrons in the atom of
 (a) ${}_4\text{Be}$ (b) ${}_8\text{O}$ (c) ${}_{14}\text{Si}$ (d) ${}_{16}\text{S}$
- (4) Which of the following represents the expected melting and boiling points of mercury?

| Choices | Melting point | Boiling point |
|---------|---------------|---------------|
| (a) | 38.83 °C | 356.7 °C |
| (b) | - 38.83 °C | - 356.7 °C |
| (c) | 38.83 °C | - 356.7 °C |
| (d) | - 38.83 °C | 356.7 °C |

- (5) Which of the following represents the element whose energy level M in its atom contains 2 electrons?
 (a) It is located in period 2 and group 2A (b) It has a low melting point.
 (c) Its valency is divalent.
 (d) It is more active than the element preceding it in the same period.

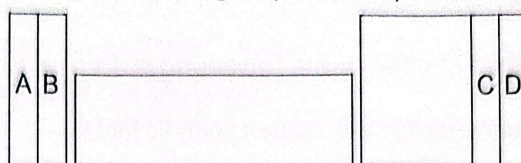
2) The opposite figure represents periods 2, 3 in the modern periodic table. Determine, with explanation:

- (1) Which of the two elements (Y) and (B) has a larger atomic radius?
 (2) Which of the two elements (W) and (D) is more chemically active?

| | 1A | 2A | 3A | 4A | 5A | 6A | 7A | 0 |
|----------|----|----|----|----|----|----|----|---|
| Period 2 | | Y | | | | | D | |
| Period 3 | | B | | | | | W | |

Note: The letters in the table do not represent the actual symbols of the elements

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



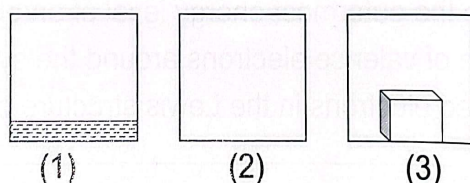
Which of the following is correct about the elements in these groups ?

- (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 $X^{\circ}\text{C}$, their physical states became as follows:



What is the temperature $X^{\circ}\text{C}$?

- (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.

**1 Write the scientific term of each of the following statements :****Attempts to classify elements and the modern periodic table**

- (1) A table in which elements are arranged in ascending order based on their atomic masses.
- (2) The first true periodic table for classifying elements.
- (3) A table in which elements are arranged in ascending order based on their atomic numbers.
- (4) A table in which elements are arranged in ascending order based on their atomic numbers and the method of filling of the energy sublevels with electrons.
- (5) The horizontal rows in the modern periodic table.
- (6) The vertical columns in the modern periodic table.
- (7) The metals which are located at the far left side of the modern periodic table.
- (8) Elements of group 7A in the modern periodic table.
- (9) The block to which halogens belong.
- (10) Elements whose electron configurations end with 5, 6 or 7 electrons.
- (11) Elements in the p-block that cannot be identified solely by the number of electrons in their outermost energy levels.

The periodic table and the electron configuration of the elements and their properties

- (12) The electrons found in the outermost energy level of an element.
- (13) The dot representation of valence electrons around the symbol of an element.
- (14) The number of unpaired electrons in the Lewis structure of an element.

2 Write the term that indicates each of the following statements :**Attempts to classify elements and the modern periodic table**

- (1) A scientist who arranged the elements in his table in ascending order according to their atomic masses.
- (2) A scientist who discovered that the nucleus of an atom contains positively charged protons.
- (3) A scientist who added the zero group to Mendeleev's periodic table.
- (4) The only liquid metal in the modern periodic table.
- (5) The only liquid nonmetal in the modern periodic table.
- (6) An element located between lithium and potassium in the alkali metals group.
- (7) The only metalloid in the 3rd period of the modern periodic table.
- (8) An element its electrons are distributed in 3 energy levels and its last energy level is completely filled with electrons.
- (9) An alkali metal located in the 2nd period.

The periodic table and the electron configuration of the elements and their properties

- (10) A scientist who proposed a simplified method to represent the number of valence electrons around the symbol of an element.
- (11) The noble gas whose Lewis structure includes 2 unpaired electrons.
- (12) The alkali metal which has the smallest atomic radius.
- (13) The most chemically active element in group 7A

3 Choose the correct answer :

Attempts to classify elements and the modern periodic table

- (1) In Moseley's table, each element exceeds the preceding element in the same period by one
- (a) neutron. (b) proton. (c) energy level. (d) atomic mass.
- (2) The alkali earth metals are located in the of the periodic table.
- (a) left (b) right (c) middle (d) bottom
- (3) The number of p-block elements in each period of the periodic table, (except the 1st period), is
- (a) 2 (b) 6 (c) 10 (d) 14
- (4) The - block contains most types of elements.
- (a) s (b) p (c) d (d) f
- (5) The zero group in the modern periodic table belongs to
- (a) s-block. (b) p-block. (c) d-block. (d) f-block.
- (6) The zero group includes
- (a) metals. (b) liquid nonmetals.
(c) metalloids. (d) inert gases.
- (7) Among nonmetals is element.
- (a) magnesium (b) sodium (c) strontium (d) bromine
- (8) is a solid halogen.
- (a) Fluorine (b) Chlorine (c) Bromine (d) Iodine
- (9) The opposite figure shows a section in the periodic table.
Which of the following is correct ?
- | | | | |
|----|----|----|----|
| Al | Si | P | S |
| Ga | Ge | As | Kr |
- (a) Al : Metal , Si : Nonmetal.
(b) P : Nonmetal , Kr : Metalloid.
(c) Ga : Metal , Ge : Metalloid.
(d) As : Metal , S : Nonmetal.
- (10) The 4th period contains elements from the blocks
- (a) s and p (b) s, d and p (c) s, f and p (d) s, p, d and f



The periodic table and the electron configuration of the elements and their properties

- (11) The elements of the (d)-block are known as
- (a) inert elements. (b) transition elements.
(c) alkali metals. (d) alkaline earth metals.
- (12) The element whose energy level M contains 2 electrons is located in the of the modern periodic table.
- (a) 2nd period, group 3A (b) 3rd period, group 2A
(c) 2nd period, group 4A (d) 4th period, group 2A
- (13) Which of the following pairs of elements are located in the same period in the modern periodic table ?
- (a) $_{10}\text{Ne}$ and $_{11}\text{Na}$ (b) $_{17}\text{Cl}$ and $_{11}\text{Na}$
(c) $_{3}\text{Li}$ and $_{2}\text{He}$ (d) $_{10}\text{Ne}$ and $_{18}\text{Ar}$
- (14) The atomic number of the inert gas which is located in the 2nd period is
- (a) 2 (b) 8 (c) 10 (d) 18
- (15) An alkali metal is located in the 2nd period, its atomic number is
- (a) 9 (b) 7 (c) 5 (d) 3
- (16) If the last energy level of a halogen atom is the level L, its atomic number is
- (a) 7 (b) 9 (c) 17 (d) 19
- (17) An element is located in period 3, group 3A and its nucleus contains 14 neutrons, so its mass number is
- (a) 30 (b) 27 (c) 24 (d) 20
- (18) Lewis structure includes 2 unpaired electrons in the atom of
- (a) $_{6}\text{C}$ (b) $_{7}\text{N}$ (c) $_{15}\text{P}$ (d) $_{16}\text{S}$
- (19) Which of the following represents the Lewis structure of nitrogen atom $_{7}\text{N}$?
- (a) $\cdot\ddot{\text{N}}$ (b) $\cdot\ddot{\text{N}}\cdot$ (c) $\cdot\ddot{\text{N}}\cdot$ (d) $\cdot\ddot{\text{N}}\cdot$
- (20) Which of the following pairs of elements are monovalent ?
- (a) $_{11}\text{Na}$ and $_{9}\text{F}$ (b) $_{7}\text{N}$ and $_{15}\text{P}$ (c) $_{11}\text{Na}$ and $_{15}\text{P}$ (d) $_{9}\text{F}$ and $_{7}\text{N}$
- (21) Iodine is
- (a) trivalent. (b) divalent. (c) monovalent. (d) zero.
- (22) The valency of argon is
- (a) 0 (b) 1 (c) 6 (d) 8
- (23) The first four elements in group 4A have the same
- (a) number of electrons in the first and last energy levels.
(b) atomic radius.
(c) number of energy levels.
(d) melting and boiling points.

(24) The element which has the smallest atomic radius among the following elements is

- (a) $_{17}\text{Cl}$ (b) $_{53}\text{I}$ (c) $_{9}\text{F}$ (d) $_{35}\text{Br}$

(25) The element which has the largest atomic radius in the same vertical group is the one with

- (a) the least number of neutrons in its nucleus.
 (b) the least number of protons in its nucleus.
 (c) the least number of nucleons in its nucleus.
 (d) the largest number of electrons revolving around its nucleus.

(26) What is the change which happens in the alkali metals as the atomic number increases ?

- (a) Their physical state changes.
 (b) Their melting points decrease.
 (c) Their atomic radii decrease.
 (d) Their boiling points increase.

(27) Which of the following describes the element ${}^7_3\text{X}$?

- (a) Its nucleus contains 4 protons.
 (b) It is a gaseous element at room temperature.
 (c) It is located in the group 3A of the periodic table.
 (d) It is located in the 2nd period of the periodic table.

(28) The vertical group in the modern periodic table that includes the most active metals is

- (a) the halogens group. (b) the alkali metals group.
 (c) the 7A group. (d) the zero group.

(29) The atomic number of the most active halogen is

- (a) 19 (b) 35 (c) 17 (d) 9

4 Choose from columns (B) and (C) what suit them in column (A) :

| (1) (A) | (B) | (C) |
|------------------|--------------------------------|--|
| The block | Its location | Its properties |
| (1) s | (1) in the middle of the table | (1) it includes transition elements |
| (2) p | (2) in the left of the table | (2) the zero group is its last groups |
| (3) d | (3) at the bottom of the table | (3) it consists of 3 vertical columns |
| | (4) in the right of the table | (4) it consists of two vertical groups |



| (2) (A) | (B) | (C) |
|------------------------|--------------------------------------|--|
| (1) ${}_7\text{N}$ | (1) is located in period 1, group 3A | (1) it is a halogen. |
| (2) ${}_{12}\text{Mg}$ | (2) is located in period 3, group 2A | (2) it is trivalent. |
| (3) ${}_3\text{Li}$ | (3) is located in period 2, group 1A | (3) it is an alkaline earth metal. |
| (4) ${}_9\text{F}$ | (4) is located in period 2, group 5A | (4) it is the least active alkali metal. |
| | (5) is located in period 2, group 7A | (5) its Lewis structure includes 4 unpaired e ⁻ |

5 Complete the following sentences :

Attempts to classify elements and the modern periodic table

- (1) The elements in Mendeleev's periodic table were arranged according to while in Moseley's periodic table, they were arranged according to
- (2) In the modern periodic table, elements are classified according to the ascending order of and the method of filling
- (3) The only liquid halogen is, while and are gaseous halogens
- (4) The number of inert gases is, while the number of other nonmetal gases is
- (5) Each period of the periodic table starts with an element, except period 1, which starts with element.
- (6) The alkali metals belong to block, while the halogens belong to block.
- (7) The elements of group 1A are called, while the elements of group 7A are called
- (8) Potassium belongs to the group, while fluorine belongs to the group
- (9) All elements of group 1A are except hydrogen, while all elements of group 7A are
- (10) Transition elements are located in the block, while inert gases are located in the block.
- (11) The transition metals start to appear in the period number
- (12) The elements of the (f)-block are located in the of the periodic table, while the elements of the (d)-block are located in the of the periodic table.

The periodic table and the electron configuration of the elements and their properties

- (13) In the periodic table, the number indicates the number of electrons in the last energy level of an element's atom, while the number indicates the number of occupied energy levels.
- (14) The two elements ${}_{12}\text{Mg}$ and ${}_{20}\text{Ca}$ are located in the same, while the two elements ${}_4\text{Be}$ and ${}_6\text{C}$ are located in the same

- (15) The Lewis model of the fluorine atom ${}_9\text{F}$ includes single electron, so its valency is
- (16) The valency of any alkali metal is, while the valency of any alkaline earth metal is
- (17) The element located in period 2, group 2A, its atomic number is and belongs to the block.
- (18) The opposite figure represents a section in the periodic table with hypothetical element symbols:
- 1- Element (L) is located in the period, group
- 2- Element (D) is a element and belongs to the block.
- (19) As the atomic number of group 7A elements increases, the atomic radius and the melting and boiling points

| | | |
|-------------------|---|---|
| X | | |
| ${}_{11}\text{Y}$ | | |
| Z | L | D |

6 Complete the following sentences using the given words :

"Names and concepts may be used more than once"

| | | | | | | |
|-----------|---|----------|---|---------------|---|----------------|
| Mendeleev | , | Neutrons | , | Moseley | , | Rutherford |
| Bohr | , | Protons | , | Atomic masses | , | Atomic numbers |

- (1) The scientist discovered that the periodicity of the properties of the elements is related to rather than
- (2) The scientist added the zero group, which includes inert gases, to table.
- (3) The scientist discovered that the nucleus of the atom contains positively charged

7 Complete the following sentences using the given words :

Greater than, Equal to, Less than "Each word can be used more than once"

- (1) The number of the inert gases is the number of the other nonmetal gases in the periodic table.
- (2) The number of elements in period 4 is the number of elements in period 3 in the periodic table.
- (3) The number of electrons in the last energy level of metals is the number of electrons in the last energy level of nonmetals.
- (4) The number of valence electrons around the symbol of fluorine in its Lewis structure is the valency of fluorine.
- (5) The valency of elements in group 7A is the group number.
- (6) The boiling point of bromine is the boiling point of chlorine.
- (7) The chemical activity of alkaline earth metals is the chemical activity of alkali metals.



8 Complete the following tables :

| ① Element | Atomic number | Electron configuration | Period number | Group number | Block |
|------------------|---------------|------------------------|---------------|--------------|-------|
| ...S | | 2, 8, 6 | ..... | ..... | ..... |
| $_{20}\text{Ca}$ | | | 4 | ..... | ..... |

| ② Element | Location in the modern periodic table | Atomic number | Block | Lewis structure |
|-----------|---------------------------------------|---------------|-------|-----------------|
| Y | Period 1, group 1A | ..... | ..... | ..... |
| Q | ..... | 12 | ..... | ..... |

| ③ Element | Electron configuration | Lewis structure | Valency | Type of element |
|------------------|------------------------|--|-----------|-----------------|
| $_{15}\text{P}$ | ..... | ..... | Trivalent | ..... |
| $_{14}\text{Si}$ | ..... | ..... | ..... | Metalloid |
| ..... | 2, 8, 3 | $\begin{array}{c} \cdot \\ \text{Al} \cdot \\ \cdot \end{array}$ | ..... | ..... |

9 Mark (✓) or (x) for each statement, with correction :

Attempts to classify elements and the modern periodic table

- (1) Mendeleev added the zero group, which includes inert gases, to his periodic table. ()
- (2) The modern periodic table consists of 9 horizontal periods and 13 vertical groups. ()
- (3) Argon and helium are both active gases. ()
- (4) The modern periodic table contains 11 gaseous elements. ()
- (5) The (p)-block in the modern periodic table consists of 5 vertical groups. ()
- (6) The (d)-block contains most types of elements. ()

The periodic table and the electron configuration of the elements and their properties

- (7) The position of an element in the periodic table can be determined by knowing its mass number. ()
- (8) Elements in the same period have similar chemical properties. ()
- (9) The element located in period 1 and the zero group has an atomic number of 1 ()
- (10) The element located in period 2 and group 16 is a divalent metal. ()
- (11) Elements $_{4}\text{X}$, $_{12}\text{Y}$, $_{20}\text{Z}$ are located in the same period and three consecutive groups. ()
- (12) The valency of an element in group 4A equals the group number. ()

- (13) Both alkali metals and halogens are monovalent. ()
 (14) The atomic radius increases in the same group as the atomic number increases. ()
 (15) Chlorine is a gaseous element with a boiling point lower than 25°C ()

10 Correct the underlined words :

Attempts to classify elements and the modern periodic table

- (1) Elements in Mendeleev's periodic table were arranged according to their atomic numbers.
 (2) Mendeleev discovered that the properties of elements repeated periodically at the beginning of each sublevel.
 (3) Most elements in the periodic table are liquids at room temperature.
 (4) The electron configuration of an alkaline earth metals end with one electron, while that of halogens end with two electrons.
 (5) Alkali metals begin to appear in period 4 in the modern periodic table.
 (6) All elements of the (f)-block are nonmetals, while metalloids belong to the (s)-block.

The periodic table and the electron configuration of the elements and their properties

- (7) The element whose atomic number is 18 is located in period 2 , group 16
 (8) Lewis dot structure of the beryllium atom $_4\text{Be}$ includes four unpaired electrons.
 (9) The valency of halogens is 7
 (10) The melting point of lithium is equal to that of sodium.

11 State the number (or the figure) which indicates each of the following :

Attempts to classify elements and the modern periodic table

- (1) The number of elements in the modern periodic table so far.
 (2) The number of periods in the modern periodic table.
 (3) The number of groups in the modern periodic table.
 (4) The number of blocks in the modern periodic table.
 (5) The number of (s)-block groups. (6) The number of (p)-block groups.

The periodic table and the electron configuration of the elements and their properties

- (7) The number of occupied energy levels with electrons in the atom of calcium element $_{20}\text{Ca}$
 (8) The number of electrons in the last energy level of neon.
 (9) The number of unpaired electrons in the Lewis structure of argon atom $_{18}\text{Ar}$
 (10) The valency of inert gases.
 (11) The number of valence electrons in the atom of phosphorus $_{15}\text{P}$

12 Determine the location of each of the following elements in the modern periodic table, and state their valencies :

- (1) $_7\text{N}$ (2) $_{10}\text{S}$ (3) $_9\text{F}$ (4) $_{19}\text{K}$
 (5) $_2\text{He}$ (6) $_{16}\text{P}$ (7) $_{14}\text{Si}$



13 What is the atomic number of each of the following elements :

- (1) An element that is located in period 2 , group 6A
- (2) An element that is located in period 3 , group zero.
- (3) An element that is located in period 1 , group zero.
- (4) An element that is located in period 3 , group 4A
- (5) An element that is located at the end of period 2
- (6) An element that is located at the beginning of period 4
- (7) The monovalent metal located in period 4
- (8) The trivalent nonmetal located in period 3
- (9) The element located in period 3 in the first group of the (p)-block groups.
- (10) The alkaline earth metal which is located in period 4

14 Give reasons for each of the following :

Attempts to classify elements and the modern periodic table

- (1) The scientists have made several attempts to classify elements.
- (2) Moseley rearranged elements in his periodic table in ascending order according to their atomic numbers.
- (3) Sodium $_{11}\text{Na}$ belongs to the alkali metals group.
- (4) It is difficult to identify metalloids based on their electron configurations.

The periodic table and the electron configuration of the elements and their properties

- (5) Potassium element $_{19}\text{K}$ is located in period 4 , group 1A in the modern periodic table.
- (6) Both elements $_{13}\text{Al}$ and $_{17}\text{Cl}$ are located in the same period in the modern periodic table.
- (7) Helium element $_2\text{He}$ is located in group zero, not in group 2A
- (8) Elements of the same group in the modern periodic table have similar chemical properties.
- (9) The valency of each of boron $_5\text{B}$ and nitrogen $_7\text{N}$ is trivalent.
- (10) Halogens are monovalent nonmetals.
- (11) The valency of any inert gas is zero.
- (12) Scientists cannot discover a new element between sulphur $_{16}\text{S}$ and chlorine $_{17}\text{Cl}$ in the modern periodic table.
- (13) Potassium is a solid element at room temperature.
- (14) Chlorine is a gaseous element at room temperature.
- (15) The boiling point of fluorine $_9\text{F}$ is lower than that of chlorine $_{17}\text{Cl}$
- (16) The melting point of lithium $_3\text{Li}$ is higher than that of sodium $_{11}\text{Na}$
- (17) Potassium reacts more vigorously with water than sodium does.

15 What is meant by each of the following :

- | | | |
|--------------------|----------------------------|---------------|
| (1) Alkali metals. | (2) Alkaline earth metals. | (3) Halogens. |
| (4) Inert gases. | (5) Metalloids. | (6) Metals. |
| (7) Nonmetals. | (8) Valence electrons. | |

16 What are the results of increasing the atomic number for each of the following :

- (1) Elements in the same group (regarding the number of occupied energy levels with electrons).
- (2) Elements in the same group (regarding the atomic radius).
- (3) Alkali metals (regarding their melting and boiling points).
- (4) Halogens (regarding their melting and boiling points).
- (5) Alkaline earth metals (regarding the chemical activity).
- (6) Group 7A elements (regarding the chemical activity).

17 Choose the odd word or (symbol) and mention the relation between the rest :

Attempts to classify elements and the modern periodic table

- (1) Mercury / Magnesium / Calcium / Potassium.
- (2) Hydrogen / Chlorine / Nitrogen / Bromine. (3) s / p / o / d / f
- (4) Group 2A / Group 3A / Group 4A / Group 5A
- (5) Chlorine / Iodine / Sulphur / Fluorine. (6) Krypton / Xenon / Nitrogen / Radon.
- (7) Silicon / Boron / Antimony / Cesium.

The periodic table and the electron configuration of the elements and their properties

- (8) $_{12}\text{Mg}$ / $_{13}\text{Al}$ / $_{14}\text{Si}$ / $_{15}\text{P}$ (9) $_{11}\text{Na}$ / $_{3}\text{Li}$ / $_{12}\text{Mg}$ / $_{19}\text{K}$
(10) $_{9}\text{F}$ / $_{6}\text{C}$ / $_{5}\text{B}$ / $_{13}\text{Al}$

18 Arrange the following sentences :

- (1) A transition element / A metalloid / An inert element / A strong metal / A nonmetal (From right to left in the modern periodic table).
- (2) $_{8}\text{O}$ / $_{6}\text{C}$ / $_{2}\text{He}$ / $_{5}\text{B}$ (In ascending order according to the number of valence electrons).
- (3) $_{9}\text{F}$ / $_{13}\text{Al}$ / $_{18}\text{Ar}$ / $_{20}\text{Ca}$ (In ascending order according to valency).
- (4) $_{7}\text{N}$ / $_{35}\text{Br}$ / $_{3}\text{Li}$ / $_{19}\text{K}$ (In ascending order according to boiling point).
- (5) $_{11}\text{Na}$ / $_{3}\text{Li}$ / $_{19}\text{K}$ / $_{55}\text{Cs}$ (In ascending order according to atomic size "or radius").
- (6) F / I / Br / Cl (In ascending order according to the chemical activity).

19 Compare between each of the following :

Attempts to classify elements and the modern periodic table

- (1) Mendeleev's periodic table, Moseley's periodic table and the modern periodic table (In terms of : The scientific basis for classification).
- (2) (s)-block and (p)-block (In terms of : Location in the modern periodic table – Number of groups – Types of elements).
- (3) Alkali metals group and halogens group (In terms of : Group number – Their block – Number of last energy level electrons – Examples of their elements).



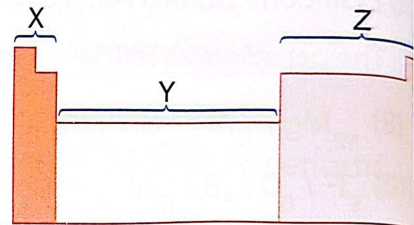
- (4) Group 2A and group zero in the modern periodic table (In terms of : Group name – their block - Number of last energy level electrons - Examples).
- (5) Mercury and Bromine (In terms of : Chemical symbol - Physical state - Type of element).
- (6) Metals and nonmetals (In terms of : Number of last energy level electrons – Their block - Physical state).

The periodic table and the electron configuration of the elements and their properties

- (7) Element ${}_{20}Y$ and element ${}_{10}X$ (In terms of : Electron configuration - Group number - Period number – The block they belong to).
- (8) Element ${}_{17}X$ and element ${}_{19}Y$ (In terms of : Location in the periodic table - Group name - Lewis dot structure - Valency).
- (9) Fluorine and Cesium (In terms of : Location in the periodic table - Chemical activity).

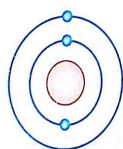
20 Study the following figures, then answer the questions:

- ① The opposite figure: represents a section in the modern periodic table:

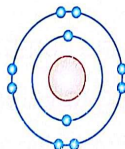


- (1) What are the names of the element blocks indicated by the letters (X), (Y) and (Z) ?
- (2) How many groups are in each block ?

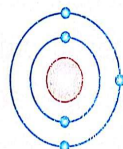
- ② The figures below show the electron configurations of some atoms :



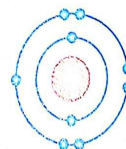
(1)



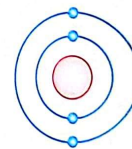
(2)



(3)



(4)



(5)

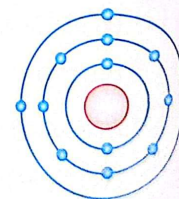
Which of these figures represents :

- (1) A metalloid.
- (2) A noble gas.
- (3) An alkali metal.
- (4) A halogen nonmetal.
- (5) An element whose Lewis dot structure includes two unpaired electrons.

- ③ The opposite figure shows the electron configuration of element (X)

(1) Determine :

- 1- The location of the element in the modern periodic table.
- 2- The block to which the element belongs.



(2) Conclude the atomic number of :

- 1- Element (Y) that follows (X) in the same period.
- 2- Element (Z) that follows (X) in the same group.

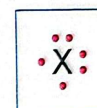
4 The opposite figure represents a part of the modern periodic table:

- (1) Determine the atomic number of the element that precedes element (Y) in the same period.
- (2) Draw the Lewis dot structure for element (Z).
- (3) Complete: These elements are located at the far of the periodic table and belong to block.

| | |
|-----------------|---|
| X | |
| ₁₇ Y | Z |
| L | |

«The letters in the table are not actual element symbols»

5 From the opposite Lewis dot structure of element (X) located in period 3 :

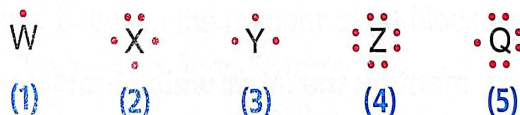


(1) Determine :

- 1- The type of the element.
- 2- The number of the group of the element in the periodic table.

(2) Conclude the valency of element (Y) which follows element (X) directly in the same group in the periodic table.

6 The following figures are the Lewis dot structures of some elements :



Relate each figure to the appropriate statement without repeating figures :

- | | |
|-----------------------------------|----------------------------|
| (1) An element with zero valency. | (2) A monovalent nonmetal. |
| (3) A trivalent nonmetal. | (4) A trivalent metal. |
| (5) A monovalent metal. | |

7 The opposite figure represents a part of the modern periodic table:

- (1) What is the type of element (B) ?
- (2) What does the shaded region in the table represent ?

(3) Mention the letter which represents:

- 1- A transition element.
- 2- An inert gas.
- 3- The element in group 1A which has the largest atomic size (radius).
- 4- Divalent elements.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
| 1 | A | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | |
| 3 | X | L | | | | | | | | | | | | | | | | | |
| 4 | | R | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | |
| 6 | E | | | | | | | | | | | | | | | | | | |

«The letters in the table are not actual element symbols»



8 The opposite figure represents the periods 2 and 3 of the modern periodic table :

- (1) Conclude the names of the elements (A) and (C).
- (2) What is the physical state of element (B) at room temperature ?
- (3) Conclude the melting point of element (Z) relative to room temperature.

| | 1A | 2A | 3A | 4A | 5A | 6A | 7A | 0 |
|----------|----|----|----|----|----|----|----|---|
| Period 2 | A | Y | | Q | | D | | Z |
| Period 3 | X | B | | | | | | C |

«The letters in the table are not actual element symbols»

9 The opposite figure represents one of the groups of the modern periodic table:

- (1) What is the name of this group ? What is the valency of any of its elements ?
- (2) Which block does this group belong to ?
- (3) Calculate the atomic number of element (Z).
- (4) Mention the letter which indicates:
 - 1- The element with the highest boiling point in this group.
 - 2- The most chemically active element in this group.

| |
|-----------------|
| X |
| ₁₁ Y |
| Z |
| L |
| M |

«The letters in the table are not actual element symbols»

10 The opposite figure represents one of the periods in the modern periodic table :

- (1) What is the number of the period shown in the figure ? Why ?
- (2) From this period, mention the letter which indicates:
 - 1- A halogen element.
 - 2- An inert gas.
 - 3- The most active nonmetal element.
- (3) Which block does element (X) belong to ?
- (4) What is the type of element (D) ?

| | | | | | | | |
|---|--|---|---|-----------------|---|---|---|
| A | | X | D | ₁₅ E | G | Y | Z |
|---|--|---|---|-----------------|---|---|---|

«The letters in the table are not actual element symbols»

21 Variant questions :

- 1 Mention the most important achievement of each of the following :
 - (1) Dmitri Mendeleev.
 - (2) Rutherford.
 - (3) Moseley.
 - (4) Lewis.
- 2 Classify each of the following set of elements into two groups , where each group of elements have similar chemical properties, then mention their block :
 - (1) $_{16}\text{S}$, $_{12}\text{Mg}$, $_{20}\text{Ca}$, $_{8}\text{O}$, $_{4}\text{Be}$
 - (2) $_{9}\text{F}$, $_{11}\text{D}$, $_{17}\text{C}$, $_{19}\text{X}$, $_{3}\text{A}$
- 3 Illustrate with a diagram the electron configuration of the element $^{16}_{8}\text{O}$, then :
 - (1) Determine the location of the element in the modern periodic table.

(2) Conclude the atomic number of :

- 1- Element (Y) that follows it in the same group.
- 2- Element (Z) that precedes it in the same period.

4 You have three elements ${}_{17}\text{X}$, ${}_{10}\text{Y}$ and ${}_{12}\text{Z}$:

- (1) Determine the type and block of each element in the modern periodic table.
- (2) Draw the Lewis dot structure of each of them.

5 Two alkali metals (X) and (Y),

If the atomic radius of element (X) is 157 pm and that of element (Y) is 191 pm :

- (1) Which is more chemically active ?
- (2) Which has higher melting point ?

6 The opposite table shows the melting and boiling points of four substances :

- (1) Determine the physical state of each substance at room temperature.
- (2) Determine which substances are in the liquid state at 85°C

| Substance | Melting point | Boiling point |
|-----------|---------------|---------------|
| (A) | 50°C | 90°C |
| (B) | 20°C | 120°C |
| (C) | 5°C | 70°C |
| (D) | -5°C | 18°C |



Higher-order Questions

Answered

2 Choose the correct answer :

(1) What is the difference between the number of (s)-block elements of the period 3 and the period 4 in the modern periodic table ?

- (a) 0 (b) 2 (c) 8 (d) 10

(2) An element its atomic number is 18, the element which precedes it by two groups its atomic number is

- (a) 2 (b) 4 (c) 16 (d) 20

(3) The opposite figure represents a section in the periodic table:

1- Element C belongs to the group of the

- (a) inert gases. (b) halogens.
(c) alkali metals. (d) metalloids.

2- Element D is

- (a) a gas. (b) a solid. (c) a liquid.

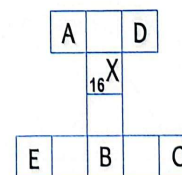
3- The atomic number of element A is

- (a) 7 (b) 8 (c) 17 (d) 18

(4) Potassium is located in period 4 , group 1A

How many neutrons are found in the nucleus of potassium-42 isotope ?

- (a) 19 (b) 20 (c) 23 (d) 42

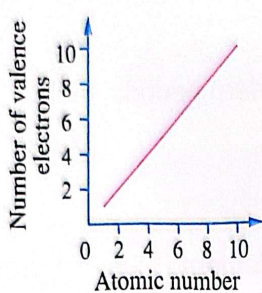


«The letters represent hypothetical symbols of six different elements»

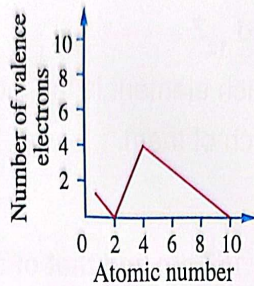
(5) Which of the following Lewis structures represents a chemically inactive element?



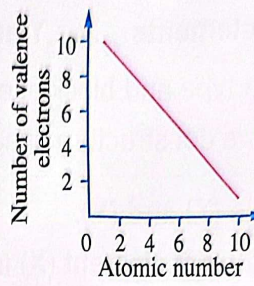
(6) Which of the following is correct?



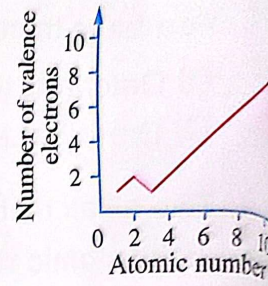
(a)



(b)



(c)



(d)

(7) From the opposite table:

At temperature 26°C ,

- (a) substance (A) is solid.
- (b) substance (C) is solid.
- (c) substances (A) and (B) are liquid.
- (d) substances (A) and (C) are gases.

| Substance | Melting point | Boiling point |
|-----------|--------------------|---------------------|
| (A) | 19°C | 102°C |
| (B) | -5°C | 18°C |
| (C) | 71°C | 134°C |

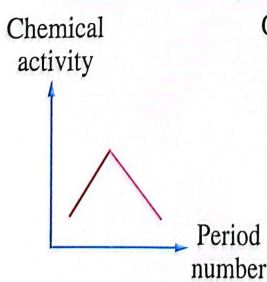
(8) From the opposite table:

The three substances are in the same physical state at

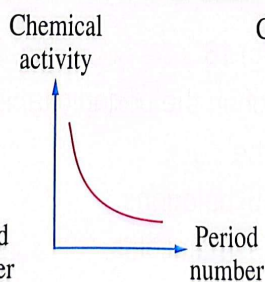
- (a) 32°C
- (b) 60°C
- (c) 75°C
- (d) 80°C

| Substance | Melting point | Boiling point |
|-----------|--------------------|--------------------|
| (A) | 42°C | 78°C |
| (B) | 28°C | 63°C |
| (C) | 54°C | 90°C |

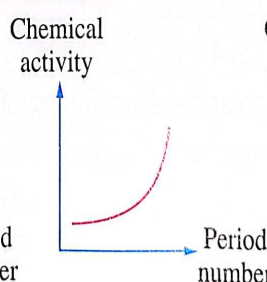
(9) The graph represents the relation between the chemical activity of alkali metals and the period number of each of them.



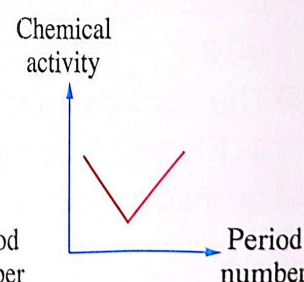
(a)



(b)



(c)



(d)

23 The opposite figure represents a section in the periodic table.

If the electron configuration of element (X) is (2, 8, 2):

(1) Write the electron configuration of each of the elements (A) and (C).

(2) Determine the period number and group number of element (D).

(3) Find the atomic number of element (B), and mention the block to which it belongs.

| | | |
|---|---|---|
| | A | |
| D | X | C |
| | B | |