

Name \_\_\_\_\_

Date \_\_\_\_\_

**STUDY GUIDE – CHAPTER 1**  
**ATOMS AND ELEMENTS**

**1) DESCRIBE THE RUTHERFORD-BOHR ATOMIC MODEL**

All matter is made of small particles called **atoms**. An atom is the smallest unit of matter that retains the identity of the substance. Scientists now know that inside an atom there are three sub-atomic particles and that atoms differ in the number and arrangement of these particles.

Particle	Charge	Location
electron	negative(-)	outside the nucleus
proton	positive (+)	inside the nucleus
neutron	neutral (0 charge)	inside the nucleus

- The protons and neutrons are found **inside** the **nucleus** of an atom.
- Electrons are found **outside** the nucleus; they move on circular paths (also called energy levels or simply shells).

**SAMPLE QUESTIONS:**

1) The term “nuclear charge” refers to the overall charge of the **nucleus** of an atom. Complete the following sentence. **The nuclear charge of an atom is always ...**

- |             |                      |
|-------------|----------------------|
| A) negative | C) neutral           |
| B) positive | D) none of the above |

2) **Choose the correct answer to complete the following sentence:** “In all neutral atoms there are always...”

- A) as many protons as electrons.  
 B) as many protons as neutrons.  
 C) as many electrons as neutrons.  
 D) more neutrons than protons.

3) **Complete the following sentences:**

i) ***“In the periodic table, elements in are organized in ...”***

- A) increasing order of their atomic number.
- B) decreasing order of their atomic number.
- C) increasing order of their atomic mass number.
- D) decreasing order of their atomic mass number.

ii) ***“The atomic number represents... ”***

- A) the number of protons in the nucleus.
- B) the number of neutrons in the nucleus.
- C) the number of electrons in the nucleus.
- D) the sum of all the of protons and neutrons.

iii) ***“In the Rutherford-Bohr atomic model, electrons are distributed in circular orbits also called...”*** \_\_\_\_\_

4) Listed below is information pertaining to the Rutherford-Bohr model of an atom of a chemical element.

- 1 – The positive charges.
- 2 – The negative charges.
- 3 – The electron shells (energy levels).
- 4 – The valence electrons.

***Which table correctly illustrates the position of each of them?***

A	Inside the nucleus	Outside the nucleus
	1, 2, and 3	4

B	Inside the nucleus	Outside the nucleus
	1	2, 3 and 4

C	Inside the nucleus	Outside the nucleus
	1 and 2	3 and 4

D	Inside the nucleus	Outside the nucleus
	2 and 3	1 and 4

## 2) REPRESENT ATOMS USING THE RUTHERFORD-BOHR MODEL

The Rutherford-Bohr atomic model represents the **nucleus** in the center of an atom. The nucleus contains all the **protons**. The **electrons** move around the nucleus on circular paths (represented by circles).

The number of protons is equal to the atomic number (the smaller number found next to the symbol of the element in the periodic table). The number of electrons is also equal to the atomic number. The number of neutrons can vary from an element to another.

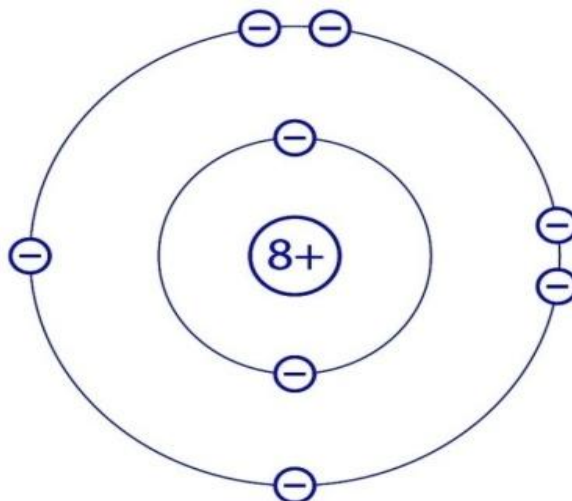
Electron shells can hold only certain numbers of electrons. The distribution of electrons for the first 20 elements is the following:

- Level 1- 2 electrons;
- Level 2- 8 electrons;
- Level 3- 8 electrons;
- Level 4- 2 electrons;

Example: the following diagram is a representation of the oxygen atom according to the Rutherford-Bohr model. The atomic number of oxygen is 8 therefore this element is represented by 8 protons (positive charges) in the nucleus and 8 electrons (negative charges) that are distributed as follows:

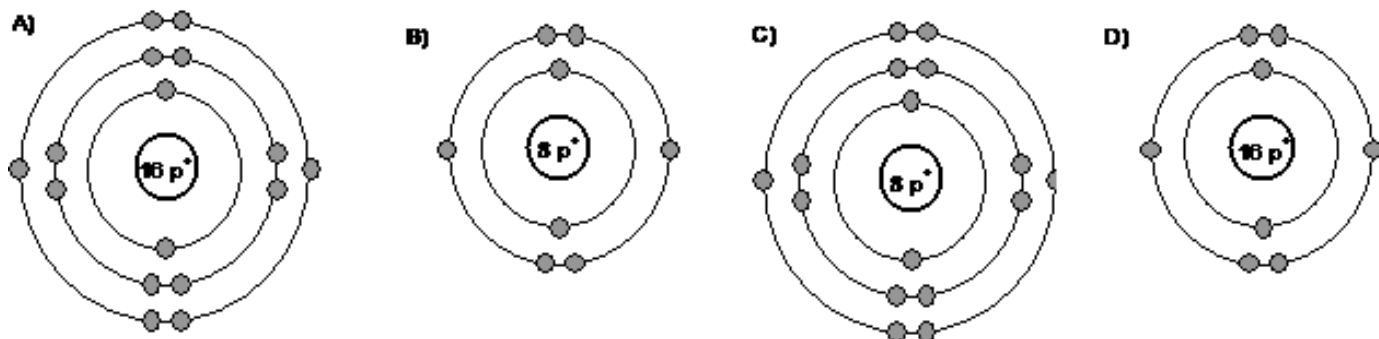
- 2 electrons on the first shell
- 6 electrons on the second shell.

Figure 1 RUTHERFORD-BOHR DIAGRAM OF AN OXYGEN ATOM

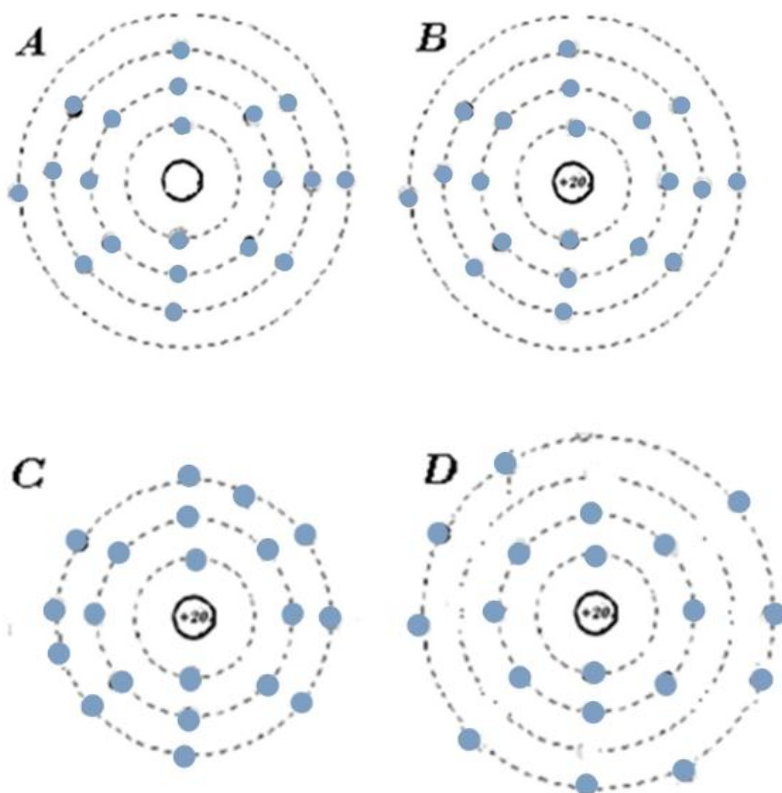


**SAMPLE QUESTIONS:**

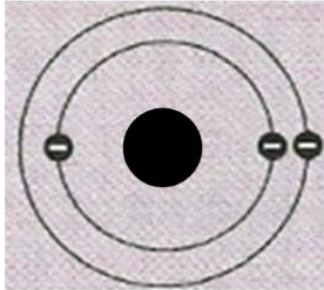
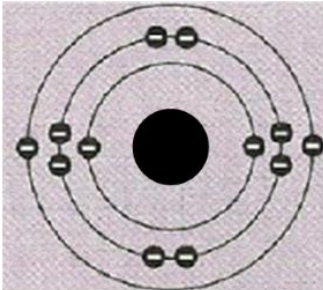
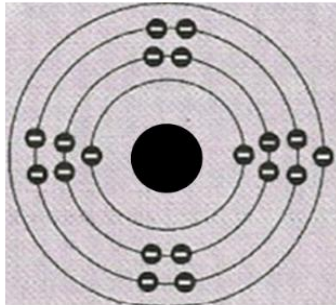
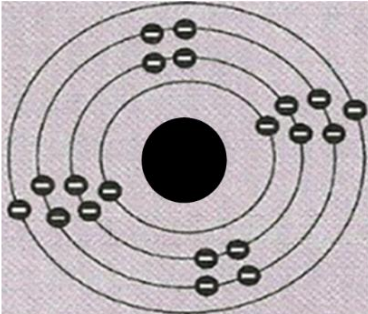
1) Oxygen is a gas important for life and it represents about 21% of the Earth's atmosphere. *Which of the illustrations below best represents a Rutherford-Bohr diagram of an oxygen atom?*



2) *Which of the following best represents the Rutherford-Bohr model of a calcium atom,  ${}_{20}\text{Ca}^{40}$ ?*



3) Four different elements are represented below according to the Rutherford-Bohr atomic model. Write the name of each of the four elements on the line under the model.

	
<p>Name: _____</p>	<p>Name: _____</p>
	
<p>Name: _____</p>	<p>Name: _____</p>

4) Draw the Rutherford-Bohr diagram of the following atoms:

<p>Sodium:</p>	<p>Fluorine:</p>
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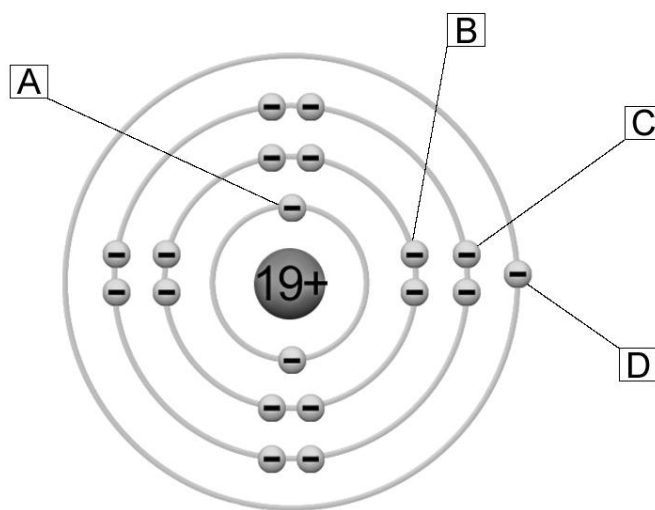
### 3) DETERMINE THE NUMBER OF VALENCE ELECTRONS IN AN ELEMENT

- The number of **valence electrons** an atom has is equal to the **second digit** of the group number that the element belongs to. Valence electrons take part in all chemical reactions.
- Elements situated in the same group have the same number of valence electrons.

I A (1)	II A (2)	III A (13)	IVA (14)	VA (15)	VIA (16)	VII A (17)	VIII A (18)
1 valence electron	2 valence electrons	3 valence electrons	4 valence electrons	5 valence electrons	6 valence electrons	7 valence electrons	8 valence electrons

#### SAMPLE QUESTIONS:

- 1) In the atomic model of potassium below, *which letter represents a valence electron?*



Potassium

2) Complete the following sentence with one of the options given: ***“The valence electrons are those electrons situated \_\_\_\_\_ of the atom”.***

- A) on the first energy level
- B) on the second energy level
- C) on the third energy level
- D) on the last energy level

3) ***What do the elements situated in the same group have in common?***

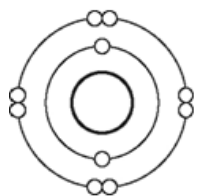
- A) The same number of valence electrons.
- B) The same number of protons.
- C) The same number of electrons.
- D) The same number of electron shells.

4) Complete the following sentence: ***“Elements situated in the same group display similar chemical properties because ....”***

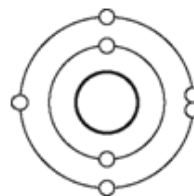
- A) They have similar sizes.
- B) They have the same number of electron shells.
- C) They have the same number of valence electrons.
- D) They belong to the same period.

5) ***Write the number of valence electrons that each of the elements depicted by the diagrams below have:***

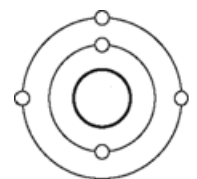
A.



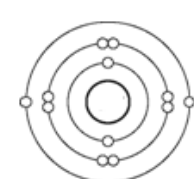
C.



B.

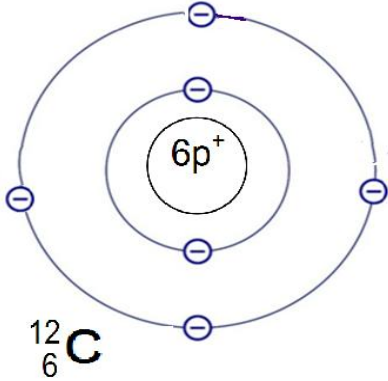



D.

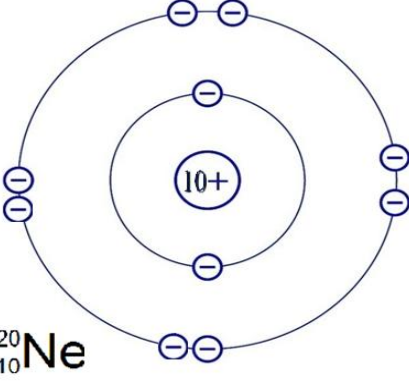



#### 4) REPRESENT ATOMS USING LEWIS NOTATION

The Lewis notation is a representation of the atom in which the **valence electrons** are illustrated by **dots** placed around the **chemical symbol** of the element. Example: the carbon atom.

Rutherford-Bohr diagram	Lewis notation
	

If an element has more than four valence electrons, they are **doubled** to form pairs of dots **around** the element. For example, neon is represented by eight valence electrons.

Rutherford-Bohr diagram	Lewis notation
	

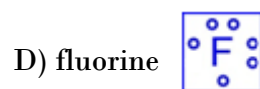
#### SAMPLE QUESTIONS:

1) Draw a Lewis structure for each of the following elements:

Potassium	Boron	Calcium	Oxygen	Fluorine	Phosphorus	Argon	Silicon



2) Which one of the following Lewis structures is NOT a CORRECT representation?



3) Draw an electron energy level diagram (Rutherford-Bohr diagram) of  $^{35}_{17}\text{Cl}$ . Then represent the chlorine atom using a Lewis diagram.

<i>Rutherford-Bohr diagram</i>	<i>Lewis notation</i>
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### 5) LOCATE THE GROUPS AND PERIODS IN THE PERIODIC TABLE

The periodic table of the chemical elements is a tabular method of displaying the chemical elements.

- A **group** (family) is a **column** (vertical line) in the periodic table of the elements. The groups are numbered in two ways: from 1-18 and with roman numerals: I, II, III, IV, V, VI, VII and VIII.

I A (1)	II A (2)	III A (13)	IVA (14)	VA (15)	VIA (16)	VII A (17)	VIII A (18)

- A **period** is a **row** (horizontal line) in the periodic table of the elements. Periods are marked with numbers from 1-7, on the left side of the periodic table.

1							
2							
3							
4							
5							
6							
7							

#### SAMPLE QUESTIONS

- Consider some elements from the periodic table represented by the following chemical symbols: F, Cl, Br, I. **What do these elements have in common?**
  - They belong to the same period.
  - They belong to the same group.
  - They are all gases at room temperature.
  - They are all liquids at room temperature.

6) ASSOCIATE THE NUMBER OF ELECTRON SHELLS IN AN ELEMENT WITH THE NUMBER OF ITS PERIOD;  
ASSOCIATE THE NUMBER OF VALENCE ELECTRONS IN AN ELEMENT WITH ITS FAMILY

- Elements situated on the **same period** have the same number of **electron shells** (energy levels).
- Elements situated in the same **group** have the same number of **valence electrons**.

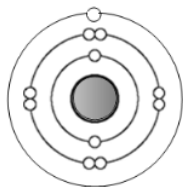
**SAMPLE QUESTIONS**

1) **What do the elements situated on the same period have in common?**

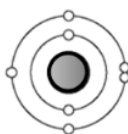
- A) The same number of valence electrons.
- B) The same chemical reactivity.
- C) The same number of electron shells.
- D) The same number of electrons.

2) Four different elements are represented below according to the Rutherford-Bohr atomic model. **On the line under the model, write the period these elements belong to.**

A.



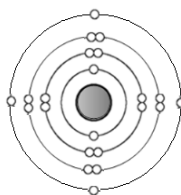
C.



B.



D.



3) **Specify the number of electron orbits and the number of valence electrons for each of the element in the table below.**

Name of element	# of electron shells	# of valence electrons	Name of element	# of electron shells	# of valence electrons
Calcium			Phosphorus		
Argon			Hydrogen		

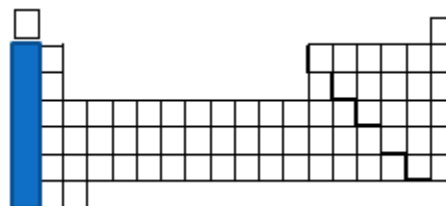


## 7) DESCRIBE THE COMMON CHARACTERISTICS OF A GROUP

- Because all elements situated in the **same group** have the same number of valence electrons, they display **similar chemical properties**. They are therefore, also called “families”.
- Some groups of the periodic table display very distinct characteristic and are given special names.

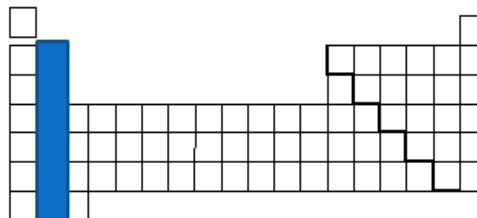
### Group 1 - ALKALI METALS (Li, Na, K, Rb, Cs, Fr)

- Soft, low melting, shiny metals: conduct heat and electricity.
- They are stored in oil due to their high reactivity (also named *oily metals*).



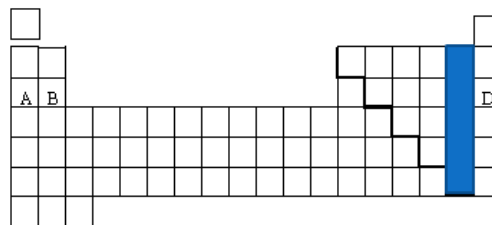
### Group 2 - ALKALINE EARTH METALS (Be, Mg, Ca, Sr, Ba, Ra)

- Harder, higher-melting metals: they conduct heat and electricity.
- They react with acids, water, oxygen and halogens, but not as violently as alkali metals.
- They are mainly found in rocks (therefore called *earth metals*).



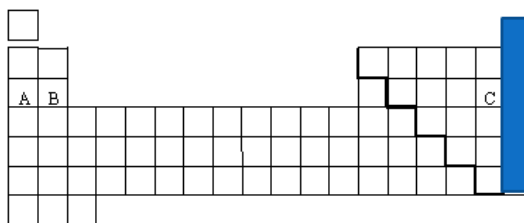
### GROUP 17 (7) – HALOGENS (F, Cl, Br, I, At)

- Very reactive elements.
- They are used for disinfecting.
- At room temperature they can be found in all three states: gases ( $\text{Cl}_2$  and  $\text{F}_2$ ), liquid ( $\text{Br}_2$ ) and solids ( $\text{I}_2$ , At).



### GROUP 18 (8) – INERT (NOBLE) GASES (He, Ne, Ar, Kr, Xe, Rn)

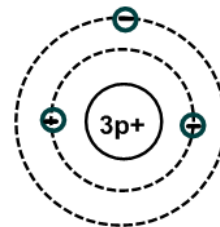
- They do not react with other elements (they are not chemically active).
- They are used in light fixtures.



**SAMPLE QUESTIONS**

- 1) The diagram on the right represents the Rutherford-Bohr atomic model of an element. **Which of the following is true?**

- A) The element is located in period 1 and is an alkaline earth metal.  
 B) The element is located in period 1 and is an alkali metal.  
 C) The element is located in period 2 and is an alkali metal.  
 D) The element is located in period 2 and is an alkaline earth metal.



- 2) **To which chemical family do the following elements belong?**

**At, Br, I**

- a) inert gases      b) alkaline earth      c) halogens      d) alkali metals

- 3) **Which of the following series of elements represents the alkali metals family?**

- a) Fe, Co, Ni, Cu, Zn      b) Li, Na, K, Rb, Cs      c) F, Cl, Br, I, At      d) Li, Be, C, N, O

- 4) **Where in the periodic table can you find the following?** (Specify the number of the group)

- a) an alkaline earth metal?  
 b) a noble gas?  
 c) a halogen?  
 d) an alkali metal?

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- 5) **Draw a Lewis structure** for each of the following elements. Remember to write the names of the elements.

I am a noble gas belonging to the second period.	I am the lightest alkali metal.
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9) Draw a Rutherford-Bohr atomic model for each of the following elements.  
Write the names of the elements in the space provided.

a) I am the third element in the group of alkali metals	b) I am a halogen metal with two electron shells.
Name of element:	Name of element:

10) Six elements from the periodic table are described below.

- A. The lightest element
- B. A gas necessary for respiration
- C. A halogen whose electrons are distributed among three energy levels.
- D. An element that belongs to Period 2 and that has three electrons on its outermost energy level.
- E. An inert gas used to inflate balloons.
- F. A metal necessary for the formation of bones and teeth.

Write the letters A, B, C, D, E and F in the appropriate boxes of the following periodic table.

I A 1						VIII A 18
II A 2	III A 13	IV A 14	V A 15	VI A 16	VII A 17	