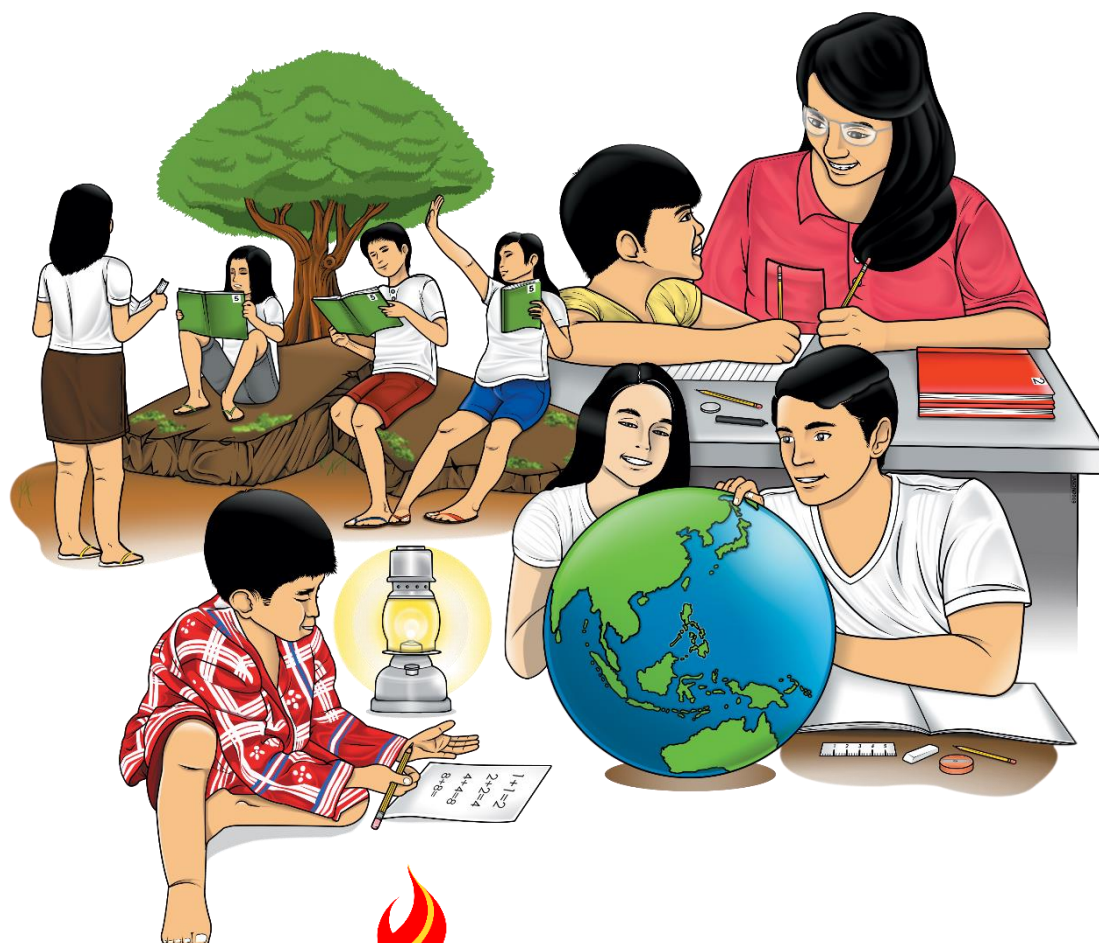


Science

Quarter 2 – Module 5: Formation of Ions



Science – Grade 9
Alternative Delivery Mode
Quarter 2 – Module 5: Formation of Ions
First Edition, 2020

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Science

Quarter 2 – Module 5:

Formation of Ions

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

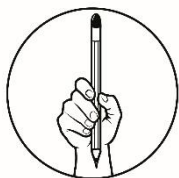
Thank you.



What I Need to Know

At the end of this module, you should be able to:

1. Explain how ions are formed. (**S9MT-IIe-f-16**)
2. Specifically, after going through this module, you will be able to:
 - a. identify the atoms that tend to lose or gain electrons;
 - b. classify ions as whether cations or anions;
 - c. illustrate how atoms loss or gain electrons;
 - d. identify the group number to which an atom belong;
 - e. identify the number of valence electron an atom has based on its group number; and
 - f. write the correct formula of the ion.



What I Know

Directions: Go over each of the following items carefully. Read each statement and choose the letter of your answer from the choices given. Write the letter of your choice on your answer sheet.

1. Which statement best describes an atom?
 - a. An atom carries a positive charge.
 - b. An atom carries a negative charge.
 - c. An atom carries either positive or negative charge.
 - d. An atom is neutral.
2. What is the term given to an atom that carry a positive or negative charge?
 - a. atom
 - b. ion
 - c. isotope
 - d. molecule
3. What sub-atomic particle determines the charge of an atom?
 - a. electron
 - b. neutron
 - c. proton
 - d. all of these

4. Elements that belong to group IA in the periodic table of elements are most likely to
- a. gain an electron
 - b. lose an electron
 - c. either gain or lose an electron
 - d. neither gain nor lose an electron
5. Which of the following is an anion?
- a. An atom that gained an electron.
 - b. An atom that lost an electron.
 - c. An atom that gained a proton.
 - d. An atom that lost a proton.
6. Which of the following group forms 1+ ion?
- a. Group 1
 - b. Group 2
 - c. Group 7
 - d. Group 8
7. Which atom is most likely to form a 3+ ion?
- a. C
 - b. Al
 - c. Ne
 - d. Si
8. An atom carries a 2+ charge. What can you say about the atom?
- a. The atom gained two electrons.
 - b. The atom lost two electrons.
 - c. The atom either lost or gained two electrons.
 - d. The atom neither lost nor gained two electrons.
9. What does a Cl^- ion tell us?
- a. it has lost one electron
 - b. it has gain one electron
 - c. it has lost one proton
 - d. it has gain one proton
10. What happens to Selenium atom if it forms an ion?
- a. It loses 6 valence electrons, and it forms an ion with a charge of 2+
 - b. It loses 6 valence electrons, and it forms an ion with a charge of 6+
 - c. It loses 2 valence electrons, and it forms an ion with a charge of 2-.
 - d. It gains 2 valence electrons, and it forms an ion with a charge of 2-.

Lesson

1

Cations and Anions



What's New

You may have heard about your mother telling you to drink oral rehydration salts when you are experiencing diarrhea to replenish the ions your body may have lost. Have you ever wondered what are those which your body may have lost? Or what are the contents in the oral rehydration salts that prevent you from being dehydrated whenever you are having a severe case of diarrhea?

You may have also seen some electronic gadgets that shows Li-ion on their battery packs. What does Li-ion mean?

Ions are atoms that carry either a positive or a negative charge. These charges are a result of the atom losing or gaining electrons.

Below are boxes that contain symbols. Check those boxes that contain ions.

Cl⁻

F²⁺

Na⁺

S²⁻

K⁺³

You would have probably checked all the five boxes above but did you now that elements have their tendency of whether to carry a positive or a negative charge? We have what we know as the general tendencies of atoms.

Sodium ion (Na⁺), chlorine ion (Cl⁻) and sulfide ion (S²⁻) are all carrying their correct charges. Fluorine (F) cannot carry a 2+ charge since it is more likely to gain an electron, hence fluorine will have a 1- charge when ionized. Potassium (K) on the other hand cannot carry a 3+ charge since it belongs to group 1 and has 1 valence electron, hence, it can only lose an electron and will have a 1+ charge when ionized.



What is It

Consider the following section of the periodic table:

1A 1							8A 18
H	2A 2	3A 13	4A 14	5A 15	6A 16	7A 17	He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar
K	Ca	Ga	Ge	As	Se	Br	Kr
Rb	Sr	In	Sn	Sb	Te	I	Xe
Cs	Ba	Tl	Pb	Bi	Po	At	Rn

Figure 1. Representative Family/Group of the Periodic Table

Q1. Which of the above elements are metals? Color them green. Which of them are non-metals? Color them yellow. Which of these elements are the noble gases? Color them blue.

Q2. Which number will give you an idea on the number of valence electron that an atom has?

Q3. What do you observe of the number of valence electron of metals, non-metals and noble gases?

Q4. What can you say of the electronegativity values of metals, nonmetals and noble gases?

Q5. How can you describe the ionization energy values of metals, nonmetals and noble gases?

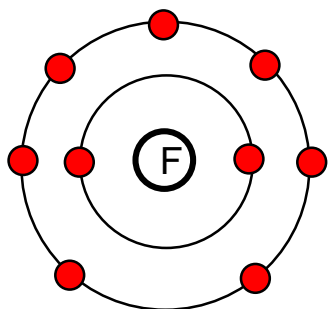
The **valence electrons** are the electrons found in the outermost shell of an atom. These are the electrons that are lost or gained in the process of forming ions. The valence electron of an atom is reflected in its group number. Hence, carbon which belongs to Group 4A has four valence electrons.

Electronegativity is the ability of an atom to attract electrons. The higher the electronegativity value of an atom, the greater is its ability to attract electrons. In period 2 of the periodic table, fluorine is located at the rightmost part of the row. Hence,

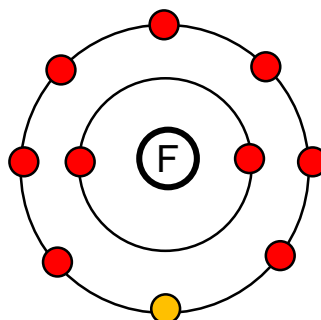
fluorine has the highest electronegativity value and it is the atom that is most likely to attract electrons. Thus, fluorine has the highest tendency to gain electrons and become negatively-charged. Generally, non-metals are the ones that tend to gain electrons and become negatively-charged ions. They are called anions.

Ionization energy is the energy required to pull or remove electrons from an atom. The lower the ionization energy value of an atom, the easier it is to remove an electron from such an atom. In period 2 of the periodic table, lithium is located in the leftmost part of the row and is the element having the lowest ionization energy, thus, it has the highest tendency to lose electrons and become positively-charged. Generally, metals are the ones that tend to lose electrons and become positively-charged ions. They are called cations.

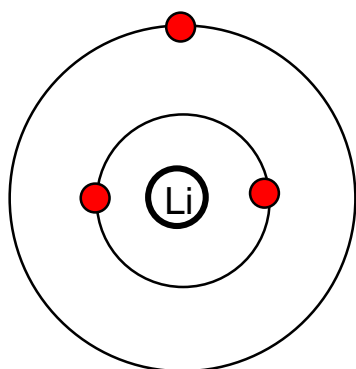
To illustrate the above atoms from their neutral state to their ionized state, we make use of the Bohr model of an atom.



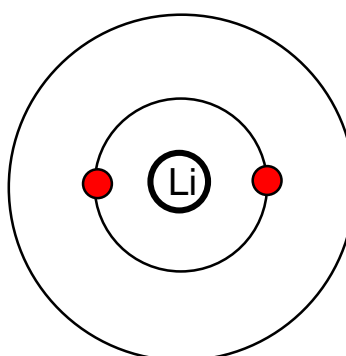
Fluorine in neutral state



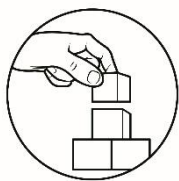
Fluorine in ionized state
(negatively - charged)



Lithium in neutral state



Lithium in ionized state
(positively - charged)



What's More

Look for the following elements in the periodic table and determine whether they tend to lose electrons and become cation or gain electrons and become anion. Put a check mark (☐) on the column that is applicable. The first item is done for you.

ELEMENT	GROUP IN PERIODIC TABLE		ATOM TEND TO:		CLASSIFICATION	
	metal	nonmetal	lose e ⁻	gain e ⁻	cation	anion
Fluorine (F)		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>
Potassium (K)						
Oxygen (O)						
Magnesium (Mg)						
Sulfur (S)						

1

2

Periodic Table of the Elements

13

14

15

16

17

18

He

3

4

No
Element

5

6

7

8

9

10

11

12

13

14

15

16

17

18

Ne

11

12

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

Ar

19

20

21

22

23

24

25

26

27

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57-71

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87

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89-103

104

105

106

107

108

109

110

111

112

113

114

115

116

117

118

K

Ca

Sc

Ti

V

Cr

Mn

Fe

Co

Ni

Cu

Zn

Ga

Ge

As

Se

Br

Kr

Rb

Sr

Y

Zr

Nb

Mo

Tc

Ru

Rh

Pd

Ag

Cd

In

Sn

Sb

Te

I

Xe

Cs

Ba

La-Lu

Hf

Ta

W

Re

Os

Ir

Pt

Au

Hg

Tl

Pb

Bi

Po

At

Rn

Fr

Ra

Ac-Lr

Rf

Db

Sg

Bh

Hs

Mt

Ds

Rg

Cn

Uut

Uuq

Uup

Uuh

Uus

Uuo

57

58

59

60

61

62

63

64

65

66

67

68

69

70

71

La

Ce

Pr

Nd

Pm

Sm

Eu

Gd

Tb

Dy

Ho

Er

Tm

Yb

Lu

89

90

91

92

93

94

95

96

97

98

99

100

101

102

103

Ac

Th

Pa

U

Np

Pu

Am

Cm

Bk

Cf

Es

Fm

Md

No

Lr

☐ Transition Metal

☐ Metal

☐ Metalloid

☐ Non-metal

☐ Noble Gas

☐ Lanthanide

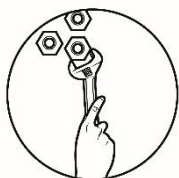
☐ Actinide



What I Have Learned

Using the Bohr model, illustrate the neutral and ionized states of sodium and chlorine atoms.

neutral state of a Sodium atom	ionized state of Sodium
neutral state of a Chlorine atom	ionized state of Chlorine



What I Can Do

Compose a pretend dialogue between a calcium atom and an oxygen atom where they talk about their experience in becoming a cation and anion respectively.

Lesson

2

Ions and Charges



What's In

Atoms are electrically neutral despite them having charged sub-atomic particles, i.e., the negatively- charged electrons and the positively -charged protons. This is because the number of negatively- charged electrons and positively -charged protons are equal.

In Lesson 1, you learned that ions are formed when an atom loses or gains electron. Atoms need to lose or gain electrons in order to be stable. They become stable when their outermost shell or valence shell contains eight (8) electrons, which satisfies the Octet Rule.

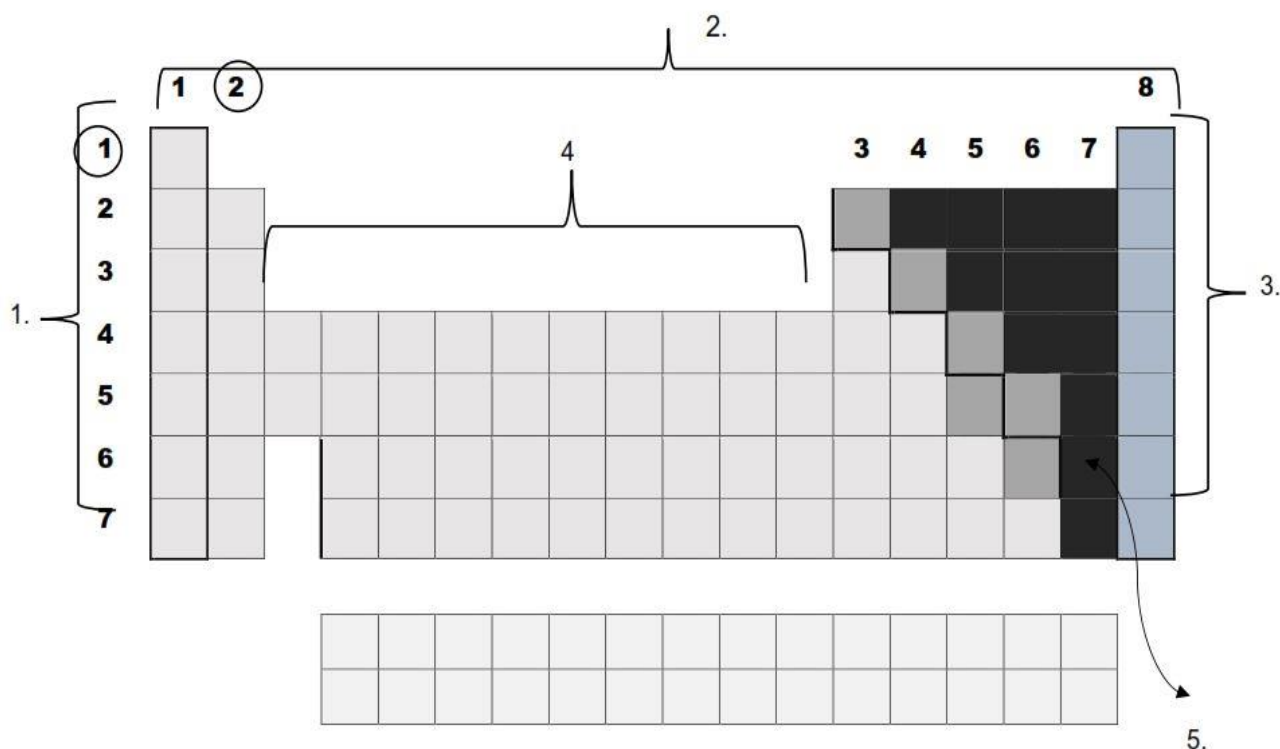
Atoms that lose an electron in its outermost shell carry a positive charge because by losing electrons, the number of positively charged protons exceed those of the negatively charged electrons. These are called cations. On the other hand, when atoms gain electrons in its outermost shell, the number of their negatively charged electrons exceed those of the positively charged protons, thus, they carry a negative charge. These are called anions.

But do you know how to determine the number of their charges? You will soon find out.



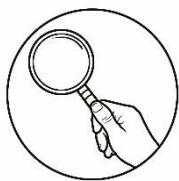
What's New

How well did you remember the periodic table? Label the numbered parts of the periodic table.



What information can be derived from the arrangement of elements in the periodic table?

The elements in the periodic table are arranged according to increasing atomic number. The rows (number 1) are called periods and the columns (number 2) are called groups. Group number in the periodic table gives us the number of valence electron in its outermost energy shell. Noble gases elements are stable elements, which is number 3 above. What is the possible reason for calling those elements noble? It means they don't have to lose or gain electrons in order to satisfy the octet rule. The elements with a lighter shade of gray are the metallic elements. What are the characteristic of these elements? They have the tendency to lose electrons in order to be stable. These elements are most stable when giving out their electrons in their outermost shell. The elements in number 5, the nonmetals, are most likely to gain electrons to attain stability.



What is It

	IA											IIIA	IVA	VA	VIA	VIIA	VIII		
																		A	
1	¹ H																		² He
2	³ Li	⁴ Be											⁵ B	⁶ C	⁷ N	⁸ O	⁹ F	¹⁰ Ne	
3	¹¹ Na	¹² Mg											¹³ Al	¹⁴ Si	¹⁵ P	¹⁶ S	¹⁷ Cl	¹⁸ Ar	
4	¹⁹ K	²⁰ Ca	²¹ Sc	²² Ti	²³ V	²⁴ Cr	²⁵ Mn	²⁶ Fe	²⁷ Co	²⁸ Ni	²⁹ Cu	³⁰ Zn	³¹ Ga	³² Ge	³³ As	³⁴ Se	³⁵ Br	³⁶ Kr	
5	³⁷ Rb	³⁸ Sr	³⁹ Y	⁴⁰ Zr	⁴¹ Nb	⁴² Mo	⁴³ Tc	⁴⁴ Ru	⁴⁵ Rh	⁴⁶ Pd	⁴⁷ Ag	⁴⁸ Cd	⁴⁹ In	⁵⁰ Sn	⁵¹ Sb	⁵² Te	⁵³ I	⁵⁴ Xe	
6	⁵⁵ Cs	⁵⁶ Ba		⁷² Hf	⁷³ Ta	⁷⁴ W	⁷⁵ Re	⁷⁶ Os	⁷⁷ Ir	⁷⁸ Pt	⁷⁹ Au	⁸⁰ Hg	⁸¹ Tl	⁸² Pb	⁸³ Bi	⁸⁴ Po	⁸⁵ At	⁸⁶ Rn	
7	⁸⁷ Fr	⁸⁸ Ra		¹⁰⁴ Rf	¹⁰⁵ Db	¹⁰⁶ Sg	¹⁰⁷ Bh	¹⁰⁸ Hs	¹⁰⁹ Mt	¹¹⁰ Ds	¹¹¹ Rg	¹¹² Cn	¹¹³ Uut	¹¹⁴ Fl	¹¹⁵ Uup	¹¹⁶ Lv	¹¹⁷ Uus	¹¹⁸ Uuo	

⁵⁷ La	⁵⁸ Ce	⁵⁹ Pr	⁶⁰ Nd	⁶¹ Pm	⁶² Sm	⁶³ Eu	⁶⁴ Gd	⁶⁵ Tb	⁶⁶ Dy	⁶⁷ Ho	⁶⁸ Er	⁶⁹ Tm	⁷⁰ Yb	⁷¹ Lu
⁸⁹ Ac	⁹⁰ Th	⁹¹ Pa	⁹² U	⁹³ Np	⁹⁴ Pu	⁹⁵ Am	⁹⁶ Cm	⁹⁷ Bk	⁹⁸ Cf	⁹⁹ Es	¹⁰⁰ Fm	¹⁰¹ Md	¹⁰² No	¹⁰³ Lr

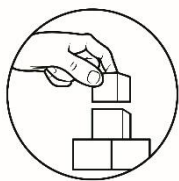
Using the periodic table above, determine the group number of the elements enumerated below.

- | | | | |
|-------|-------|-------|-------|
| 1. Na | _____ | 6. B | _____ |
| 2. F | _____ | 7. N | _____ |
| 3. P | _____ | 8. Be | _____ |
| 4. Ba | _____ | 9. Ra | _____ |
| 5. C | _____ | 10. S | _____ |

The group number in the periodic table gives the number of electron in its outermost shell or the valence shell, thus it is called as the **valence electron**. The valence electron gives us the number of electron that an atom may loss or gain. An atom that losses or gains electron will become positively or negatively charged ion. For example, Lithium belongs to group 1. It means it can lose 1 electron to become stable.

Use the periodic table above to determine the valence electron of the following elements:

- | | |
|-------|-------|
| 1. P | _____ |
| 2. Cl | _____ |
| 3. K | _____ |
| 4. Ca | _____ |
| 5. S | _____ |



What's More

I. Write the name and symbol of the ion formed when

1. A Chlorine atom gains one electron _____
2. A zinc atom loses two electrons _____
3. An iron atom loses two electrons _____
4. An aluminum atom loses three electrons _____
5. A bromine atom gains one electron _____

II. Using the periodic table, write the ion formula of the elements below.

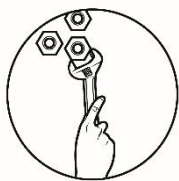
1. Nitrogen _____
2. Francium _____
3. Strontium _____
4. Sodium _____
5. Phosphorus _____
6. Gallium _____
7. Arsenic _____
8. Potassium _____
9. Calcium _____
10. Beryllium _____



What I Have Learned

Supply what is ask in each column. The 1st and 3rd numbers are done for you.

Name of Element	Symbol	Group number	Number of valence electron	Ion formula
Bromine	Br	7	7	Br ⁻
Nitrogen				
Aluminum	Al	3	3	Al ³⁺
Barium				
Copper				
Strontium				
Iodine				
Magnesium				
Fluorine				
Sulfur				



What I Can Do

It's more fun in our house!!!! Make a tour around your house and list the different elements you can find among the many appliances and equipment. Write the ion formula of the elements you have identified.

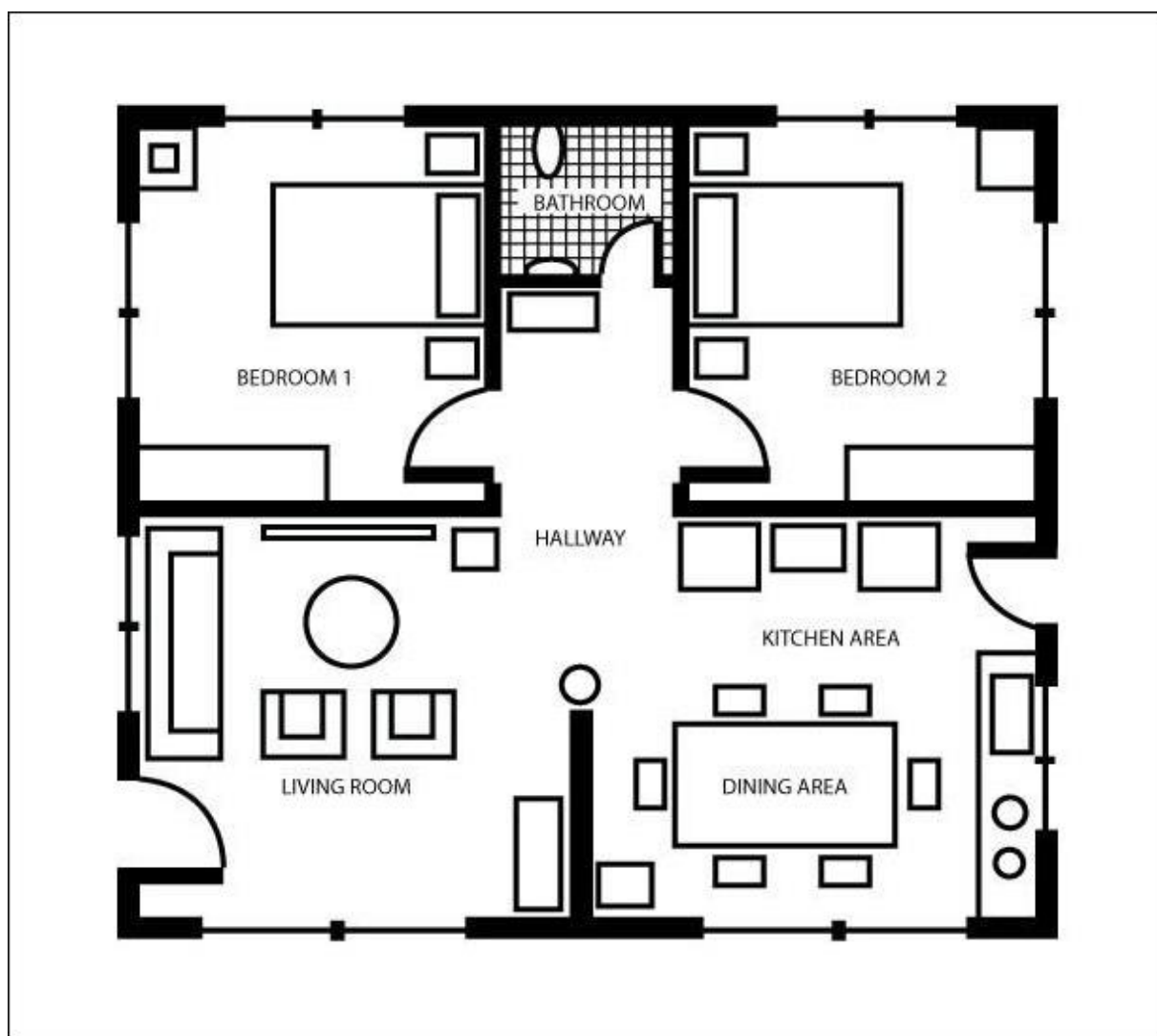
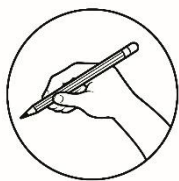


Figure 2. Sample Floor Plan

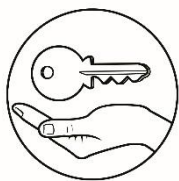


Assessment

Multiple Choice: Read each question carefully. Choose the **BEST** answer. Write the letter of your answer on your answer sheet

1. What sub-atomic particle is mainly involved in the formation of ions?
 - a. electrons
 - b. neutrons
 - c. protons
 - d. all of them
2. Potassium belongs to group IA in the periodic table. Potassium is most likely to
 - a. gain an electron
 - b. lose an electron
 - c. either gain or lose an electron
 - d. neither gain nor lose an electron
3. Which of the following atoms is most likely to become a cation?
 - a. Argon
 - b. Bromine
 - c. Calcium
 - d. iodine
4. Which atom is most likely to form a 1- ion?
 - a. Ag
 - b. I
 - c. P
 - d. S
5. Which is a general characteristic of metals?
 - a. losing valence electrons.
 - b. gaining valence electrons.
 - c. Sharing valence electrons.
 - d. sometimes gaining and sometimes losing valence electrons.
6. How many valence electrons does an atom of an element in Group 7A has?
 - a. 2
 - b. 4
 - c. 7
 - d. 8

7. Calcium belongs to Group IIA. What will be the charge of calcium when it becomes an ion?
- 2+
 - 6+
 - 2-
 - 6-
8. An atom carries a 2+ charge. What can you say about the atom?
- The atom gained two electrons.
 - The atom lost two electrons.
 - The atom either lost or gained two electrons.
 - The atom neither lost nor gained two electrons.
9. What happens when Fe^{3+} ion is formed?
- an atom of iron loses three electrons
 - an atom of iron loses three protons.
 - an atom of iron gains three electrons.
 - an atom of iron gains three protons
10. What happens to metals in Groups 5A, 6A, and 7A when they form ions?
- lose electrons
 - form positively charged ions.
 - form ions with charges of 3-, 2-, and 1-, respectively.
 - form ions with a numerical charge equal to their group number.



Answer Key

Assessment post-test

1. A 3. C 5. A 7. A 9. A
2. B 4. B 6. C 8. B 10. C

What's More

I.
1. Cl-
2. Zn²⁺
3. Fe²⁺
4. Al³⁺
5. Br-

II.
1. N³⁻
2. Fr²⁺
3. Sr³⁺
4. Na⁺
5. P³⁻

6. Ga³⁺
7. As³⁻
8. K⁺
9. Ca²⁺
10. Be²⁺

A.

1. P -5
2. Cl -7
3. K -1
4. Ca -2
5. S -6

What is it

1. Na
2. F
3. P
4. Ba
5. C

- group 1
- group 7
- group 5
- group 2
- group 4

6. B
7. N
8. Be
9. Ra
10. S

- group 3
- group 5
- group 2
- group 2
- group 6

What's New

1. Period
2. Group
3. Noble gases
4. Metals
5. Non-metals

What's More

ELEMENT	GROUP IN PERIODIC TABLE		ATOM TEND TO:		CLASSIFICATION	
	metal	nonmetal	lose e.	gain e.	cation	anion
Fluorine (F)	✓			✓		✓
Potassium (K)	✓		✓		✓	
Oxygen (O)		✓		✓		✓
Magnesium (Mg)	✓		✓		✓	
Sulfur (S)		✓		✓		✓

What Is It

1.

2. Group number
3. metals have lesser valence electrons than nonmetals while noble gases have 8 valence electrons
4. Metals have lower electronegativity values compared to nonmetals
5. Metals have lower ionization energy compared to nonmetals

LESSON 1

What's New

Boxes with check mark: Na⁺ Cl⁻ S²⁻

What I Know (Pre-Test)

1. D 3. A 5. A 7. B 9. B
2. B 4. B 6. A 8. B 10. D

References

- Alvarez, Liza and Dane G. Angeles et al., Science Learner's Material 9
(Department of Education-Instructional Materials Council Secretariat 2014),
132-137
- Soult, Allison. "2.5 Ion Formation - Chemistry LibreTexts." 9 September. 2019
[https://chem.libretexts.org/Courses/University_of_Kentucky/UK%3A_CHE_103_Chemistry_for_Allied_Health_\(Soult\)/Chapters/Chapter_2%3A_Elements_and_Ions/2.5%3A_Ion_Formation](https://chem.libretexts.org/Courses/University_of_Kentucky/UK%3A_CHE_103_Chemistry_for_Allied_Health_(Soult)/Chapters/Chapter_2%3A_Elements_and_Ions/2.5%3A_Ion_Formation)
- "Ions: Predicting Formation, Charge, and Formulas of Ions." *Study.com*, 28 March 2013, study.com/academy/lesson/ions-predicting-formation-charge-and-formulas-of-ions.html

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