Learning Guide Module

Subject Code	Chem 1	**Chemistry 1**
Module Code	4.0	**Chemical Bonding**
Lesson Code	4.1	**Types of Chemical Bonds**
Time Frame		30 minutes

Components	Tasks	TA[1] (min)	ATA[2] (min)
Target 	After working on this module, you are expected to: 1. Determine how the different chemical bonds are formed. 2. Identify the chemical bonds that exist in a substance given its chemical formula. 3. Relate the properties of substances with its chemical bonds.	1	
Hook 	Let us start our discussion by having a game. Try this game with your siblings, your parents or anyone that is in your house. In thirty seconds write as many as you can the things in your house that is a product of chemistry, involves chemistry in any way of making the product, or a product that has direct or indirect application of chemistry. You can use the template below as your guide. "Chemistry Related Things in The House" 1. _____ 2. _____ 3. _____ 4. _____ 5. _____ How many objects or products did you come up with? Ten? Twenty? Thirty? Or more? What are these products? Do they have different sizes and shape? Do they have different states?	5	

[1] Time allocation suggested by the teacher.
[2] Actual time allocation spent by the student (for information purposes only).

	Now try to compare the ones that you wrote with the ones that the other player also wrote. Then, strike out the ones that are common. Like the example below **Player 1** "Chemistry Related Things in The House" ~~1. Sugar~~ ~~2. Water~~ ~~3. Table salt~~ 4. Soap 5. Flour **Player 2** "Chemistry Related Things in The House" 1. Coffee ~~2. Water~~ 3. Creamer ~~4. Sugar~~ ~~5. Table Salt~~ 6. Metallic Spoon Now, count the total objects or products that you and co-player have. The one that is unique will count as one for each player while the one that has a strike-out will count as two for both players. What is your total score? The common items or objects you wrote are like your "bonds" with the other players. You both benefit because of these bonds. In this lesson, we are going to discuss more about the different types of chemical bonds.		
Ignite 	Could you imagine a world that is governed by non-interacting elements in the periodic table? We will only have 118 unique substances. With this poor diversity of substance, life, the earth and the other substances that we know of will never exist. To solve this dilemma we need to understand how chemical bonds are formed. According to Tro, (2017), bond formation is an underlying concept that requires knowledge in quantum mechanics and thermodynamics.	10	

Nonetheless, bond formation is possible because "they lower the potential energy between the charged particles that compose the atom". Or in a simpler term bond formation promotes stability to the resulting molecule or compound. This stability happens when an atom of the compounds achieves a noble gas electronic configuration.

However, before we illustrate the concept of bonding we need to understand first that bonding only happens to the valence electrons of the representative elements. This can be illustrated using a Lewis dot symbol. A **Lewis dot symbol** consists of the symbol of the element and one dot for each valence electron in one element. As shown in the figure below.

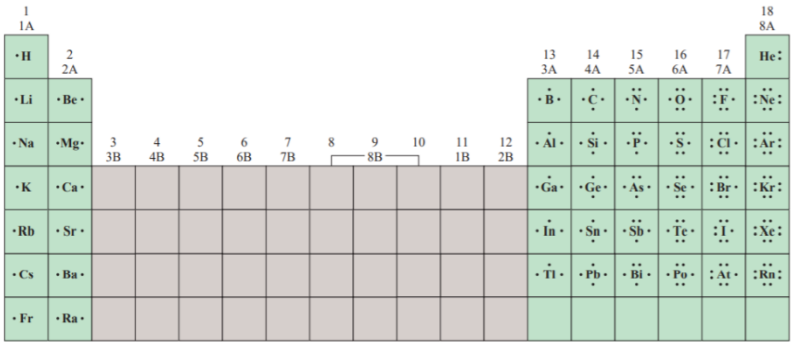


Figure 1. Lewis dot symbol for representative elements and noble gases (Chang,2008)

The dots are placed in four sides of the chemical symbol (top, bottom, left and right) where each side can accommodate two electrons. This means that the maximum electrons that can be expressed in a Lewis symbol is 8. This configuration is represented by the noble gases which follows what we call the octet rule.

The **octet rule** is the guiding principle wherein atoms that undergo reaction eventually end up with 8 valence electrons (except hydrogen and helium). The process of achieving 8 or 2 valence electrons in a reaction can be done by either giving or losing (transferring) electrons in an ionic bond or through sharing electrons in a covalent bond.

IONIC BONDING:

Ionic bond is a bond formed between oppositely charged ions. The ions are formed from atoms by transfer of one or more electrons. This happens when a metallic atom transfers an electron to a non-metal atom. Consider for example, a reaction between sodium and chlorine to form sodium chloride, commonly called table salt, used for flavoring, seasoning and preserving food.

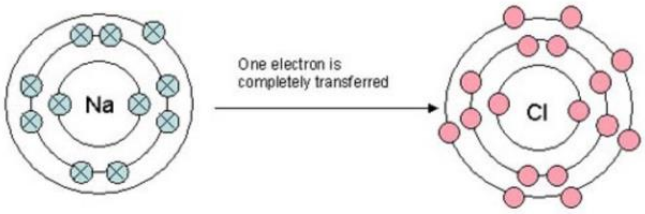


Figure 2. Sodium atom transferring electron to chlorine atom. (RevisionScience, n.d.)

Sodium being a metal has very low first ionization energy and tends to give of easily its valence electron. Thus, sodium can give off its electron and become a positively charged ion. On the other hand, chlorine being a non-metal has negative first electron affinity and can easily gain electrons that are given off by metals. Thus, the chlorine atom that receives the electron becomes a negatively charged ion.

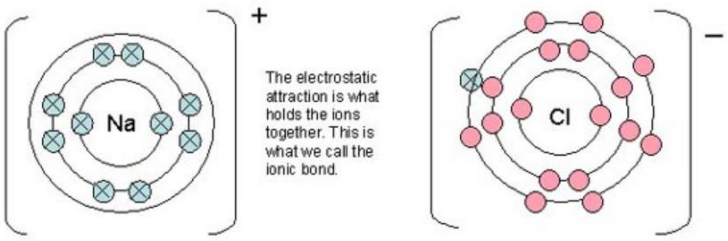
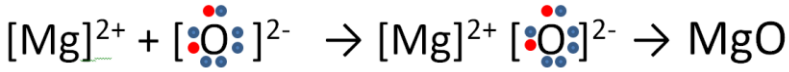


Figure 3. The ionic bond between sodium and chlorine (RevisionScience, n.d.)

Your resulting compound consists of a cation (positively charged ion) and an anion (negatively charged ion). That is held together by ionic bond. And if we are to count the valance electrons of the resulting ions they will all have eight (8) valence electrons. Thus satisfying our octet rule. Substances that have ionic bond are what we call as **ionic compounds**.

Let us consider a reaction between magnesium and oxygen to form magnesium oxide (MgO) a powdered substance usually used as an antacid to treat indigestion. This time we will try by illustrating it through a Lewis dot symbol.

Then,

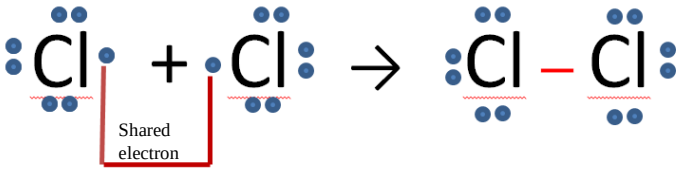


In this reaction magnesium transferred two (2) electrons to oxygen. Giving magnesium a positive two (2+) charge, while oxygen now has a negative two (2-) charge.

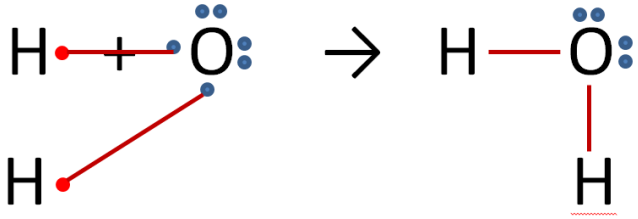
We should always remember that in a ionic bonding the reaction should have a cation (positively charge ion) and an anion (negatively charge ion).

COVALENT BONDING

The second type of bonding that exists is what we call as covalent bonding. **Covalent bonding** arises when an electron is shared by two atoms. Being non-metals, they tend to have higher first ionization energy; therefore they cannot easily remove their own electrons. This means that these non-metals, to satisfy octet rule, must share their electrons. Let us visualize it first with chlorine gas (Cl_2) a green gas that is toxic when inhaled.



In this reaction each chlorine atom shared 1 electron to another chlorine atom. As a sign of bonding a dash line (—) is used to illustrate that there is a shared electron between two atoms. If we are to count the number of electrons present in both chlorine atoms it will sum up to eight (8) electrons (the dash will count as two electrons). Thus satisfying our octet rule. Let us have another example by illustrating the universal solvent, which is water.



As we can see in the example for water, two (2) hydrogen shared their one (1) electron to oxygen, while the oxygen shared one (1) electron to each hydrogen. This resulted to the hydrogen having two electrons and the oxygen having eight electrons. This now satisfies the octet rule (in the case of hydrogen duplet).

METALLIC BONDING

The third type of bonding happens when metal interacts with another metal. Since metals have low ionization energies they lose their electrons easily. The simplest model for metallic bonding is the electron sea model, wherein it depicts the metal as an array of cations in a "sea" of valence electrons. This happens because the electrons are confined to the metal by electrostatic attractions to the cation, that they are distributed uniformly through the structure. Because of metallic bonding, metals have the properties of malleability, ductility and other physical properties inherent to metals.

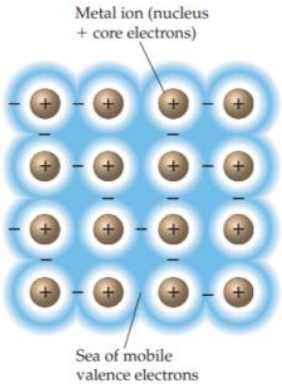


Figure 4 .Electron sea model for metallic bonding (Brown et. al., 2014)

Remember that bonding is not only limited to atoms and molecules. It can also be related to simple activities at home that we do. Just like playing the activity that we did with your family and friends. This bonding activity may involve giving and receiving information or gifts, transferring knowledge, sharing ideas, stories or experiences simply we just go with the flow. However, the ultimate goal of bonding may it be in the atoms or molecules or with someone is to achieve stability to whom we are paired up with. Do not let this pandemic hinder your ability to bond with your family and friends.

Navigate

Work on the following exercises to find out if you understood the lesson.

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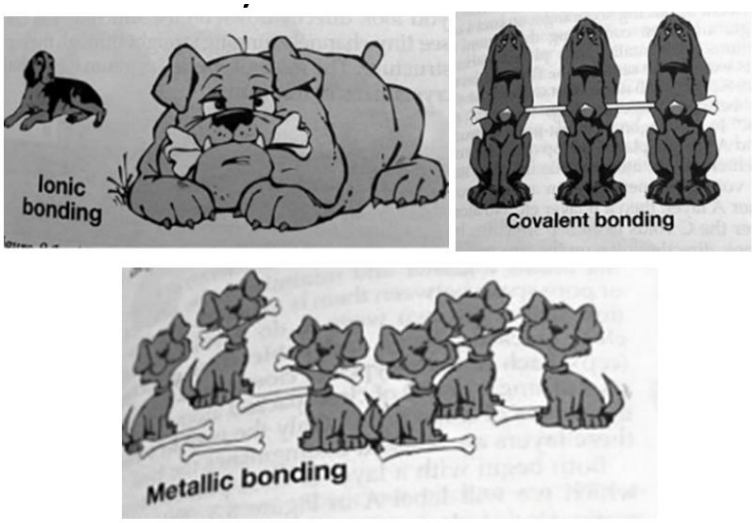
NON-GRADED ASSESSMENT:

	1.) Illustrate creatively by either writing a comic strip or illustration of the three different types of bonding. Just like the example below.  Figure 5 Creative illustration for Chemical bonding. (Imgur Inc. 2017) GRADED ASSESSMENT: 2.) Identify the bonds that are present in the following compounds. A. Lithium bromide B. Aluminum oxide C. Ammonia D. Hydrochloric acid E. Gold foil F. Sodium bromide G. Magnesium fluoride H. Lead slugs I. Glucose		
Knot 	Here are some of the significant key ideas that you should remember about the types of chemical bonding: • Bonding occurs to provide an avenue for compounds to achieve noble gas configuration or simply to achieve stability • The octet rule is a guideline to determine whether or not bonding is possible. • Bonding can be in the form of giving or receiving electrons, sharing electrons or simply by electrons flowing from different forms of metals.	2	

To summarize the types of bonding kindly see the table below.

Table 1	Types of Chemical Bonding	
Types of Atoms/ions	Type of Bond	Characteristic of Bonding
Metal and non-metal	Ionic bonds	Giving and receiving (Transferring) electrons
Non-metal and non-metal	Covalent bonds	Sharing of electrons
Metal and metal	Metallic bonding	Pooling of electrons

References

Brown T., LEMay, H., Murphy, C & Woodward, P. (2014).*Chemistry: The Central Science 13th Edition*.USA: Pearson Education Inc.

Chang, Raymond (2008), *General Chemistry: The Essential Concepts 5th Edition*. New York: McGraw-Hill Companies.

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Picture Sources:

Brown T., LEMay, H., Murphy, C & Woodward, P. (2014).*Chemistry: The Central Science 13th Edition*.USA: Pearson Education Inc.

Chang, Raymond (2008), *General Chemistry: The Essential Concepts 5th Edition*. New York: McGraw-Hill Companies.

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