Name: _____ Per:_____

# Outline Unit 4 – Chemical Bonding & Molecules

## Essential Skills/ State Standards:

1. Know how to use the periodic table to determine the number of electrons available for bonding.
2. Know atoms combine to form molecules by sharing electrons to form **covalent** or **metallic bonds** or by exchanging electrons to form **ionic bonds** and how **electronegativity** and **ionization energy** relate to bond formation.
3. Know salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by **electrostatic attraction**.
4. Know chemical bonds between atoms in molecules such as $H_2$, $CH_4$, $NH_3$, $H_2CCH_2$, $N_2$, $Cl_2$, and many large biological molecules are **covalently bonded**.
5. Know how to draw **Lewis dot structures**
6. Know large molecules **(polymers),** such as proteins, nucleic acids, and starch, are formed by repetitive combinations of simple subunits (**monomers**). Know the name of the monomers that make up each of these polymers.
7. Know the bonding characteristics of carbon that result in the formation of a large variety of structures ranging from simple hydrocarbons to complex polymers and biological molecules.

## Vocabulary

- Ionic bond
- Covalent bond
- Metallic bond
- Polar
- non-polar
- octet rule
- Lewis dot structure
- Electronegativity
- valence electron
- ion & polyatomic ion
- Crystal lattice
- Electrostatic attraction
- VSEPR Theory
- lone pair electrons
- hydrogen Bond
- intermolecular force
- intramolecular force
- conductivity
- solubility
- melting point
- HONC rule
- single, double, & triple bond
- polymers
- monomers
- Proteins, amino acids, polypeptide
- nucleic acid, nucleotide, polynucleotide
- starch, polysaccharide, carbohydrate, monosaccharide
- Lipids , triglycerides, glycerol & fatty acids

## Book Assignments (Chapters 6 and 7 in Chem. book)

| Topic | Read | Problems |
|---|---|---|
| 1. Intro. to Bonding | Pg 161-163 | Sec Rev 6-1, pg 163 **(#1-4)** |
| 2. Covalent Bonding | Pg 164- 175 | Sec Rev 6-2, pg 175 **(#1- 4)** |
| 3. Ionic Bonding | Pg 176 -180 | Sec Rev 6-3, pg 180 **(#1-4)** |
| 4. Molecular Geometry | Pg 183-193 | Review Probs, pg 197 **(#45-48)** |
| 5. Chem. Names/ Formulas | Pg 203-215 | Sec Rev 7-1, pg 215 **(#1-4)** |

## Study Guide (Use notes, book assignments, and other worksheets for a complete review)

1. Compare an **Ionic bond** to a **covalent bond** to a **metallic bond:**

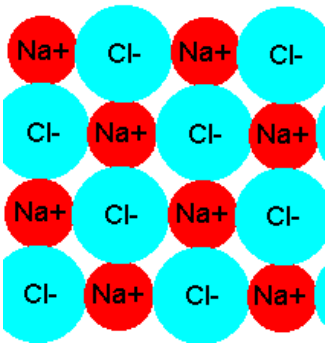
| | Between what types of elements? | What happens to the electrons? | melting point (high/low)? | Soluble in $H_2O$? | Conducts electricity? | Shapes it can form? |
|---|---|---|---|---|---|---|
| **Ionic** | metal and a non-metal | a transfer of electrons from one atom to another causing cations and anions | High | Yes | Yes, but only when dissolved in water | Crystal lattice |
| **Covalent** | Between 2 non-metals | Electrons are shared between atoms. Can be polar or non-polar | Low | Yes | No | VSEPR Shapes (tetrahedral, bent, etc.) |
| **Metallic** | between two metal atoms | Electrons clouds overlap and for a "sea of electrons" | High | No | yes | Lots, it's malleable and can form lots of shapes. |

| 2. Elements to bond | S & O | Cl & Cl | Mg & O | Na & F | Ag & Au |
|---|---|---|---|---|---|
| Bond Type | Covalent (polar) | Covalent (non-polar) | Ionic | Ionic | Metallic |
| How do you know? | 2 non-metals | 2 non-metals | Metal and a non-metal | Metal and a non-metal | 2 metals |

3. How does the **electronegativity** of the two elements bonding influence the **bond type?** (ex: 2 strongly electronegative elements bond vs. 1 strong & 1 weak).

- electronegativity is an atom's ability to pull electrons off of other atoms. Fluorine is "strongest" and any atom near fluorine is also highly electronegative. Generally, metals are less electronegative than non-metals .
- a metal (weak) is bonded to a non-metal (strong), the non-metal is usually able to pull the electrons away from the metal (ionic bond).
- When they are close to being equal in strength, they must share the electrons (covalent bond).

4. a. Draw the ionic structure of a NaCl as it would appear on the molecular level b. How does **electrostatic attraction (aka electromagnetic)** keep these **ionic** compounds together?

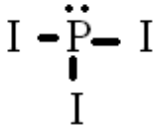



a. Crystals are formed from ionic compounds. There is a repeating pattern of positive and negative ions holds it together.

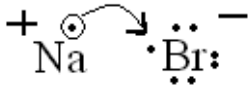
b. cations and anions (+ and – charges) are attracted to each other. We call that electrostatic attraction (sometimes known as electromagnetic attraction). It's what holds ionic compounds together.

5. **a.** Indicate the bond type for each compound **b.** Draw a Lewis dot structure for each of the following:

**$PI_3$** = covalent



**NaBr** = Ionic



**$N_2$**= covalent

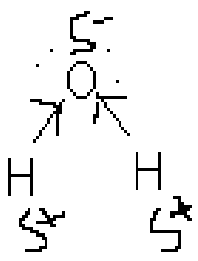
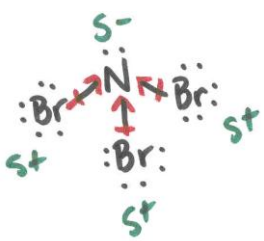
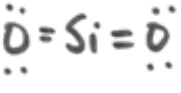
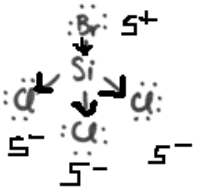
6. a. How many electrons are shared in a single bond, double bond and triple bond?

**Single bond – 2** **Double Bond – 4** **Triple Bond - 6**

b. What type of bond do they occur between (ionic, covalent, metallic)? **Covalent**

c. Compare the bond energy & length between atoms bonded with single, double, & triple bonds.

- **Atoms that are single bonded have the LARGEST bond length & therefore are the easies to break so they have a LOW bond energy.**
- **Atoms that are triple bonded are the closest together & thus have the SMALLEST bond length between atoms & are the most difficult to break apart (thus a HIGH bond energy)**

| 7. | a. $H_2O$ | b. $NBr_3$ | c. $SiO_2$ | d. $SiCl_3Br$ |
|---|---|---|---|---|
| **a) Correct VSEPR 3-D drawing:** **b)** *Is the molecule polar or non-polar?* **c)** Draw the arrows to show partial charges where needed |  |  Polar |  |  Polar |

| | Polar | | Non-Polar | |
|---|---|---|---|---|
| **Name of shape?** | **Bent** | **Pyramidal** | **Linear** | **Tetrahedral** |

8. What is the HONC rule? How does it help make drawing structural formulas easier for large, organic molecules? HONC 1234 is the rule that says Hydrogen will want to make 1 bond (has 1 valence and needs 1 more to get to 2) , Oxygen wants to make 2 (it has 6 valence electrons and needs 2 more to get to the octet rule), Nitrogen wants to make 3 bonds (it has 5 valence electrons and wants to get 3 more to get to the octet rule), and carbon wants to make 4 bonds (has 4 valence electrons and needs 4 more).

   - It helps in drawing structural formulas because you don't have to draw all the Lewis dot structures to see how they will bond, you always know HONC 1234.

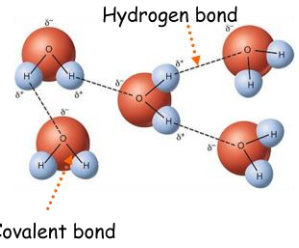
9. Explain why shape is important in terms of how your body functions.

Shape is important because it can partially explain how molecules are sensed by your body's sensory receptors. Examples of this include taste, smell, and how your brain communicates to your body using neurotransmitters.

10. a. Compare a **Polar covalent bond** to a **Non-polar covalent bond**. b. Give an example of each.
    a. In both cases electrons are shared, but
       - in a polar covalent bond there is a "pull" to one side of the molecule causing a slight negative and positive end
         - water molecules are examples of polar
       - Non- polar is when the electrons are shared equally.
         - $O_2$ is an example of a non-polar molecule
    b. Polar= $H_2O$
       Nonpolar= $O_2$

11. a. How do 2 polar molecules interact with each other (attracted or not)? b. 2 nonpolar molecules?
    Attracted not attracted
    c. 1 polar & 1 non polar? d. 1 polar & one ionic?
    Not attracted attracted

12. **Water** has many unique properties due to the fact that **hydrogen bonds** occur between water molecules.
    a. Draw a picture of hydrogen bonds between 3 water molecules.
    b. Explain why hydrogen bonds are formed.




Because water is polar (has charged ends), one water molecule is weakly attracted to charged ends of other water molecules.

    c. How does this affect the behavior of water molecules?

Water sticks to other water molecules and any other polar or ionic substances (charges always attract)

13. Classify the following as being either a **intermolecular** or **intramolecular** force & explain why:

| hydrogen bond= | metallic bond= | covalent bond= | ionic bond= |
|---|---|---|---|
| Inter | Intra | Intra | Intra |

14. a. Why is the **carbon** atom the backbone to so many large, complex biological molecules (proteins, carbohydrates, lipids, and nucleic acids)?

It's so versatile because it has 4 bonding sites and can make all sorts of combinations with itself and other atoms.

| 15. **Class** | **Polymer** | **Mononmer** | **2 common exs:** |
|---|---|---|---|
| **a. Carbohydrates** | Polysaccharide | monosaccharide | Starches & Cellulose/Fiber |
| **b. Nucleic Acids** | Poly- nucleotide | **Nucleotide** | **DNA & RNA** |
| **c. Protein** | Poly- Peptide | **Amino Acid** | **Hair, skin, enzymes, meat, dairy….. etc.** |
| **d. Lipids** | Tri-glyceride | Glycerol & fatty acids | **Saturated/ Unsaturated, Cholesterol, phospholipid bi-layer** |