Reference Sheets for
Unit #5 – Bonding and Structure

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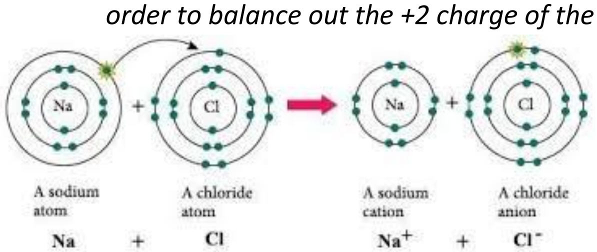
DVHS Chemistry
Types of Bonds Reader

Name: **Period:** **Seat#:**

Directions:
Read this page and take notes and/or annotate it. We will not be doing a traditional lecture on this material because it is mostly review material. There is potentially information in here you may not be familiar with. If you come across anything you do not understand you need to ask about it! At the end there are questions to check that you were able to follow and grasp the material talked about here. These are selections of reading by various people, credit given when possible.

Types of Bonds – *by Janet Rae-Dupree, Pat DuPree. Edited to suit our purposes here.*
Atoms tend to arrange themselves in the most stable patterns possible, which means they have a tendency to complete or fill their valence shells. They join with other atoms in order to do that. The force that holds atoms together as "molecules" or "compounds" is referred to as a *chemical bond.* There are three main types of bonds, and they each may have some sub categories that are more specific.

Ionic Bond – *by Janet Rae-Dupree, Pat DuPree. Edited to suit our purposes here.*
Ionic bonding involves the transfer of electrons. One atom gains one or more electrons, while another atom loses one or more electrons. The atom that gained an electron carries a negative charge (anion), and the atom that lost an electron carries a positive charge (cation). Because opposite charges attract, the atoms bond together to form a compound. The electrostatic attraction is the "bond." Ionic bonds are formed when one atom has a low ionization energy (cation, metal) and another atom has a high electron affinity (anion, nonmetal). That essentially results in needing a metal and a non-metal to form an ionic bond. You can also have polyatomic ions forming ionic bonds because they have charges even though they are made of nonmetals.
Examples: NaBr – sodium is a metal, bromine is a nonmetal. Na turn into Na^+ and gives its electron to Br which turns into Br^-
MgF_2 – magnesium is a metal, fluorine is a nonmetal. Mg turns into Mg^{2+} and gives two electrons to the fluorine atoms. Each fluorine turns into F^- so you need two fluorine atoms in order to balance out the +2 charge of the Mg

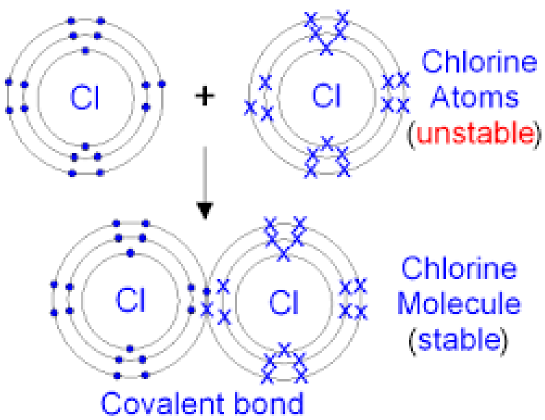


Covalent Bond – *by Janet Rae-Dupree, Pat DuPree. Edited to suit our purposes here.*

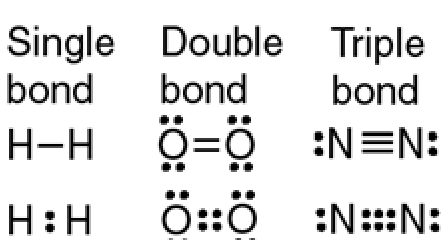
Covalent Bonds involve the sharing of electrons between two atoms. The pair of shared electrons holds the atoms close together and this sharing of electrons is the bond. Covalent bonds form when there is not an atom with a sufficiently low ionization energy to simply “give up” the electron, and the other atom does not have a sufficiently high electronegativity to “steal” the electron completely. That essentially results in needing two (or more) nonmetals to form the bond. One thing to note is that when a covalent bond is formed, neither atom truly has a complete valence shell. It “feels” like it has a full shell due to the sharing, but it doesn’t completely “own” those electrons.

Examples: H_2O – each hydrogen and each oxygen “donate” an electron to a shared bon. Both hydrogen and oxygen are nonmetals. They are not strong enough to steal the electron completely from the other atom.

Cl_2 – Each chlorine only has 7 valence electrons. If they each “donate” one to share then they are tricked into thinking they each have 8 valence electrons.



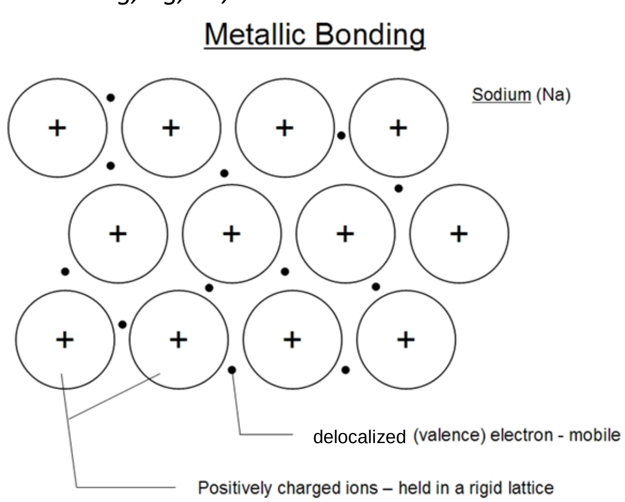
Nonmetals can donate one electron each to form a single bond (2 electrons being shared), or they can each donate two electrons to form a double bond (4 electrons being shared), or they can each donate three electrons to form a triple bond (6 electrons being shared).



Metallic Bond –

Metallic bonds form when one or more types of metals are together. The vacant p and/or d orbitals in the metal atoms' outer energy levels overlap, and allow outer valence electrons to move freely through the metal. The valence electrons basically "detach" and float around as a "sea of electrons." We say that the electrons are "delocalized" and no longer belong to any particular atom. This sea of electrons effect allows the electrons to flow through the material – this is how electricity can be conducted through something like a metal wire. All the delocalized electrons are flowing from one end of the wire to the other because they are not attached to their nuclei anymore. If you have more than one type of metal atom present it is called an "alloy." These metallic mixtures can form unique properties that can be useful.

Example: Cu – note: you do not need to include a subscript for metallic materials. It is not practical to tell someone how many atoms are present in a chunk of metal. Because the electrons essentially belong to every atom, it isn't really a molecule or compound in the traditional sense. If you just see a metallic element listed by itself you can assume there are lots present and it is a metallic bond – like Mg, Ag, Cu, Fe



DVHS Chemistry
Nomenclature Reader

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Nomenclature – *by the International Union of Pure and Applied Chemistry Edited to suit our purposes here.*

A system of rules for naming chemical compounds. The International Union of Pure and Applied Chemistry (IUPAC) devised the system for naming compounds in order to ensure uniformity, consistency, and avoid ambiguity.

Ionic Compounds

For simple binary ionic compounds (ionic compounds composed of one kind of metal and one kind of nonmetal) the cation name comes first and then the anion. Simple *cations* take the name of their element, for example, the name for K^+ would be potassium, and the name for Zn^{2+} would be Zinc. Elements that form two or more ions need a roman numeral to denote their charge. For example, many transition metals can form ions with different charges, although they will always form cations. For example, copper can form Cu^+ which would be named copper (I), or it can form Cu^{2+}, which would be named copper (II).

Simple *anions* use the base name of the element, but end in *–ide.* For example, F^- would be named fluoride, and I^- would be named iodide.

Put the name of the cation and anion together to name the ionic compound. For example, NaCl is named sodium chloride. ZnS is named Zinc sulfide.

Compounds made with polyatomic ions do not change their anion name – keep the special polyatomic names for both cation and anion! NH_4I is named Ammonium Iodide, Li_2CO_3 is named Lithium carbonate.

Note: Some stable ions do not have noble gas configurations! Polyatomic Ions (ions with several types of atoms have names that will need to be memorized. Check your Common Ions table for the ions you will be required to memorize.

Naming Covalent Molecules – *by Eden Francis. Edited to suit our purposes here.*

Covalent molecules use a different system for nomenclature. Simple covalent molecules are generally named by using **Greek prefixes** to indicate how many atoms of each element are shown in the formula and the ending of the last element is changed to **-ide**.

The **mono-** prefix is usually not used for the first element in the formula. Some double vowels are omitted to help with ease of pronouncing the molecule name. The "o" and "a" endings of these prefixes commonly are dropped when they are attached to "oxide." See the table below for the Greek prefixes you will need to memorize.

number of atoms	prefix	example	
1	mono	NO	nitrogen monoxide
2	di	NO_2	nitrogen dioxide
3	tri	N_2O_3	dinitrogen trioxide
4	tetra	N_2O_4	dinitrogen tetraoxide
5	penta	N_2O_5	dinitrogen pentaoxide
6	hexa	SF_6	sulphur hexa fluoride
7	hepta	IF_7	iodine hepta fluoride
8	octa	P_4O_8	tetra phosphur decoxide
9	nona	P_4S_9	tetra phusphur nona sulphide
10	deca	AS_4O_{10}	tetra arsinic decoxide

Diatomic Molecules

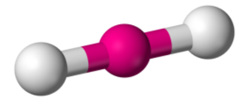
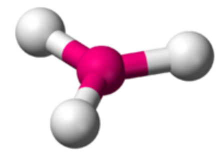
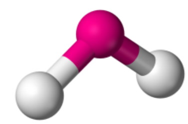
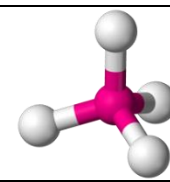
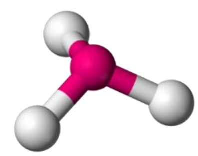
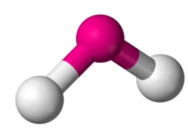
A molecule composed of only two atoms is said to be diatomic. There are several diatomic molecules made of the same element that you will need to memorize. Luckily, there is a mnemonic device for this. ***H***orses ***N***eed ***O***ats ***F***or ***Cl***ear ***Br***own Eyes ***(I)*** will help you remember that H_2, N_2, O_2, F_2, Cl_2, Br_2, and I_2 are all diatomic molecules. Another mnemonic is “H-7” which reminds you that there are seven diatomic elements, they make the shape of a seven on the periodic table, starting with N, and that Hydrogen is one of the diatomic elements.

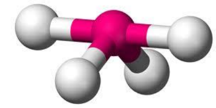
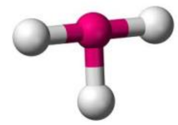
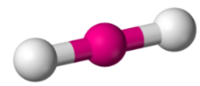
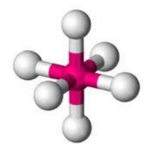
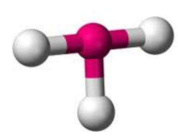
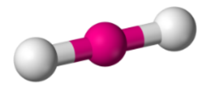
Practice – *We will review these names in class!*

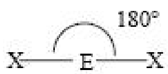
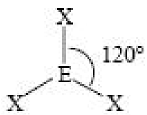
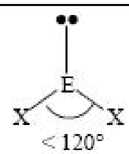
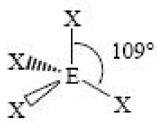
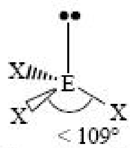
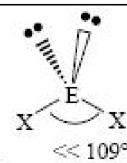
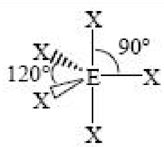
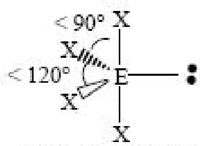
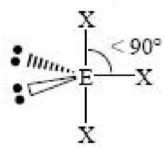
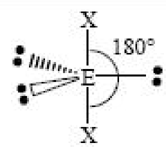
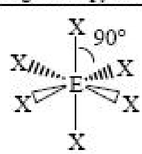
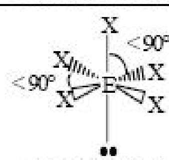
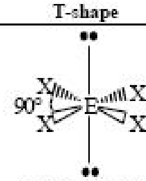
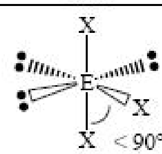
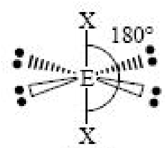
1. CO
2. CO_2
3. S_4N_2
4. N_2O_6
5. PF_3

VSEPR

Predicting Molecular Geometry and Hybridization

Electron Groups	Bonding Groups	Lone Pairs	Electron Geometry *(Hybridization)*	Molecular Geometry *(VSEPR class)*	Approximate Bond Angles	Geometry Examples
2	2	0	Linear *(sp)*	Linear *(AX_2)*	180	
3	3	0	Trigonal Planar *(sp^2)*	Trigonal Planar *(AX_3)*	120	
	2	1		Bent *(AX_2E)*		
4	4	0	Tetrahedral *(sp^3)*	Tetrahedral *(AX_4)*	109.5	
	3	1		Trigonal Pyramidal *(AX_3E)*		
	2	2		Bent *(AX_2E_2)*		

Electron Groups	Bonding Groups	Lone Pairs	Electron Geometry *(Hybridization)*	Molecular Geometry *(VSEPR class)*	Approximate Bond Angles	Geometry Examples
5	5	0	Trigonal Bipyramidal *(sp^3d)*	Trigonal Bipyramidal *(AX_5)*	120 (in plane) 90 (above and below)	
	4	1		Seesaw *(AX_4E)*		
	3	2		T-Shaped *(AX_3E_2)*		
	2	3		Linear *(AX_2E_3)*	180	
6	6	0	Octahedral *(sp^3d^2)*	Octahedral *(AX_6)*	90	
	5	1		Square Pyrimidal *(AX_5E)*		
	4	2		Square Planar *(AX_4E_2)*		
	3	3		T-Shaped *(AX_3E_3)*		
	2	4		Linear *(AX_2E_4)*		

VSEPR Geometries					
Steric No.	Basic Geometry 0 lone pair	1 lone pair	2 lone pairs	3 lone pairs	4 lone pairs
2	 **Linear**				
3	 **Trigonal Planar**	 **Bent or Angular**			
4	 **Tetrahedral**	 **Trigonal Pyramid**	 **Bent or Angular**		
5	 **Trigonal Bipyramid**	 **Sawhorse or Seesaw**	 **T-shape**	 **Linear**	
6	 **Octahedral**	 **Square Pyramid**	 **Square Planar**	 **T-shape**	 **Linear**