INTRODUCTION TO CHEMICAL BONDING

I. Types of Chemical Bonding

A. ______________________: mutual electrical attraction between the nuclei and valence e- of different atoms that binds the atoms together

B. Why do atoms bond together?

1. Atoms by themselves have ________ potential energy
2. Want to have ________ P.E. (this is what happens in nature)
3. In other words, atoms are **LESS** stable alone than combined with other atoms

C. Electrons are ____________________ during bonding

D. Types of chemical bonding

1. ______________________: results from attraction between large numbers of cations and anions; involves the **transfer** of electrons (one atom loses e-, the other atom gains e-)
   a. ________________: positive ion; atom that has lost e-
   b. ________________: negative ion; atom that has gained e-
2. ____________________: results from **sharing of e- pairs** between two atoms
   a. ______________________: type of bond resulting from the unequal sharing of electron pairs
   b. ________________________: type of bond resulting from the equal sharing of electron pairs

E. Determining Ionic or Covalent Bond (Official Way)

1. Remember electronegativity? (how much an atom wants to gain an e-)
2. Difference in EN tells whether bond is ionic or covalent
   a. EN difference less than ________ = COVALENT
      1. ____________COVALENT: EN difference ______ to ______
      2. ____________COVALENT: EN difference ______ to ______
   b. EN difference greater than ______ = IONIC

F. Determining Ionic or Covalent Bond (Easy Way)

1. ____________________: metal & nonmetal in formula
2. ____________________: 2 or more nonmetals
   a. __________________________: 2 different nonmetals
   b. __________________________: 2 of the same nonmetal

COVALENT BONDING AND MOLECULAR COMPOUNDS

I. Molecules & Molecular Formulas

A. ________________: neutral group of atoms held together by covalent bonds

B. ______________Molecule: molecule that contains only two atoms (of the same element)

--> there are only 7 of them; they are

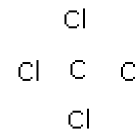
LEWIS STRUCTURES: formulas which symbols represent nucleus & inner shell electrons; dot pairs or dashes represent electron pairs in covalent bonds

1. __________________: (lone pair) pair of electrons that is not involved in bonding & belongs to only one atom
2. ________________________________: produced when one pair of e- is shared between two atoms
3. MULTIPLE BONDS: stronger & shorter than single bonds
   a. Double Bond: produced when ______ pairs of e- are shared between two atoms
      ~ shown by 2 side-by-side pairs of dots
      ~ stronger and shorter than a single covalent bond
   b. _____________Bond: produced when 3 pairs of e- are shared between two atoms
      ~ shown by 3 side-by-side pairs of dots
      ~ stronger and shorter than single and double covalent bonds

STEPS FOR DRAWING LEWIS STRUCTURES NOTES

1. Count the total number of valence electrons in the compound.
EXAMPLE: CCl_4

C: 1 x 4 e- = 4
Cl: 4 x 7 e- = <u>28</u>
32



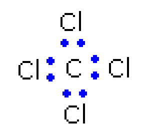
2. Draw the symbols for the elements with the central atom in the middle.
(The central atom is the one that is written first, except hydrogen will never be central.)

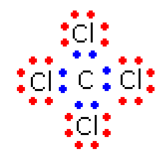
3. Connect the surrounding atoms to the central atom with a pair of electrons.

Had 32 e- to start (step 1)

Used 8 e- to connect

Have 24 e- left





4. Put electrons around surrounding atoms until all have 8 electrons around them.
(Exception: Hydrogen will only have 2 e- around it.)
Have 24 e- left
Used 24 e- to complete surrounding
Have 0 e- left to use

5. If there are any electrons left over, put them on the central atom.
6. Check to make sure that all atoms have 8 electrons around them.
7. If there are not enough electrons to give all atoms 8 electrons around them, try multiple bonds.

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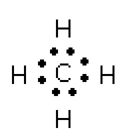
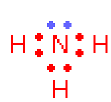
<u>VSEPR (Valence Shell Electron Pair Repulsion) THEORY NOTES</u>
valence electrons in an atom will orient themselves to be as far apart as possible

<u>* CLASSES OF MOLECULES</u>
A = central atom
B = surrounding atoms
E = unshared electron pairs on central atom
*** subscript tells how many of each you have ***



EXAMPLE 1: CH_4
1 central atom, 4 surrounding atoms, no unshared e- prs. on central atom CLASS = AB_4



EXAMPLE 2: NH_3
1 central atom, 3 surrounding atoms, 1 unshared e- pr. on central atom CLASS = AB_3E

* SHAPES OF MOLECULES

CLASS	SHAPE
AB_2	linear
AB_2E	bent
AB_2E_2	bent
AB_3	trigonal planar
AB_3E	trigonal pyramid
AB_4	tetrahedral

MOLECULAR POLARITY vs. BOND POLARITY

BOND POLARITY

~ refers to the equal (____________) or unequal (____________) sharing of electrons

~ What makes a bond polar (covalent)?

* If the bond occurs between two __________________ nonmetals

MOLECULAR POLARITY

~ refers to the symmetry (____________) or asymmetry (____________) of a molecule

~ What makes a molecule asymmetrical?

* If there are ________________________________ around the central atom.

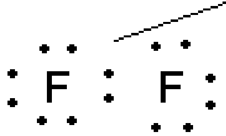
and/or

* If the surrounding atoms are different ______________________________

Special Cases Regarding Molecular Polarity:

~ When there are only 2 atoms in the compound or ion…

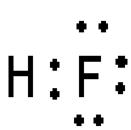
* examples: F_2 or HF



There is no central atom; the bond is in the middle of this molecule. Therefore, when there are only 2 atoms in a molecule, the bond polarity will be the same as the molecular polarity.

Therefore, this is a nonpolar molecule because the bond between the two atoms is nonpolar covalent because the bond is between 2 atoms of the same element.

Molecular polarity will be determined by (and the same as) bond polarity ONLY WHEN THERE ARE ONLY 2 ATOMS IN THE MOLECULE.



There is no central atom on this molecule either. The bond is in the center. This bond occurs between 2 different nonmetals, so the bond is polar covalent and the molecule is polar.

LEWIS STRUCTURES 1 WORKSHEET

1. SiF_4 Molecular Polarity: Class: Shape:	2. BF_3 Molecular Polarity: Class: Shape:	3. NH_3 Molecular Polarity: Class: Shape:
4. H_2O Molecular Polarity: Class: Shape:	5. $CHBr_3$ Molecular Polarity: Class: Shape:	6. HI Molecular Polarity: ~~Class:~~ Shape:
7. SO_3 Molecular Polarity: Class: Shape:	8. $AsCl_3$ Molecular Polarity: Class: Shape:	9. H_2S Molecular Polarity: Class: Shape:
10. SeH_2 Molecular Polarity: Class: Shape:	11. PO_4^{-3} Molecular Polarity: Class: Shape:	12. NO_2^{-1} Molecular Polarity: Class: Shape:

13. ClO_3^{-1} Molecular Polarity: Class: Shape:	14. HCN Molecular Polarity: Class: Shape:	15. PI_3 Molecular Polarity: Class: Shape:

LEWIS STRUCTURES 2 WORKSHEET

1. OF_2 Molecular Polarity: Class: Shape:	2. GeI_4 Molecular Polarity: Class: Shape:	3. SCl_2 Molecular Polarity: Class: Shape:
4. SeO_2 Molecular Polarity: Class: Shape:	5. PCl_3 Molecular Polarity: Class: Shape:	6. NH_4^{+1} Molecular Polarity: Class: Shape:

7. NOCl Molecular Polarity: Class: Shape:	8. CO_2 Molecular Polarity: Class: Shape:	9. SO_4^{-2} Molecular Polarity: Class: Shape:
10. ICl Molecular Polarity: ~~Class:~~ Shape:	11. CH_2Cl_2 Molecular Polarity: Class: Shape:	12. H_3O^{+1} Molecular Polarity: Class: Shape:
13. N_2 Molecular Polarity: ~~Class:~~ Shape:	14. ClO^{-1} Molecular Polarity: ~~Class:~~ Shape:	15. CH_2O Molecular Polarity: Class: Shape:

Ionic Bonding & Ionic Compounds Notes

A. ______________________________: composed of + and - ions whose charges cancel each other out

1. Most exist as ____
2. _________ network of + and - ions; not composed of individual units

B. Formation of Ionic Compounds

1. Na · + : Cl : -->
2. Ionic compounds minimize P.E. by organizing into ____________________

IONIC VS. COVALENT (MOLECULAR) COMPOUNDS NOTES

Ionic Compounds	**Covalent/Molecular Compounds**
Formed by transfer of electrons	Formed by sharing of electrons
Occurs between metal & nonmetal	Occurs between nonmetals
Smallest unit = "formula unit"	Smallest unit = "molecule"
Most exist as solids, usually with crystal structure	Exist as liquids, gases, non-crystal solids
Have high melting points	Have low melting points
Most dissolve in water	Few dissolve in water
Conduct electricity when melted (molten) or dissolved in water	Do not conduct electricity when melted or dissolved in water
Fixed + and – parts; anions & cations	May be neutral or have slightly + and – parts
Examples = KCl, NaF	Examples: NH_3, CO_2, CH_4

Polyatomic Ions Notes

1. ______________________________: charged group of covalently bonded atoms
2. Combine with ions of ____________________ charge to form ionic compounds
3. Compounds with polyatomic ions have ____ bonding
4. Lewis Structures
   a. Negatively charged polyatomic ion = ________ e- to total number of valence e- for cmpd
   b. Positively charged polyatomic ion = ______________ e- from total # of valence e- for cmpd

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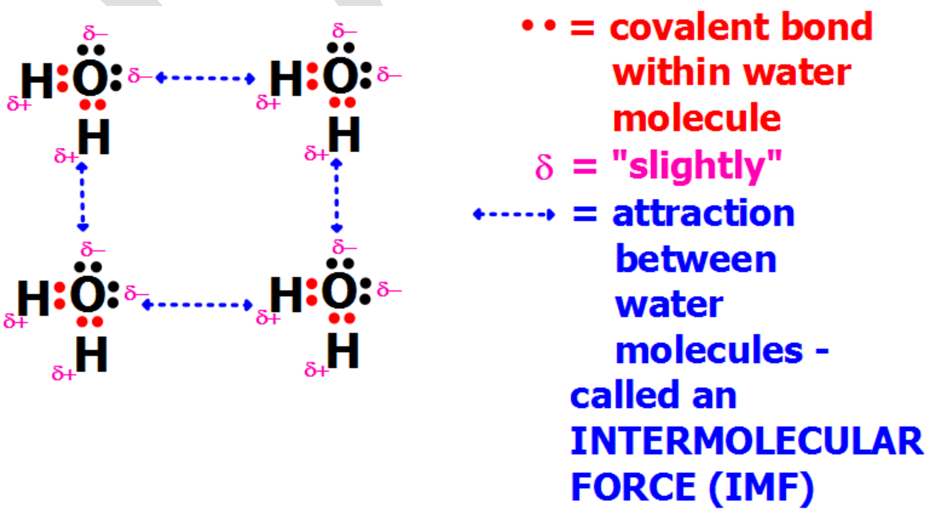
INTERMOLECULAR FORCES (IMFs) NOTES

intermolecular forces: forces of attraction between molecules in a sample of a compound

3 TYPES OF IM FORCES (in order from strongest to weakest)

1. HYDROGEN "BONDING"
   * occurs between molecules with hydrogen & nitrogen, hydrogen & oxygen, and hydrogen & fluorine
   * accounts for the unusually high boiling point of NH_3, H_2O, and HF



IMFs are not as strong as covalent bonds!

2. DIPOLE-DIPOLE FORCES
   * occurs between polar molecules (dipoles)
   * the slightly positive end of one polar molecule is attracted to the slightly negative end of another polar molecule
   * same principle as hydrogen bonding, but not quite as strong of an IMF

3. LONDON DISPERSION FORCES
   * occurs between all molecules
   * allows for noble gases and nonpolar molecules to be liquefied
   * moving electrons (in electron cloud of an atom) temporarily attract the electrons from another atom

** COVALENT BONDING IS STRONGER THAN ANY OF THESE IM FORCES. **

Unit 6 Review Worksheet

1. Individual atoms of elements are (more / less) stable than when they are combined with other elements.
2. What is the difference between ionic and covalent bonding?
3. What is the cut-off number for the difference in electronegativity to determine whether a bond is ionic or covalent? Polar or nonpolar covalent?
4. Between what types of elements does ionic bonding occur?
5. Between what types of elements does polar covalent bonding occur? Nonpolar covalent?
6. When must you use multiple bonds when drawing a Lewis structure?
7. How can you tell which is the central atom by looking at the chemical formula?
8. What two (2) requirements must a molecule meet in order to be considered nonpolar?
9. What do "A", "B", and "E" stand for when determining the class of a molecule?
10. What does the subscript "2" mean in the class AB_2E?
11. Which classes of molecules have a bent shape?
12. Which class of molecules has a linear shape?
13. Which class has a tetrahedral shape?
14. Which class has a trigonal planar shape?
15. Which class has a trigonal pyramid shape?
16. What is the smallest unit of an ionic compound called? A covalent compound?
17. Which type of compound has low melting points?
18. Which type of compound dissolves in water?
19. Which type of compound conducts electricity when melted?
20. Which type of compound occurs as liquids, gases, or non-crystalline solids?
21. What are the three types of intermolecular forces?
22. Between which types of compounds do these intermolecular forces (#21) occur?
23. Arrange the following in order of increasing strength:
    (A) hydrogen bonding (B) covalent bonding
    (C) dipole-dipole forces (D) London dispersion forces
24. For each of the following compounds, draw the Lewis structure. Then tell the molecular polarity, class, and shape of the molecule. Also tell the type(s) of IM forces that occur within

a sample of that compound.

(A) SiF_4 (B) SBr_2 (C) NH_3
(D) SO_3 (E) SiO_2 (F) SeS_2

Unit 6 Summary (Graphic Organizer)