CHEM 1305 - Chapter 12 - Handout

Memorize:
The five electronic geometries; Table 12.4

Define the following terms; explain the following concepts, and answer the following questions:

1) Two types of bonds: **ionic** and **covalent**.

2) For a bond between two different atoms, electrons shared unequally. This behavior is best rationalized using the property called **electronegativity**.

3) Electronegativity (hereafter, EN) generally (**increases** / decreases) as one moves right-to-left on the periodic chart; and it (increases / **decreases**) as one moves top-to-bottom.

4) The ***polarity*** of a bond depends on the **difference** between the EN of the bonded atoms. The larger the difference, the (**greater** / less) the polarity.

5) Which of the following bonds is more polar:

   a) H —S or $\boxed{\text{H—F}}$

   b) O—S or $\boxed{\text{O—F}}$

   c) N—S or $\boxed{\text{N—Cl}}$

   d) C—S or $\boxed{\text{C—Cl}}$

6) A *molecule* with a center of positive charge and a center of negative charge necessarily has a(n) **dipole moment**.

7) Can a molecule made from polar bonds be nonpolar? ($\boxed{Y}$ / N)
Explain your answer.
(To help you visualize the problem, consider carbon tetrachloride: CCl_4. This molecule contains four bonds, each of which is polar.)

```
      Cl
      |
Cl— C — Cl
      |
      Cl
```

Yes, a molecule made from polar bonds can be non-polar. To do this, the magnitude of the polar bonds must be arranged such that they cancel each other.

By *analogy*, consider two people pulling a rope, in which one person pulls with exactly the same force as the other, but the two are pulling in opposite directions. Although a lot of force is being applied by each person, the rope does not move -- the opposing forces cancelled each other out.

Returning to the above example, each C-Cl bond is polar, but each is pointing away from the others such that the net polarity of the molecule AS A WHOLE is zero. Hence, "the whole thing" is nonpolar.

8) In almost all stable compounds composed of representative (aka: “maingroup” or “A” or "s-block and p-block") elements, all of the atoms want to a(n) **NOBLE GAS** electron configuration.

a) This means they want **8** [number] in their outer, or valence, shell.

b) This idea is expressed by the **OCTET** rule.

c) Notable exceptions are the elements:

i) **hydrogen**, **helium** and **lithium**, which want two valence electrons

ii) **beryllium**, which wants four valence electrons

iii) **boron**, which wants six valence electrons.

9) The representation of a molecule that shows how the valence electrons are arranged is called the **Lewis Dot Structure**.

10) Valence electron pairs that do not in participate in bonding are referred to as **Lone Pairs**.

11) (T / $\boxed{\text{F}}$) Lewis structures indicate the spatial ("3-D") arrangement of atoms within a molecule.

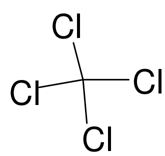
(COMMENT: Lewis Dot Structures indicate which atoms are connected to which, but it does not indicated how that are orientated with respect to 3-dimensional space. Lewis dot structures provide a structure that are limited to 2-dimensional space, or more simply put, that are limited to the plane of a sheet of paper.)

12) The acronym we employ to execute steps necessary to determine Lewis Structures is: **NASA**.

13) Draw Lewis structures for the following molecules. Be sure to draw all lone pairs as dots. Bonded electron pairs can be represented with straight lines.

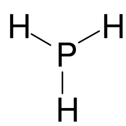
{NOTE: due to software limitation, lone pairs are not shown, but are described in parantheses)

a) CCl_4



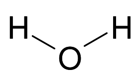
(each Cl has 3 LP's)

b) PH3



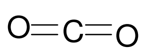
(neither P nor H has LP's)

c) H_2O



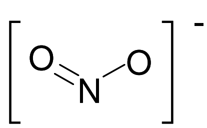
(the O has 2 LP's)

d) CO_2



(each O has 2 LP's; the central C has none)

e) NO_2^- anion



(for the resonance structure shown, the N has 1 LP, the O on the left has 2 LP's, and the O on the right has 3 LP's)

14) Sometimes several Lewis structures can be drawn for the same molecule or ion. There are referred to as **resonance** structures.

15) The VSEPR, when combined with the Lewis Structure, allows us to determine the **spatial, or 3-D (3-dinemsional)** arrangement of a molecule.

16) ***Electronic*** geometry and ***Molecular*** geometry differ in that the latter excludes **Lone Pairs** on the central atom.

17) There are many molecular geometries, but only three electronic geometries are covered in this course. List the three ***electronic*** geometries:

    a) **linear**
    b) **trigonal planar**
    c) **tetrahedral**

18) Water has a :

    a) **tetrahedral** electronic geometry ["shape"]
    b) **bent** molecular geometry ["shape"]

19) A molecule with a tetrahedral electronic geometry and one lone pair will have a **trigonal pyramid** molecular geometry ["shape"]

ELECTRONIC SHAPE		***IF "LONE PAIR" ADJUSTMENTS***
linear		
trigonal planar	-->	*bent*
tetrahedral	-->	*trigonal pyramidal, bent*

N = needed	octet rule, or known exception
A = available	electron count, based on Periodic Chart
S = shared	(= N - A)
A' = additional	(= A - S)