R&MN 4.1 Practice #3-5, 10, 12

CHAPTER 4 CHEMICAL BONDING

4.1 Lewis Theory of Bonding (pg. 224)

Bonds are theoretical pictures based on strong empirical evidence

- Each element had a fixed bonding capacity
  - How elements combined in a compound
- Friedrich Kekule (structural diagrams)
- Ability of some substances to affect light
  - Explained by 3D structure
- Why does bonding occur?
  - Stability of noble gases
  - Rearrangement of outer electrons to mimic noble gases
- Key Ideas of Lewis Theory (pg. 224)

Ionic compound – ionic bonding???

Empirical evidence:

Molecular compound – covalent bonding???

Empirical evidence:

Molecular compound – polar covalent bonding???

Empirical evidence:

What is a Chemical Bond?

Chemical bond – the simultaneous electrostatic force of attraction of two or more nuclei for electrons.

What types of chemical bonds are there?

Ionic bond – the electrostatic attraction that results between two or more atoms as a result of a transfer of electrons between the atoms (EN diff $\geq$ 1.7) eg]

Covalent bond – the electrostatic attraction that results between two or more atoms as a result of a mutual attraction to shared electrons (EN diff = 0) eg]

Polar (covalent bond) – the attraction that results between two or more atoms as a result of a mutual attraction to unevenly shared electrons ($0 \leq$ EN diff $\leq$ 1.7) eg]

Metallic – mutual attraction of atomic kernels in a "sea" of electrons

Modelling Bonding

Lewis Structures (electron dot formulas) – (just outer electrons) eg] Na, Cl, Ar, C

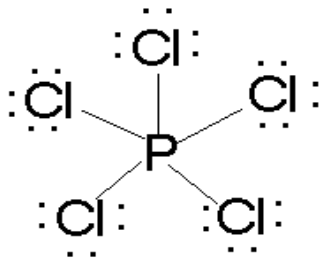
Octet rule – atoms tend to lose, gain or share e- in order to have 8 e- in outer shell. Why? (_____)
Eg. F_2, OF_2, H_2O

The octet rule, like any rule, has exceptions. Not all species have 8 e- in outer shell.

1. Atoms bonding to form He arrangement → 2e-

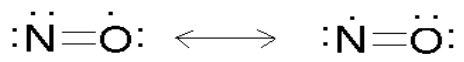
2. Molecules in which more than 4 atoms are bonded to a central atom

   Eg. PCl_5 or SF_6 or BrF_5

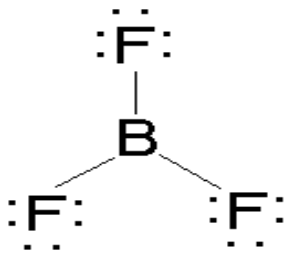


3. Molecules containing an odd number of bonding electrons

   Eg. NO



4. Species that contain no multiple bonds and whose central atom has less than four bonding e-

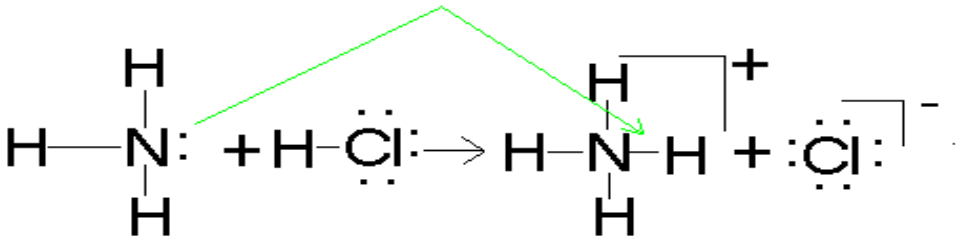


Eg. BF_3

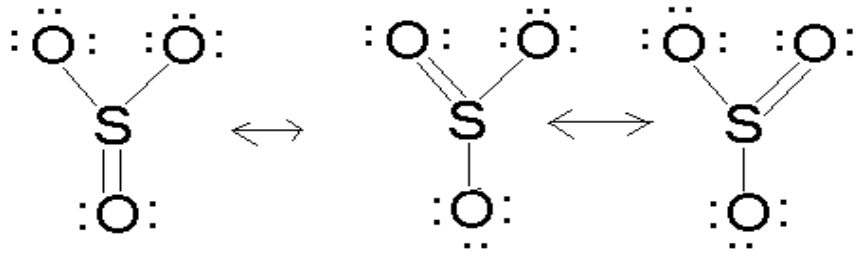
Multiple bonds – result from the sharing of two or three pairs of e- and are stronger and shorter than single bonds eg. CO_2 or N_2

Coordinate covalent bonds – polyatomic ions – a covalent bond in which both e- are donated by one atom

Eg] NH_3 + HCl



Resonance structures – imaginary structures representing the distribution of e- density. No single representation is



correct but all representations can be averaged to indicate reality. Eg] SO_3

The physical size and geometric arrangement of molecules can explain some of their properties. Proteins, enzymes, antibodies

How Does Quantum Fit In?

- Quantum mechanics and bonding theory occurring at same time there are some connections
- Electron Configuration and Structure Connection
- Stable octet = full s and p orbitals
    - o Ionic bonding example

    - o covalent bonding example

Rules for Drawing Lewis Structures (pg. 225 and 229)

Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Examples:

NH_4^+ $\underline{C}H_2O$

SF_4

Draw Lewis structures for each of the following.

OF_2, BrO_4^-, PO_4^{-3},BeF_4^{-2}, BH_4^-, ICl_2^-, IO_3^-, SO_4^{-2}, H$\underline{O}$Cl, NO_3^-