I. Chapter 8: Basic Concepts of Chemical Bonding

- There are three types of chemical bonds: **ionic**, **covalent**, and **metallic**.
- Ionic bonds are formed due to the attraction between oppositely charged ions.
- Covalent bonds are formed by the sharing of electrons between atoms.
- Metallic bonds are formed by electrons that are relatively free to move though the metal.

A. 8.1 Lewis Symbols and the Octet Rule

- The electrons involved in chemical bonding are called **valence electrons**, which are those electrons on the outermost occupied shell.
- The **Lewis symbol** for an element is the element's symbol and dots that represent valence electrons around the symbol.
- Each side of the symbol can accommodate for two electrons

1. The Octet Rule

- **The octet rule**: *atoms tend to gain, lose, or share electrons until they are surrounded by eight valence electrons.*
- An octet consists of full *s* and *p* subshells in an atom.

B. 8.2 Ionic Bonding

- Ionic substances generally result from the interaction of metals on the left side of the periodic table with nonmetals on the right side of the periodic table (not noble gases thought).
- Electron transfer to form oppositely charged ions occurs when one atom readily gives up an electron (low ionization energy) and another atom readily gains an electron (high electron affinity).
- Properties of ionic substances: brittle, high melting point, usually crystalline.

1. Energetics of Ionic Bond Formation

- Heat of formations of ionic substances are "hella" negative.
- The loss of electrons from an atom is always an endothermic process.
- When nonmetals gain an electron, the process is generally exothermic (as seen from the negative electron affinities of the elements).
- The principle reason ionic compounds are stable is the attraction between oppositely charged ions.
- A measure of how much stabilization results from arranging oppositely charged ions in an ionic solid is given by **lattice energy**.
- Lattice energy is the energy required to completely separate one mole of a solid ionic compound into its gaseous ions.
- The separating of solid ionic compounds into gaseous ions is highly endothermic. The reverse process is highly exothermic- no shit.
- Large positive lattice energies indicate that ions are strongly attracted to one another in ionic solids.
- The strong attractions cause most ionic materials to have high melting points.

- Magnitude of lattice energy of an ionic solid depends on the charges of the ions, their sizes, and their arrangement in a solid.
- The potential energy of two interacting charged particles is given by

$$E_{el} = \frac{KQ_1Q_2}{d}$$

- Q_1 and Q_2 represent the charges on the particles.
- d represents the distance between the centers of the particles.
- K is a constant $8.99 \times 10^9 J-m/C^2$
- The equation indicates that the attraction between oppositely charged particles increases as the magnitude of their charges increase and as the distance between their centers decreases.
- Thus, *for a given arrangement of ions, the lattice energy increases as the charge on the ions increase and as their radii decrease*.
- The magnitude of lattice energy depends predominately on the ionic charges because ionic radii vary only over a limited range.
- From top to bottom lattice energy decreases.

2. Electron Configuration of Ions of the *s*- and *p*- Block Elements.

- Group 1A metals are found in ionic substance only as 1+ ions because the increase in lattice energy is not enough to compensate for the energy needed to remove an inner-shell electron.
- Adding electrons to nonmetals is either exothermic or slightly endothermic as long as the electrons are added to the valence shell.
- We expect to ionic compounds of the representative metals from groups 1A, 2A, and 3A to contain 1+, 2+, and 3+ cations, respectively.
- We expect ionic compounds of the representative nonmetals of groups 5A, 6A, and 7A to contain 3-, 2-, and 1- anions, respectively.
- A **Born-Harber cycle** is a thermochemical cycle used to analyze the factors contributing to the stability of ionic compounds.

3. Transition Metals

- Ionization energies increase rapidly after each successive electron is removed.
- Lattice energies of ionic compounds are generally large enough to compensate for the loss of up to only three electrons from atoms.
- Most transition metals have more than three electrons beyond a noble gas core.
- Transition metals generally do not form ions that have a noble-gas configuration- so the octet rule doesn't work here.
- *In forming ions, transition metals lose the valence-shell s electrons first, then as many d electrons as required to reach the charge of the ion*.

C. 8.3 Covalent Bonding

- A chemical bond formed by sharing a pair of electrons is a *covalent bond*.

- Atoms in H_2 are held together principally because the two positive nuclei are attracted to the concentration of negative charge between them.
- The shared pair of electrons in any covalent bond "acts as a kind of glue to bind the atoms together." Wow vivid analogy.

1. Lewis structures

- Lewis structures or "Lewis electron-dot structures" are diagrams that show the bonding between atoms of a molecule and the lone pairs of electrons that may exist in the molecule.
- In writing Lewis structures, we show a shared electron pair as a line and any unshared electron pairs as dots.
- For nonmetals, the number of valence electrons in a neutral atom is the same as the group number.

2. Multiple Bonds

- A shared electron pair constitutes a single covalent bond, generally referred to as a **single bond**.
- In many molecules atoms shared more than one pair of electrons.
- When two electron pairs are shared, two lines are drawn in the Lewis structure, representing a **double bond**.
- A **triple bond** corresponds to the sharing of three paired electrons.

D. 8.4 Bond Polarity and Electronegativity

- When two identical atoms bond, the electrons pairs must be shared equally.
- When two atoms from opposite side of the periodic table bond, there is relatively little sharing of electrons.
- **Bond polarity** is a measure of how equally or unequally the electrons in any covalent bond are shared.
- A **nonpolar covalent bond** is one in which the electrons are shared equally.
- In a **polar covalent bond**, one of the atoms exerts a greater attraction for the bonding of electrons than the other.
- If the distance in relative ability to attract is large enough, an ionic bond is formed.

1. Electronegativity

- We use a quantity called electronegativity to estimate whether a given bond is nonpolar covalent, polar covalent, or ionic.
- **Electronegativity** is define as the ability of an atom *in a molecule* to attract electron to itself.
- The greater the atom's electronegativity, the greater its ability to attract electrons to itself.
- Factors that contribute to an atom's electronegativity are its ionization energy and electron affinity, *which are properties of isolated atoms.*
- An atom with very negative electron affinity and a high ionization energy both attracts electrons from other atoms and resists having electrons attracted away= it is highly electronegative.
- From left to right across the periodic table, electronegativity generally increases.