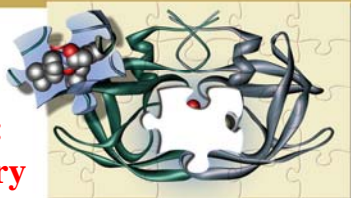


Chapter 9
Chemical
Bonding I:
Lewis Theory



Roy Kennedy
Massachusetts Bay Community College
Wellesley Hills, MA
2008, Prentice Hall

Bonding Theories

- explain how and why atoms attach together
- explain why some combinations of atoms are stable and others are not
 - ✓ why is water H₂O, not HO or H₃O
- one of the simplest bonding theories was developed by G.N. Lewis and is called **Lewis Theory**
- Lewis Theory emphasizes valence electrons to explain bonding
- using Lewis Theory, we can draw models – called **Lewis structures** – that allow us to predict many properties of molecules
 - ✓ aka Electron Dot Structures
 - ✓ such as molecular shape, size, polarity

Tro, Chemistry: A Molecular Approach

2

Bonding

- a chemical bond forms when the potential energy of the bonded atoms is less than the potential energy of the separate atoms
- have to consider following interactions:
 - ✓ nucleus-to-nucleus repulsion
 - ✓ electron-to-electron repulsion
 - ✓ nucleus-to-electron attraction

Tro, Chemistry: A Molecular Approach

3

Ionic Bonds

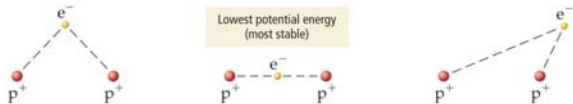
- when metals bond to nonmetals, some electrons from the metal atoms are transferred to the nonmetal atoms
 - ✓ metals have low ionization energy, relatively easy to remove an electron from
 - ✓ nonmetals have high electron affinities, relatively good to add electrons to

Tro, Chemistry: A Molecular Approach

4

Covalent Bonds

- nonmetals have relatively high ionization energies, so it is difficult to remove electrons from them
- when nonmetals bond together, it is better in terms of potential energy for the atoms to share valence electrons
 - ✓ potential energy lowest when the electrons are between the nuclei
- shared electrons hold the atoms together by attracting nuclei of both atoms



Tro, Chemistry: A Molecular Approach

5

http://www.wisc-online.com/objects/index_tj.asp?objID=GCH6404

Tro, Chemistry: A Molecular Approach

6

Determining the Number of Valence Electrons in an Atom

- the column number on the Periodic Table will tell you how many valence electrons a main group atom has
 - Transition Elements all have 2 valence electrons; Why?

1A	2A	3A	4A	5A	6A	7A	8A
Li	Be	B	C	N	O	F	Ne
1 e ⁻	2 e ⁻	3 e ⁻	4 e ⁻	5 e ⁻	6 e ⁻	7 e ⁻	8 e ⁻

Tro, Chemistry: A Molecular Approach

7

Lewis Symbols of Atoms

- aka electron dot symbols
- use symbol of element to represent nucleus and inner electrons
- use dots around the symbol to represent valence electrons
 - pair first two electrons for the *s* orbital
 - put one electron on each open side for *p* electrons
 - then pair rest of the *p* electrons

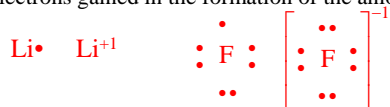


Tro, Chemistry: A Molecular Approach

8

Lewis Symbols of Ions

- Cations have Lewis symbols without valence electrons
 - Lost in the cation formation
- Anions have Lewis symbols with 8 valence electrons
 - Electrons gained in the formation of the anion



Tro, Chemistry: A Molecular Approach

9

What We Know

- the noble gases are the least reactive group of elements
- the alkali metals are the most reactive metals and their atoms almost always lose 1 electron when they react
- the halogens are the most reactive group of nonmetals and in a lot of reactions they gain 1 electron

Tro, Chemistry: A Molecular Approach

10

Stable Electron Arrangements And Ion Charge

- Metals form cations by losing enough electrons to get the same electron configuration as the previous noble gas
- Nonmetals form anions by gaining enough electrons to get the same electron configuration as the next noble gas
- The noble gas electron configuration must be very stable

Atom	Atom's Electron Config	Ion	Ion's Electron Config
Na	[Ne]3s ¹	Na ⁺¹	[Ne]
Mg	[Ne]3s ²	Mg ⁺²	[Ne]
Al	[Ne]3s ² 3p ¹	Al ⁺³	[Ne]
O	[He]2s ² 2p ⁴	O ⁻²	[Ne]
F	[He]2s ² 2p ⁵	F ⁻¹	[Ne]

Tro, Chemistry: A Molecular Approach

11

Octet Rule

- when atoms bond, they tend to gain, lose, or share electrons to result in 8 valence electrons
- ns^2np^6
 - ✓ noble gas configuration
- many exceptions
 - ✓ H, Li, Be, B attain an electron configuration like He
 - He = 2 valence electrons
 - Li loses its one valence electron
 - H shares or gains one electron
 - ✦ though it commonly loses its one electron to become H⁺
 - Be loses 2 electrons to become Be²⁺
 - ✦ though it commonly shares its two electrons in covalent bonds, resulting in 4 valence electrons
 - B loses 3 electrons to become B³⁺
 - ✦ though it commonly shares its three electrons in covalent bonds, resulting in 6 valence electrons
 - ✓ expanded octets for elements in Period 3 or below
 - using empty valence *d* orbitals

Tro, Chemistry: A Molecular Approach

12

Lewis Theory

- the basis of Lewis Theory is that there are certain electron arrangements in the atom that are more stable
 - ✓ **octet rule**
- bonding occurs so atoms attain a more stable electron configuration
 - ✓ more stable = lower potential energy
 - ✓ no attempt to quantify the energy as the calculation is extremely complex
