

When does the octet rule fail?

I. Small atoms

a) H, He and Li

Helium strives for 2 valence electrons: $1s^2$ configuration

Hydrogen will sometimes will share its one electron with another atom, forming a single covalent bond

Lithium will lose its lone valence electron, gaining the $1s^2$ configuration of He

b) Be

Be will sometimes lose its 2 valence electrons, gaining the $1s^2$ configuration of He

Be will sometimes form 2 covalent bonds, giving it 4 valence electrons

-nuclear charge of +4 cannot handle 8 valence electrons

c) B

Boron will often make three covalent bonds using its three valence electrons

-nuclear charge of +5 cannot handle 8 valence electrons in a stable manner

II. Molecular compounds with metals

Some metals will form covalent compounds with nonmetals: Hg, Ga, Sn, Mg, Fe, and others

The octet rule is not followed for the metals, but is followed for nonmetals

III. P, S, Cl, Se, Br, I

Elements in the third period and lower have empty *d* orbitals

-there is room for more than 8 valence electrons

These elements will *at times* make more than 4 covalent bonds as central atoms

IV. Free Radicals

Some molecules have an odd number of electrons

Ex: NO, NO₂, OH

Often highly reactive species

Place the unpaired electron on the central atom

Rules for Drawing structural formulas

- 1) Determine the central atom, place the other atoms evenly spaced around the outside
- 2) Count the total number of valence electrons
- 3) Draw single bonds between the central atoms and each of the outside atoms
- 4) Complete the octet on the outside atoms by placing electrons in pairs around the outside atoms (*lone pairs*)
- 5) Place any remaining electrons on the central atom in pairs
- 6) If the central atom does not have its minimum number of electrons (usually 8), form double bonds by moving lone pairs off of the outside atoms and drawing them as bonding pairs