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

b) Be

- Be will sometimes lose its 2 valence electrons, gaining the Is^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 – the central atom - but is followed for nonmetals around them.
- Never draw a double or triple bond to a metal. Draw the single bonds to the outside atoms and leave the metal alone.

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 – as a central atom

IV. Free Radicals

Some molecules have an odd number of electrons

Ex: NO, NO_2, 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