Outcome 2: Molecular Compounds and Intermolecular Forces

Topic 1: Lewis and Structural Diagrams for Molecular Compounds

Molecular (covalent) Bonding

- Occurs between non-metal atoms
- If the atoms are the same the result is a molecular element.
  - Eg. $N_{2(g)}$, $O_{2(g)}$, $P_{4(s)}$
- If the atoms are different, the result is a molecular compound.
  - E.g. $CO_{2(g)}$, $H_2O_{(l)}$, $N_2O_{(g)}$

Animation
http://bcs.whfreeman.com/thelifewire/content/chp02/02020.html

Types of formulas:

CO_2 CH_3OH ~~CH_4O~~

Molecular formula - shows all atoms in the compound, often in the order that they are bonded

Lewis formula - uses Lewis symbols to show bonding

Structural formula - shows which atoms are bonded using lines between atom symbols

Sterechemical formula - represents the 3D shape of the compound

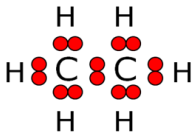
Shape Diagram

Example - ethane

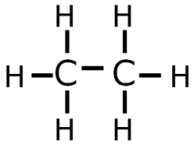
Molecular Formula

C_2H_6

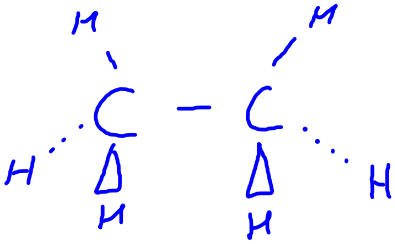
Lewis Formula



Structural Formula

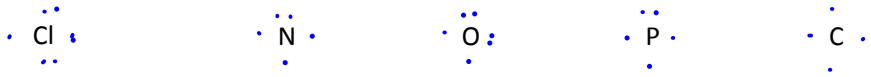


Stereochemical formula



Bonding Capacity

- (Def) - max. number of bonds that an atom can make
- Equals the number of bonding electrons that an atom has
- What is the bonding capacity of:

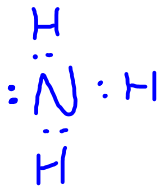


Creating the Lewis Diagram for Molecular Compounds

1. Count total valence e^- in the compound by adding the valence e^- for each atom.
   - Eg. SO_2 -
     - S has 6, O has (6 x 2 atoms) 12
     - 6 + 12 = 18 valence electrons
   - You try - NH_3 -
     - N has 5, H has (1 x 3 atoms)
     - 5 + 3 = 8 valence electrons

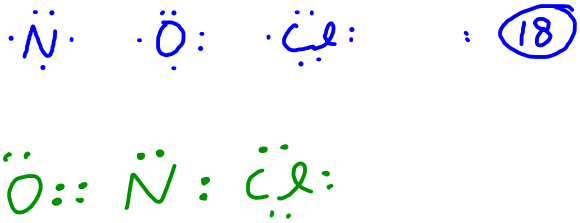
2. Arrange peripheral atoms around central atom
   - Central atom is one with highest bonding capacity
3. Place one pair of electrons between each peripheral atom and the central atom
4. Place more pairs of electrons on all the peripheral atoms to complete their octets
5. Place any remaining valence electrons on the central atom as lone pairs

Example: NH_3 (8)



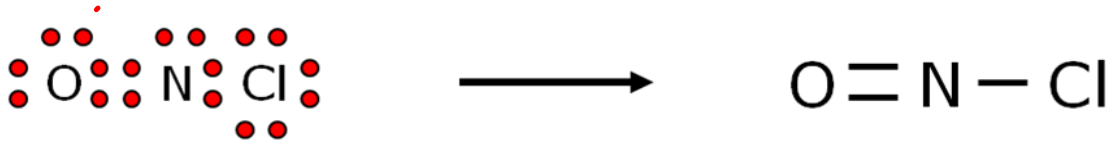
6. If the central atoms octet is not complete move a lone pair from a peripheral aton to a position between it and the central atom (keep bonding capacity in mind)

Example: NOCl (18)



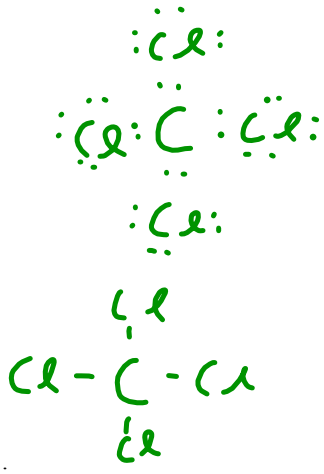
Structural Diagrams

- To create a structural diagram
  - First start with the Lewis Diagram
  - Replace every pair of <u>shared</u> electrons with a single line
  - Don't show lone pairs

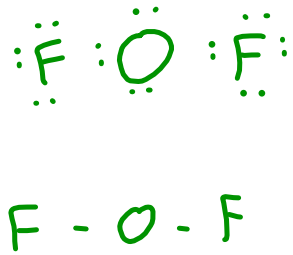


Examples: Draw the Lewis and Structural Diagrams for the following compounds

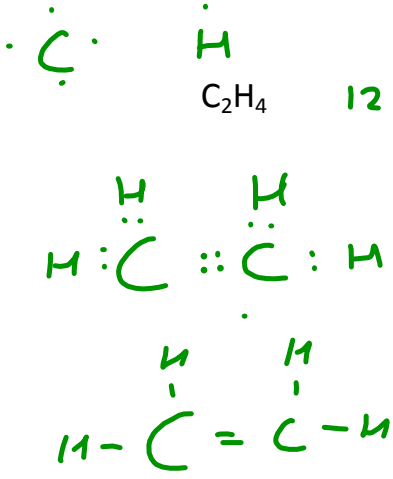
CCl_4 32



OF_2



C_2H_4 12



1. Use bonding theory to draw Lewis formulas for the elements in the halogen family. How are these diagrams consistent with the concept of a chemical family?

2. Use a Lewis formula to explain the molecular formula for nitrogen, $N_2(g)$. Recall that N atoms always obey the octet rule

3. Use both Lewis formulas and structural formulas to represent molecules of the following compounds:

(a) $CS_2(l)$, carbon disulfide (b) $H_2Se(g)$ hydrogen selenide (c) $PH_3(g)$, phosphine

(d) $CH_3SH(g)$, methanethiol (e) $H_2S(g)$, hydrogen sulfide

4. Why is it incorrect to write the structural formula of the H_2S molecule as H-H-S?

5. Why is the molecular formula for the methanol molecule usually written as CH_3OH instead of CH_4O? (Do the Lewis diagram to help you answer this)

6. For each of the following molecular compounds, name the compound, and explain the empirically determined formula drawing a Lewis formula and a structural formula:

(a) HCl (b) CO_2

7. Use the bonding capacities listed in Table 1 (page 87) to draw a structural formula of each of the following entities. In each case (for these particular molecules), every C must connect to 4 lines, every N to 3 lines, every O to 2 lines, and every to one line because C, N, and O atoms always obey the octet rule. Hint: Use the sequence of atoms in some of these molecular formulas to guide you.

(a) H_2O_2 (b) C_2H_4 (c) HCN

(d) C_2H_5OH (e) CH_3OCH_3 (f) CH_3NH_2

8. Using Lewis symbols, predict the simplest binary molecular compound and write the chemical name for a product of ea of the following reactions. Include a structural formula for a molecule of the product.

(a) $I_2(s) + Br_2(l)$ -->

(b) $P_4(s) + Cl_2(g)$ -->

(c) $O_2(g) + Cl_2(g)$ -->

(d) $C(s) + S_8(s)$ -->