Announcements

To join clicker to class today (Clickers with LCD display joins automatically):

- Turn on the Clicker (the red LED comes on).
- Push "Join" button followed by "20" followed by the "Send" button (switches to flashing green LED if successful).

- Suggested reading for next section and answers for this section will be sent out soon.

- 3-4 PM discussion quizzes from last week are available on up front on bench.
- Please make sure your lab instructor gets your prelabs for grading.

Review

- Valence (outer) e^- take part in bonding. Main group elements form bonds to get "octet".
  - Ionic species exchange e^- and become charged.
  - Covalent bonds are made by sharing e^-.
  - Unequal sharing leads to polar bonds. (look at electronegativities)
- Single, double and triple bonds
  - Length: triple < double < single
  - Strength: triple > double > single
- Formal method for drawing Lewis structures.
- Complication of "resonance":

Systematic Lewis Structures

1. Octet rule: all main group (s and p block) elements except B (6) and H (2) will share electrons to get 8 valence electrons.
2. Count the total number of valence electrons on all atoms. Add or subtract from this to account for the overall charge on the species.
3. Next draw single bonds from each of the outer atoms to the central atom. Subtract two electrons from the total number of electrons for each bond you have made = # electrons you have left to use elsewhere.
4. Put electrons on the outer atoms to give each atom a total of eight (an octet). (H) hydrogen only needs 2 electrons. (B) boron usually only 6 electrons. Keep track of how many electrons you are using. If you run out of electrons before filling the outer atoms' octets, stop.
5. Any electrons that were not used up in step 3 should be put on the central atom. You should now have no unused valence electrons.
6. If any atoms do not have octets, make multiple bonds (double and triple) by sharing electron pairs from atoms that do have octets.
7. Look for resonance structures. If you have made multiple bonds or have odd electron species where all the atoms cannot have octets, there may be more than one way to arrange the multiple bonds or place the odd electron. If so, the molecule is better modelled as an average of all the possible structures.
8. Use "Formal Charge" to pick best resonance structures.

Ozone, O_3

- Allotrope of oxygen (allotropes are differently bound forms of the same element)
- O_3 is one of the irritants in smog.
- O_3 in the stratosphere (ozone layer) is good.
  - It protects us from UV radiation by absorbing radiation between 242 nm and 320 nm.

$$O_3 + h\upsilon(\leq 320 \text{ nm}) \rightarrow O_2 + O$$

  - O_2 only absorbs radiation with $\lambda \leq 242$ nm (higher energy)

$$O_2 + h\upsilon(\leq 242 \text{ nm}) \rightarrow O + O$$

Catalytic destruction of O_3 by Cl

1) $CCl_3F + h\upsilon \rightarrow CCl_2F + Cl$

2) $Cl + O_3 \text{ -> } ClO + O_2$

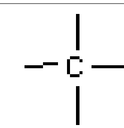
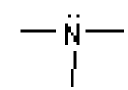
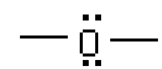
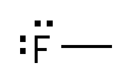
3) $ClO + O \text{ -> } Cl + O_2$

(O from O_3 and $O_2 + h\upsilon$)

- Last two RXNs constitute a catalytic cycle
  - Cl used in RXN 2, but produced in equal amounts in RXN 3.
  - Sum of RXNs 2 &3: $Cl + O_3 + O \text{ –> } Cl + 2O_2$

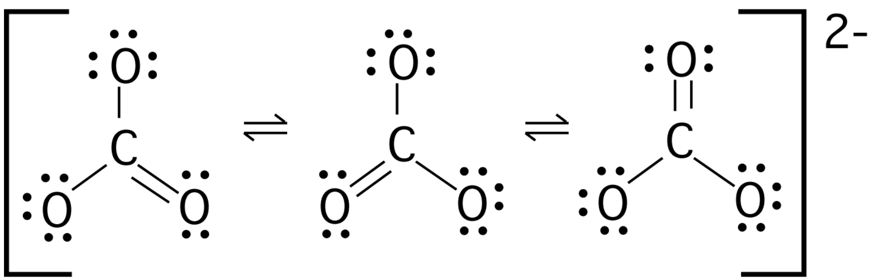
Quick rules for simple Lewis Structures

- Works well for some period two atoms (H, C, N, O, F) and the halogens (group 17) most of the time.

Atom	Number of Bonds	Lewis Cartoon
H	1	H-
C	4	
N	3	
O	2	
F (same for other halogens)	1	

Bond Order

- Bond order between 2 atoms = # shared electrons/2. Ex: H–H bond order = $(^1/_2)2 = 1$
- In resonance structures bond order = weighted average of bond order in each resonance structure.
- CO bond order in $CO_3^{2-} = (^1/_3)2 + (^2/_3)1 = 1^1/_3$



Formal Charge

- Useful for determining most likely resonance structures.
- Formal charge = the charge an atom would have if all bonding electrons are shared equally.
- Calculation: Formal Charge = # valence e^- -[# non-bonding e^- + (1/2)•(# bonding e^-)]
- Electro-neutrality Principle: the resonance structure with formal charges closest to zero is the largest contributor.