Announcements for Thursday, 10OCT2024

- Today's Office Hours are Extended to go until **4:00 PM**
- Week 6 Homework Assignments available on eLearning
  - Graded and Timed Quiz 6 – "Compounds" due **Monday, 14OCT2024, at 6:00 PM (EDT)**
- Application deadline for transfer into Chem 133 is **today**
  - if you got $\leq$ 44% on the first exam, you should ***strongly*** consider transferring as Chem 161 will only get harder as the semester progresses
  - see Canvas announcement from Oct 8 and "Transfer to Chemistry 133" module for more details and application directions
- Exam 1 is now available for reviewing through ***Gradescope***
- Requests for Exam Question Regrades
  - Monday, 14OCT2024, 12:01 AM (EDT) – Wednesday, 16OCT2024, 11:59 PM (EDT)
  - MUST be submitted through ***Gradescope*** (do not email instructors)
  - Canvas announcement will be made providing details of policies and procedure

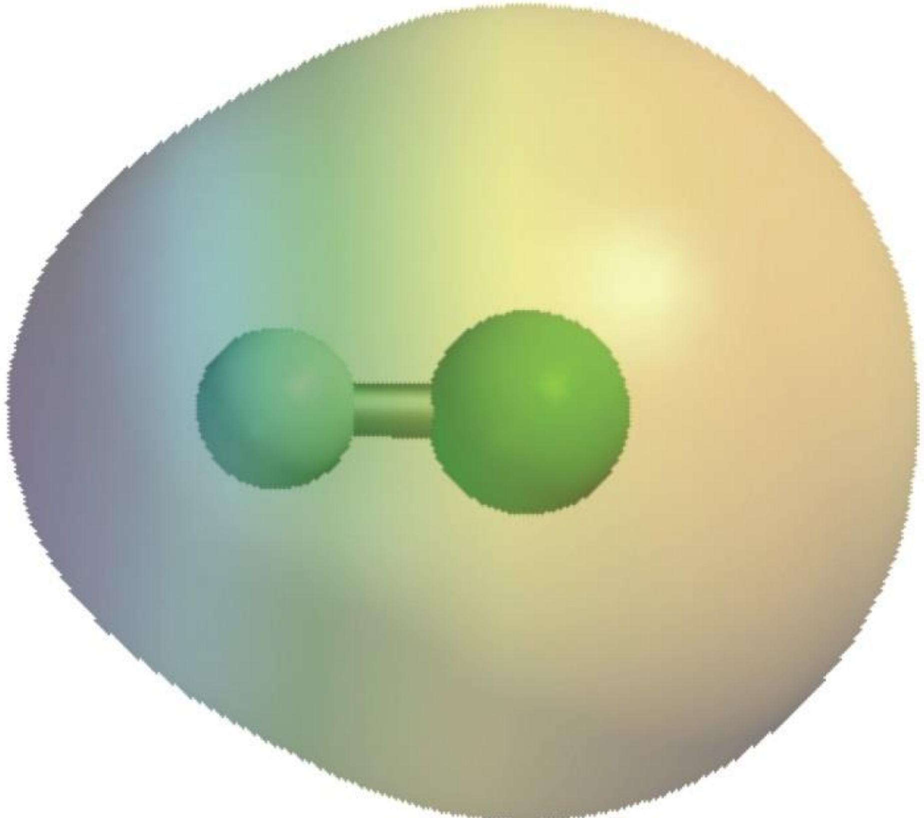
ANY GENERAL QUESTIONS? Feel free to see me after class!

Determining Empirical and Molecular Formulas

- What is the empirical formula of a compound that is composed of 5.00×10^{24} hydrogen atoms, 5.00×10^{24} bromine atoms, and 2.00×10^{25} oxygen atoms? $HBrO_4$
- 60.00 g of a compound containing only sulfur and oxygen contains 24.03 g sulfur. What is the empirical formula of this compound? SO_3
- Determine the empirical formula of a compound that is 21.95% sulfur by mass and 78.05% fluorine by mass. SF_6
- Determine the ***molecular*** formula of a compound that is 65.19% arsenic by mass, 34.81% oxygen by mass , and has a molar mass of 459.68 g/mol. As_4O_{10}
- Combustion analysis of 12.01 g of an organic compound containing only carbon, hydrogen, and oxygen produces 14.08 g CO_2 and 4.32 g H_2O. Determine the compound's empirical formula. $C_2H_3O_3$

Representing Dipole Moments/Polar Bonds

- a dipole moment is caused by a charge separation
  - the magnitude of the charges are ***partial charges***
- δ **–** and δ **+** vs. an arrow
- electrostatic potential map
  - sometimes it's beneficial to picture the electrons as a cloud of charge that can be smeared around the molecule



electrostatic potential map for HF

Try This On Your Own

Rank the following bonds in order of increasing polarity and indicate the dipole moment of each bond (if present) with an arrow.

C–F   C–O   C–H

Calculating Dipole Moments

- dipole moment, μ, is a measure of bond polarity
  - it occurs any time there is a charge separation of a (+) and a (–) by a distance
  - μ (dipole moment) = q × r

    q = magnitude of charge (in C)

    r = distance (in m) between charges

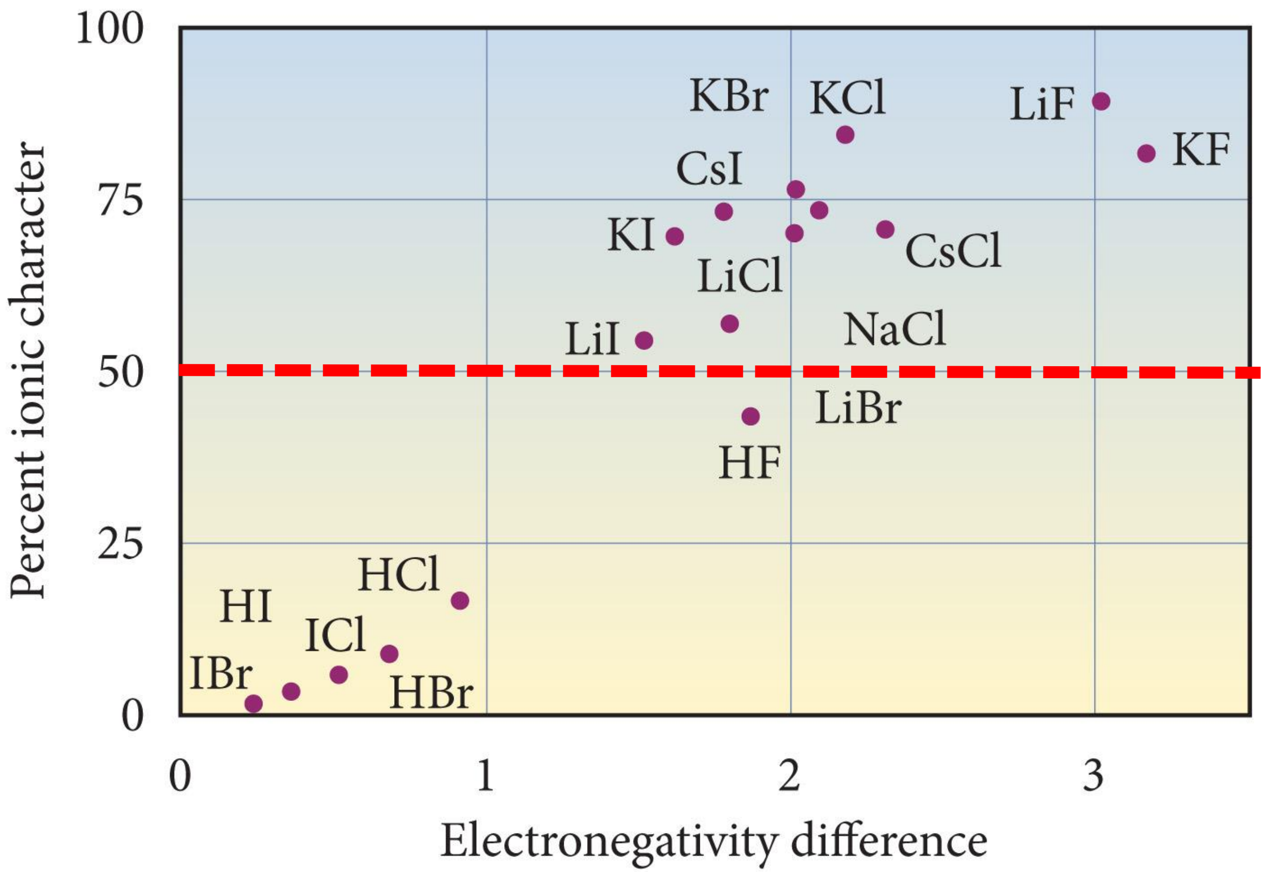
    - it is directly proportional both to the magnitude of the partial charge and to the distance (r) between them
  - commonly measured in debyes (D) where 1 D = 3.34×10^{-30} C·m

TABLE 5.2 Dipole Moments of Several Molecules in the Gas Phase

Molecule	ΔEN	Dipole Moment (D)
Cl_2	0	0
ClF	1.0	0.88
HF	1.9	1.82
LiF	3.0	6.33

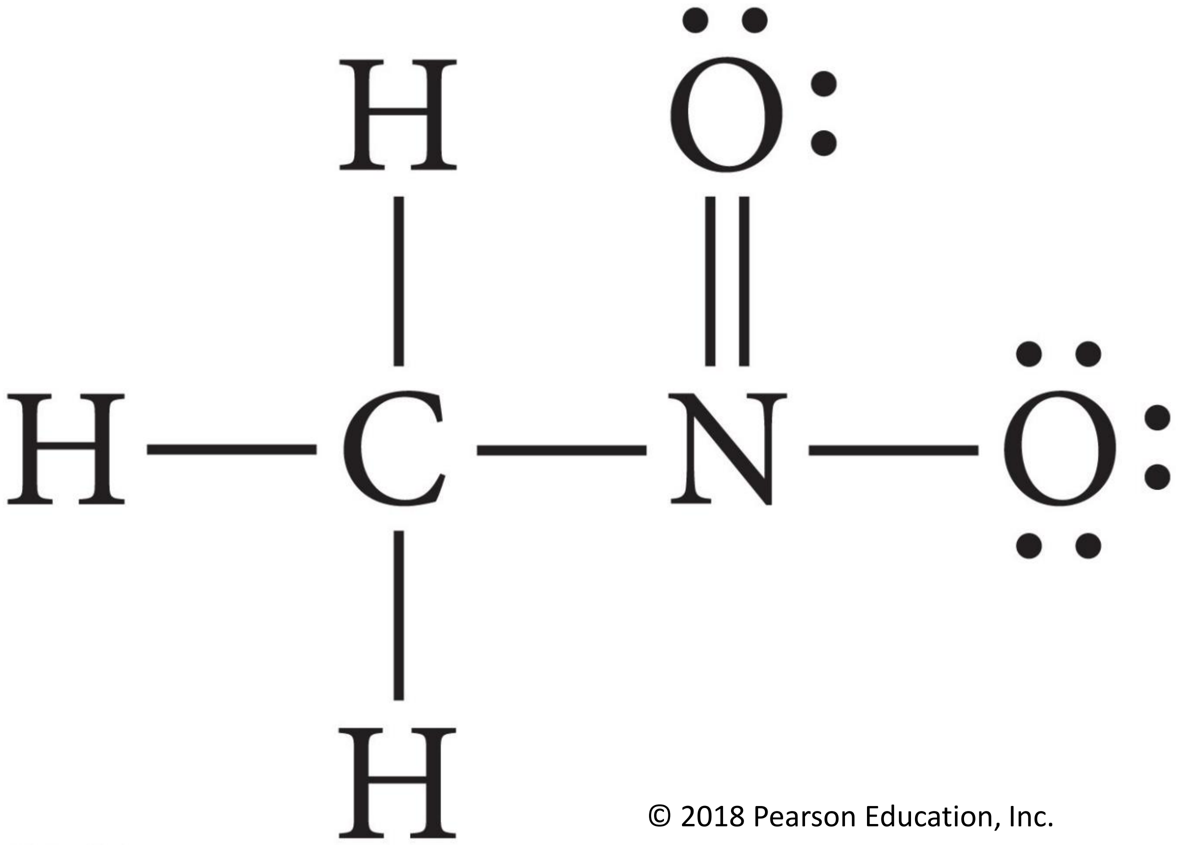
Percent Ionic Character

- indicates the extent of electron transfer between two atoms within a bond
- it is the ratio of a bond's actual dipole moment to the dipole moment the bond would have if electron was completely transferred
- % ionic character increases as electronegativity differences increase
- bonds with 50% or above ionic character are referred to as ionic bonds



Properly Drawing Lewis Structures

- a Lewis structure is a simple way of representing the structure of a molecule or polyatomic ion
  - bonding electrons shared by two atoms represented by dashes
  - unshared, nonbonding electrons shown as dots
- drawing Lewis structures quickly and effectively is an important skill for the course
- I will be using a method that is different than the book's method. Use whatever method you like more.
- lecture notes posted online will have full step-by-step procedure



Properly Drawing Lewis Structures

★This method is different than the book's method. Use whatever you like more

1. establish the total number of electrons that your final structure must have by adding up the valence electrons of each atom in the compound
   - adjust the total number of electrons for ions
     - for each positive charge, subtract 1 electron from the total
     - for each negative charge, add 1 electron to the total
2. from the formula, choose the central atom(s)
   - sometime there may be more than one central atom
   - the less electronegative atoms tend to be central atoms, the more electronegative atoms tend to be terminal (i.e., outer) atoms
   - carbon will (almost) always be central
   - H and F will never be central
3. start by connecting the terminal atoms to the central atom using single bonds to form a skeleton. The dashes represent bonding pairs of electrons
   - for more complex molecules, the skeleton should be symmetrical (unless otherwise stated)
   - for hydrogens attached to an oxyanion: the hydrogen(s) **never** attach directly to the central atom; they attach to oxygen(s) (which attaches to the central atom)
4. go atom-by-atom and give enough nonbonding electrons (as lone pairs) to each atom to fill the atom's octet (i.e., eight electrons surrounding the atom). The bonding pairs belong to both atoms of the bond, while the lone pairs only belong to one atom.
   - hydrogen only needs two electrons (a duet)…never give H more than 2 electrons
   - be aware at this point for atoms that can have incomplete octets, such as Be and B
   - also be aware at this point for atoms that can expand their octets (P, S, Cl…Period 3 elements and beyond)

Properly Drawing Lewis Structures (continued)

5. once you’ve completed all the atoms’ octets, count up the total number of electrons in the Lewis structure and compare this number to the number calculated in Step 1
6. if the numbers are the same, the structure you drew is acceptable (but not necessarily the best Lewis structure…use formal charges to establish “the best”)
7. a. if the number of electrons is MORE than the number established in step 1, subtract the numbers and divide by 2. The resulting answer tells you the number of extra bonds that must be added to your skeleton
   b. rather than erasing electrons from the skeleton, REDRAW the skeleton, but this time include the extra bond(s) between atoms capable of forming multiple bonds (never H and almost never F)
   c. if there is more than one way to distribute the extra bonds, the species exhibits resonance and you should draw all of the possible arrangements
   d. once again, go atom-by-atom and complete their octets with lone pairs
   e. count up the total electrons in your structure(s) and confirm that it matches the number in Step 1
8. if the number of electrons in your initial structure is LESS than the number established in Step 1, this indicates that the central atom can expand its octet. Simply add the remaining electrons around the central atom.
9. once the structure has the proper number of electrons, go atom-by-atom and assign formal charges. If there is more than one possible structure that differs based on formal charges, choose the structure(s) that minimize formal charges, and that place negative formal charges on the more electronegative atoms.

Common Oxyanions That May Have H^+(s) Attached to Oxygen(s)

- nitrate ion NO_3^-
- nitrite ion NO_2^-
- carbonate ion CO_3^{2-}
- oxalate ion $C_2O_4^{2-}$
- sulfate ion SO_4^{2-}
- sulfite ion SO_3^{2-}
- phosphate ion PO_4^{3-}
- phoshphite ion PO_3^{3-}
- perchlorate ion ClO_4^-
- chlorate ion ClO_3^-
- chlorite ion ClO_2^-
- hypochlorite ion ClO^-
- acetate ion CH_3COO^-
- formate ion $HCOO^-$

highlighted hydrogens in **CH_3**COO^- and **H**COO^- are attached to carbon though any subsequent hydrogens attach to oxygen

Properly Drawing Lewis Structures – Examples