Announcements – 9/13/00

- Labs begin TODAY!
- Old exams on website
- Problem Set Solutions?
- Exam #1
  - -covers matl thru this Friday (Ch 1&2)
  - -email/contact me ASAP if you have a conflict with exam time
- Demo and Quiz on Friday

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Bonding: Ionization Energies

- Ionization Energy (IE)

-quantifies the tendency of an electron to leave an atom in the gas phase:

$X\ (g) \quad X^+\ (g) + e^- \quad \Delta E = IE$

IE: -***always*** positive (energy ADDED)
-INCR across row
-DECR down a group

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Bonding: Electron Affinity

- Electron Affinity (EA)

-quantifies ability of an atom to *attract* an e^- in the gas phase

$X\ (g) + e^- \rightarrow X^-\ (g) \quad -\Delta E = EA$

EA: -it's the energy *released* upon addition of an electron to an atom

-can be *positive* or *negative*
(**pos**: atom *wants* the e^-
neg: atom happy as an atom)

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Bonding: Electronegativity

- Electronegativity (EN)

-combines IE and EA terms to give the relative ability of an atom to attract e^-'s to itself ***when bonded*** to another atom

EN: -INCR across a row
-DECR down a group
-Best to consider ΔEN for a bond

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EN: Examples

- NaCl: Na EN = 0.93
  ΔEN = 2.23 (ionic)
  Cl EN = 3.16
- O_2: O EN = 3.44 ΔEN = 0 (covalent)
- HCl: H EN = 2.2
  ΔEN = 0.96 (?)
  Cl EN = 3.16 (polar covalent)

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Bond Polarity: Dipole Momement

- HCl δ+ δ- ← partial charges
  H – Cl
  2.2 3.2

Polar Covalent bond*:* share e^-, but not equally

-Quantify via: DIPOLE MOMENT (μ)

$\mu = \delta \times d$ ← Bond length (m)

1 Debye (D) = 3.34×10^{-30} C-m

Amt of displaced charge (C)

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Dipole Moment Examples

- H_2O O EN = 3.44
  H EN = 2.2 ΔEN = 1.24

  -*each H-O bond* is polar, but does the MOLECULE have a *net* dipole moment?
- CH_4 C EN = 2.55
  H EN = 2.2 ΔEN = 0.35

  -*each C-H bond* has a dipole moment, but does the entire MOLECULE have a *net dipole moment?*

We need to know the STRUCTURE!

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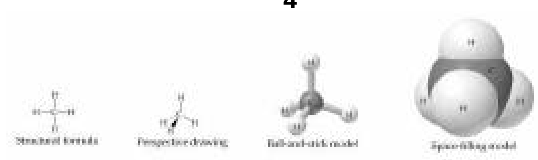
Visualizing Molecules

CH_4



How do we figure out the structure?

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Lewis Bonding Theory

- **<u>Based on some simple assumptions</u>**:
  -*valence electrons* are the major players in chemical bonding
  -**ionic bonds** form when electrons are <u>transferred</u> between atoms
  -**covalent bonds** form when electrons are <u>shared</u> by atoms
  -the extent of electron transfer/sharing is so as to give each atom a stable electron configuration (usually an **octet**)

Lewis Symbols

- Place *valence electrons* around element symbol:

:X: <- element X (4 e^-)

- pair electrons, when possible
- bonds represented by dashes (-)

<u>Example:</u> :F̤ - F̤:

Drawing Lewis Structures

- **<u>The Quick and Dirty Method:</u>**
  1. Add up the **<u>total</u>** number of valence electrons (from Group #)
  2. Draw *skeleton structure* with only single bonds
  3. <u>Distribute</u> remaining electrons around atoms as *non-bonding* electrons
  4. *<u>Redistribute</u>* non-bonded electrons into *multiple bonds* so that each atom has an **octet**

Example

<u>Sulfur Dioxide (SO_2):</u>

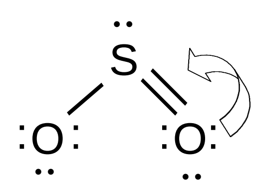
S & O: Group 6A -> *6 x 3 = 18 e^-*

-Draw Skeleton structure

2 e^-/bond, leaves **14 e^-**

-Move e^- to make multiple bonds and octets

Done!



Getting Structures

- Once we have the <u>Lewis diagram</u>, we can determine the *structure* by looking at the distribution of bonded and non-bonded electron pairs about a central atom, using:

  <u>**V**alence **S**hell **E**lectron **P**air **R**epulsion Theory</u>

  - *electron pairs* will ***repel*** each other and will distribute themselves about a central atom so as to <u>maximize their separation</u> in 3-dimensional space

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VSEPR Theory

- Count electron pairs (include non-bonded!)

  2 -> **Linear** (180^o bond angle)
  3 -> Trigonal Planar (120^o bond angle)
  4 -> Tetrahedral (109.5^o bond angle)
  5 -> Trigonal Bipyramidal
  6 -> Octahedral

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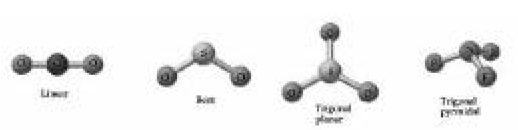
VSEPR Structures



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