Thursday Notes 10/3/13

Clicker Quiz

Ionic: M + NM covalent: NM + NM Metallic: M + M

Sulfur trioxide: SO_3 ← covalent compound

Sulfite: SO_3^{2-}

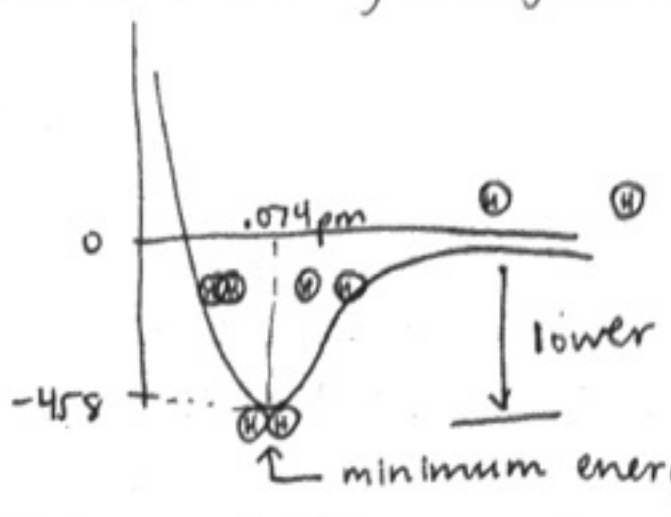
NH_4OH: Ammonium Hydroxide

Practice with Nomenclature worksheet in eBook

*How are covalent compounds put together? * → Sharing of electrons!

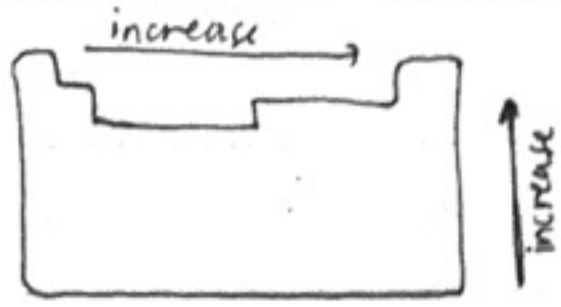
Bonds are characterized by:
- Bond length
- Bond Strength
- equal / unequal sharing

Chemical Bonding Diagram (H_2 molecule):

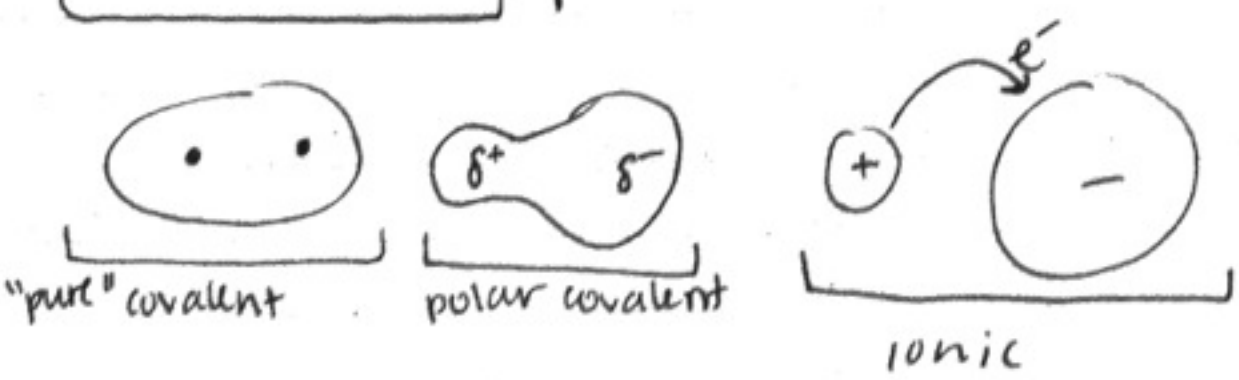


Electronegativity

- Attraction of electrons in an element



* large dif. in electronegativity → ionic bond
* small dif. in electronegativity → covalent bond

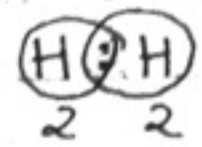


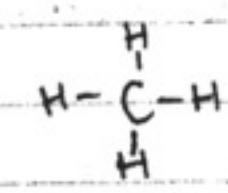
What is attached to what?

valence electrons — Lewis symbols — Lewis structure — satisfy octet

↑ outside core

↑ what is bonded to what

H_2 $H^\cdot + H^\cdot$ H–H 

CH_4  C has 8e⁻ ✓ H has 2e⁻ ✓

Lewis Structure Rules

Determine total # valence electrons

Predict total # bonds: $S = N - A$ rule

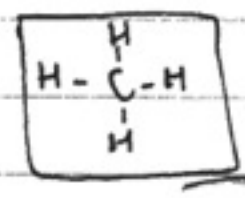
shared = needed e⁻ − available e⁻

Draw skeletal structure

Place Nonbonding electrons

Fix the # bonds

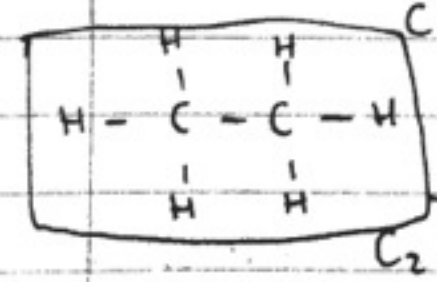
examples:



CH_4 C 4 A = 8

H $1 \times 4 = 4$ N = 8 + 4(2) = 16

$S = N - A = 16 - 8 = 8 \rightarrow$ 4 bonds



C_2H_6 C $4 \times 2 = 8$ A = 14

H $1 \times 6 = 6$ N = 16 + 6(2) = 28

$S = 28 - 14 = 14 \rightarrow$ 7 bonds

C_2H_2 C 2 A = 10

H 2 N = 20

$S = 20 - 10 = 10 \rightarrow$ 5 bonds

$H-C \equiv C-H$

		Bond strength (kJ/mol)	Bond length (pm)
C–C	single	348	154
C=C	double	614	134
C≡C	Triple	839	120

longer bonds = weaker

fewer bonds = weaker

C_2H_6O

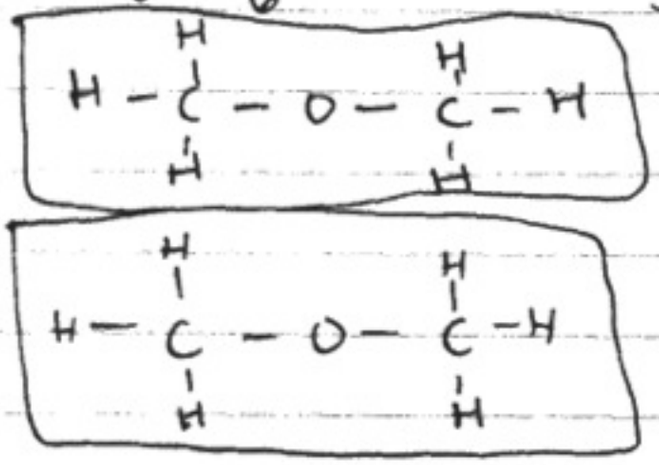
CH_3OCH_3

C	8
H	6
O	6

$A = 20$

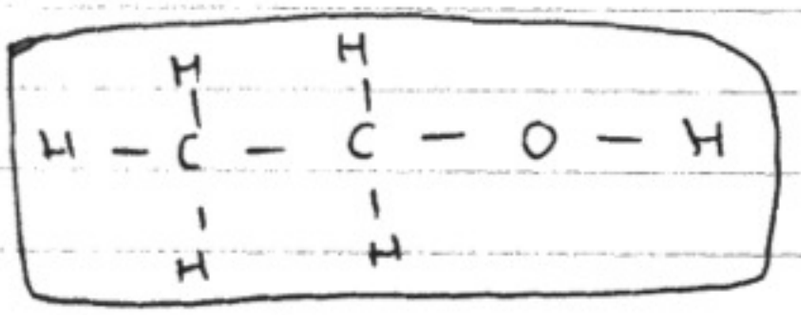
$N = 16 + 12 + 16 = 44$

$S = 44 - 20 = 24 \rightarrow$ 12 bonds



carbon has 4 bonds
Oxygen has 2 bonds
Hydrogen has 1 bond

C_2H_5OH



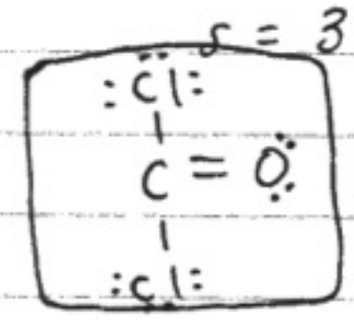
$COCl_2$

C	4
O	6
Cl	14

$A = 24$

$N = 8 + 8 + 16 = 32$

$S = 32 - 24 = 8 \rightarrow 4$ bonds



$FC_O = 6 - (1+6) = 6 - 7 = -1$

$FC_{Cl} = 7 - (2+4) = 7 - 6 = +1$

*To be sure: Formal charge check

$FC_{atom} = \text{Group \#} - (\text{bonds} + \text{nonbonded } e^-)$

$FC_{atom} = \text{\#valence} - \frac{1}{2}\text{shared} + \text{nonbonded}$

You want the structure that minimizes FC!

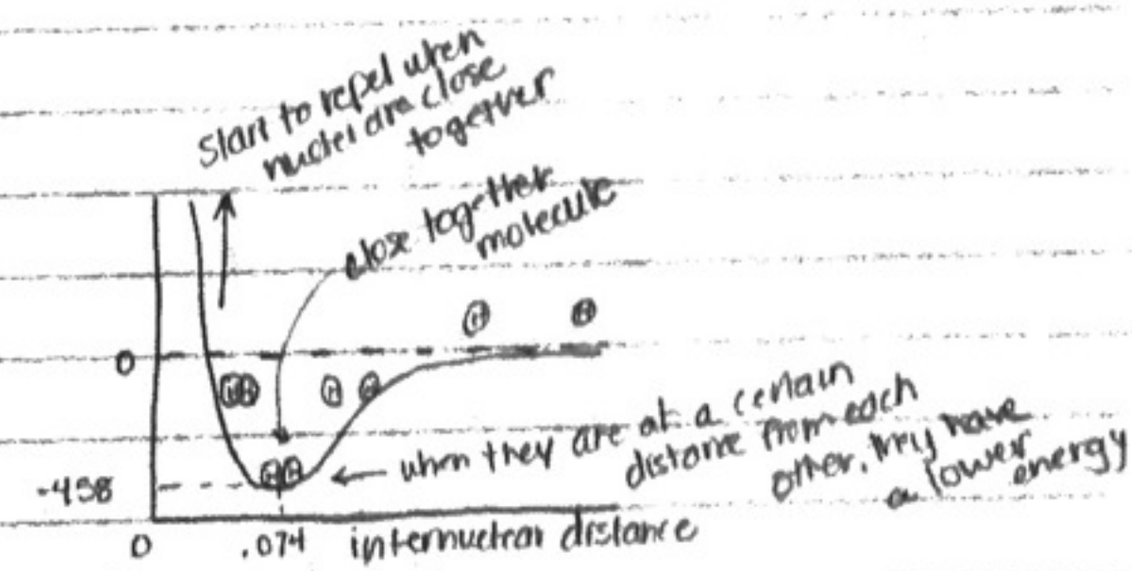
Sum FC on all atoms = charge of compound

Next time: work for "candy" or "fame"

NO_3^-

10/3/13 - Electrons and compounds

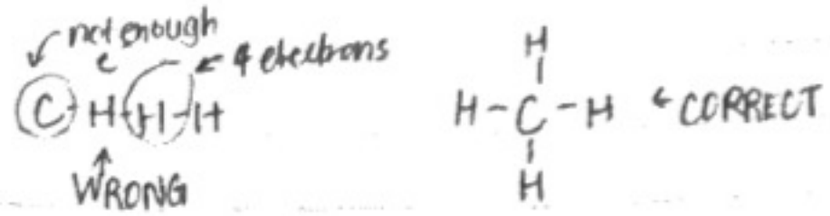
- Electron conf. and bonding
  - use lewis dot structures to predict bonding
  - concept of resonance
- bonds:
  - metallic: metal + metal
  - covalent: nonmetal + non-metal
  - ionic: non-metal + metal
- Think about how covalent compounds are put together
  - Characterize the bond:
    - bond length
    - bond strength
  - Electron pair shared equally?
    - YES - Pure covalent
    - NO - Polar covalent
- Compounds that aren't ionic are covalent
  - Non metal + non-metal
  - Electrons are "shared"
  - 2 non-metals w/ similar electronegativities



- electronegativity
  - How tightly is an atom holding onto its electrons?
  - Hard to pull electrons off of Fluorine, so it has a high electronegativity
  - When there is a small difference in electronegativity = you will make a covalent compound
- Ionic vs Covalent bonds
  - all bonds can be viewed as hybrids between purely ionic and purely covalent
  - when 2 identical atoms are bound, it is purely covalent
  - when 2 different atoms are bound, one may have a greater attraction for e⁻ and have a partial negative charge
  - polar covalent bond - degree is measured as dipole movement
  - when one atom has a much stronger attraction for an electron. then it may take the electron and form an ionic bond.
- Dash between 2 atoms in structure is a shared pair of electrons

- What is attached to what?
  - Valence electrons - Lewis symbols - Lewis structures - satisfy the octet rule
    - outside of core
    - what is bonded to what
  - H_2

    Drawn as H-H H:H
  - Methane - CH_4



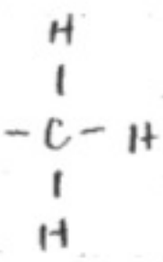
- Lewis Structure Rules
  - Determine total # of valence electrons
  - Predict total # of bonds: S = N - A rule

    A: sum of valence electrons
    N: sum for noble gas for all atoms
    S: shared electrons
    N: needed electrons
    A: available electrons
  - Draw skeletal structure (usually has a central atom
  - Place nonbonding electrons
  - Fix the # of bonds
- Demonstrate Lewis structure

  CH_4 C: 4 A: 8

  H: 1·4 N: 8+4(2): 16

  S: 16-8: 8



- Take a little moment

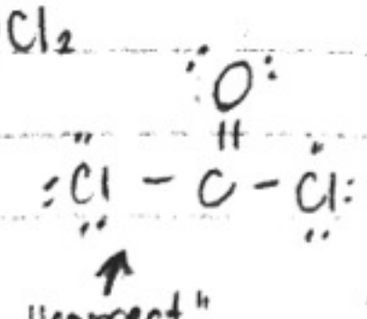
		Bond strength (KJ/mol)	Bond length (pm)
single	C-C	348 KJ/mol	154
double	C=C	614 KJ/mol	134
triple	C≡C	839 KJ/mol	120

- C_2H_6O: condense formula (no hint to structure)

  CH_3OCH_3 and C_2H_5OH → structural formulas
  - generally speaking, O has 2 bonds and C has 4 bonds
- Formal charge (FC atom) = Group # - (bonds + nonbonded e^-)

  # of valence electrons

  $COCl_2$



  oxygen usually makes 2 bonds
  fluorine usually makes 1 bond
  - Pick the structure that minimizes formal charge.

  $FC_O = 6-(2+4)\cdot 0$

  $FC_{Cl} = 7-(1+6)\cdot 0$

  $0+0=0$
  - sum FC on all atoms = charge on compound, so FC should

Isoelectronic = same # of valence e⁻

$O^- \leftrightarrow F$ $\quad O^{2-} \leftrightarrow F^- \leftrightarrow Ne$

$O^+ \leftrightarrow F^{2+}$

paramagnetic: unpaired

diagmagnetic: paired

bond length $1 > 2 > 3$

str $1 < 2 < 3$

polar HI HCl more negative on Chlorine

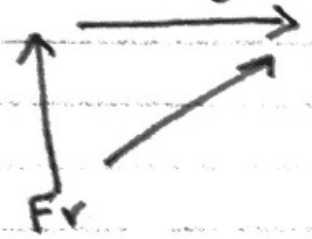
nonpolar H-H share 50%

Cl-Cl

NaCl: Ionic polar

~~is~~ so seperate = no sharing of electrons

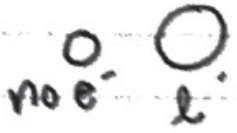
Electronegativity:



nonpolar

polar

] covalent



ionic

molecular: covalent

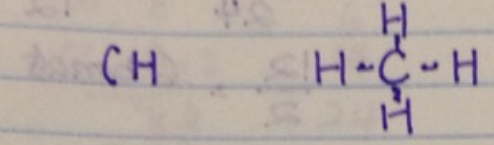
X – Y

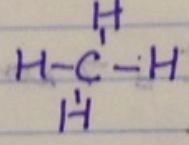
↑ shared.

Covalent compounds

H_2 H—H H—H

CH





POOR

Lewis Structure Rules

- Determine total # of V. e⁻
- how many bonds S = N − A
  - S: shared # e⁻
  - N: needs (to complete octet rule)
  - A: valence e⁻

$\frac{10}{2}$ = shared e⁻

$\frac{S}{2}$ = # of bonds

CH_4 S = N − A

C: ~~8~~ − 4

N A

H: 2 × 4 = 8

16

16 − 8 = $\frac{8}{2}$

4 bond

1 × 4 = 4 4 + 4 = 8

C_2H_6 N A

8 × 2 = 16 4 × 2 = 8

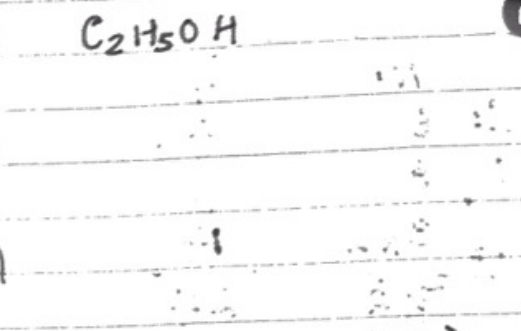
2 × 6 = 12 1 × 6 = 6

28 14

$\frac{28 - 14}{2} = 7$ bonds

Structural Formula

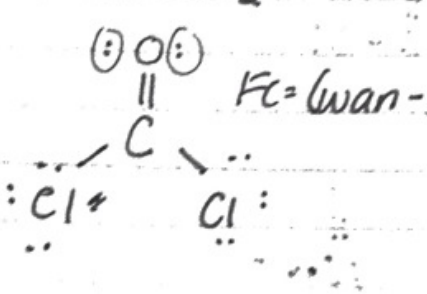
C_2H_6O CH_3OCH_3 C_2H_5OH



Formal Charge

$FC_{atom} = Group\# - (bonds + non\ bonded\ e^-)$

$COCl_2$



FC = (wan - have)

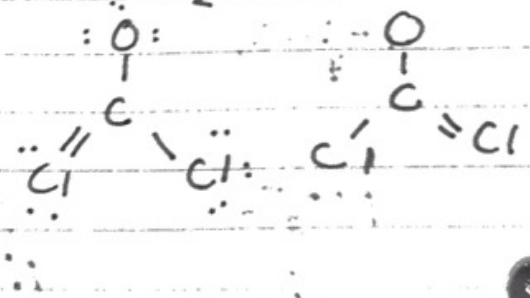
$O: 6-6=0$

$C: 4-4=0$

$2\times Cl = 7-7=0$

0

$COCl_2$



$O: 6-7=-1$

$C: 4=4=0$

$2\times Cl: 7-7=0$

$Cl: 7-6=+1$

0

Resonance structures