LEC (2) CHEM 30A Apr 6th

1. CHEMICAL BONDING
2. LEWIS STRUCTURES
3. FORMAL CHARGE
4. SHAPES of MOLECULES
5. DRAWING ORGANIC STRUCTURES

HMK READ 1.3–1.4

PROBLEMS: 1.6–1.13, 1.23–1.47 (3/4 Ed)
* 2 EXTRA PROBLEM SETS ON WEBSITE

(1) CHEMICAL BONDING

Valence electrons (outer shell electrons)
=> these involved in BOND FORMATION

# VALENCE e⁻	1	2		3	4	5	6	7	8
	H								He
	Li	Be	d-block	B	C	N	O	F	Ne
	Na	Mg		Al	Si	P	S	Cl	Ar

ELECTRONEGATIVITY (EN) – AN ATOM'S ATTRACTION FOR ELECTRONS IT SHARES IN A CHEMICAL BOND WITH ANOTHER ATOM

F has HIGHEST VALUE => 4.0

← decreases

F

↓ decreases

PAULING SCALE
(Linus Pauling 1901-1994) CHEM 1954 PEACE 1962

ORGANIC CHEMISTRY ⇒ COVALENT BONDS ⇒ EN DIFFERENCES < 2

so, consider:

Na F (3.1)
0.9 4.0 ⟶ NaF (Na^+F^-) IONIC Salt

O H (1.4) δ- δ+
3.5 2.1 ⟶ O—H  polar covalent

e⁻ clouds

C C (0)
2.5 2.5 ⟶ C—C  non polar covalent

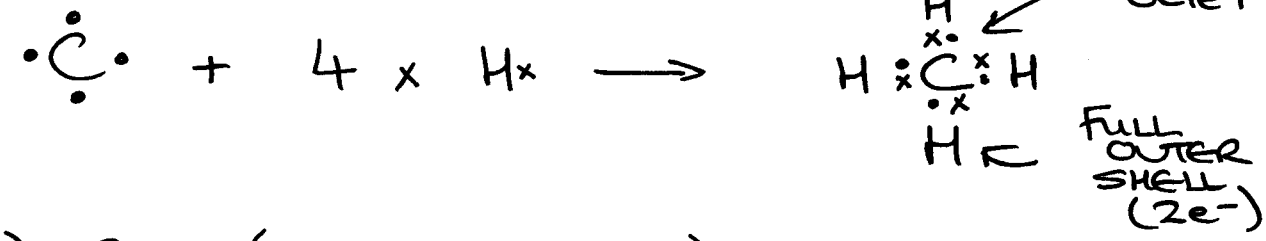
EN difference < 0.5 ≅ NONPOLAR

C—H check out Table 1.5 Page 7
2.5 2.1 know values for common elements & know TRENDS

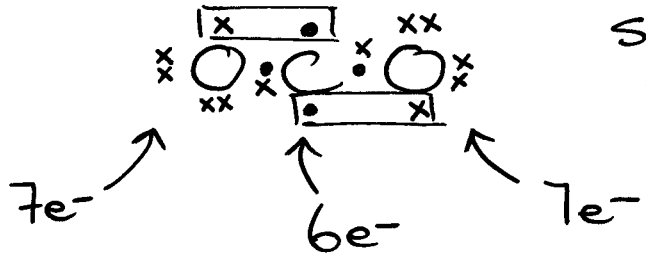
② LEWIS STRUCTURES

- # of valence e⁻ on each atom
- least EN element in center (not H)
- form single bonds
- fill octets (multiple bonds / charges)

a) CH_4 (methane)

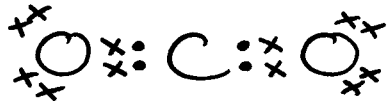


b) CO_2 (carbon dioxide)

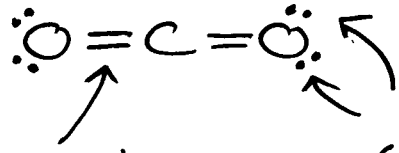


Single bonds, but OCTETS not full

- share more electrons (MULTIPLE BONDS)
  ⇒ redraw



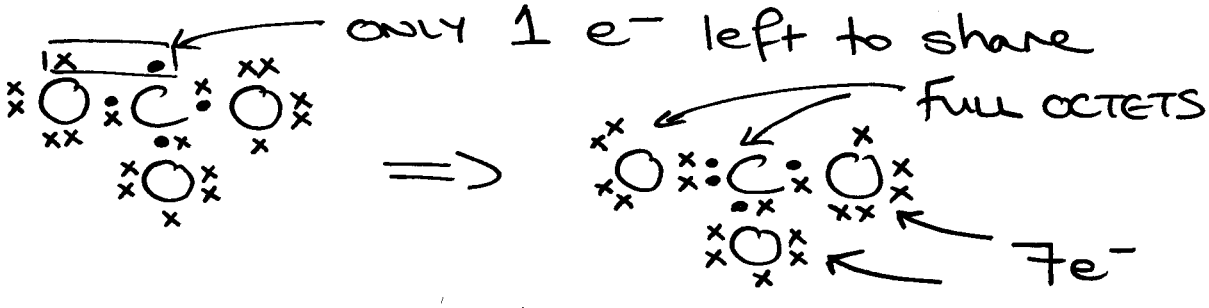
ALL ATOMS HAVE FULL OCTETS



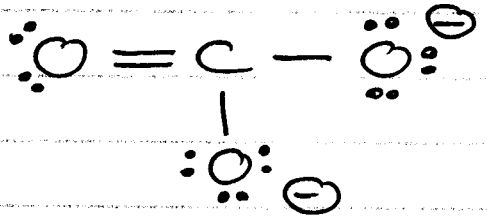
bonding pairs

lone pairs (non-bonded)

c) CO_3^{2-} (CARBONATE ANION)

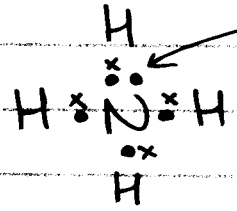


So, add in 2 electrons to fill octets (DRAW THEM IN ABOVE)



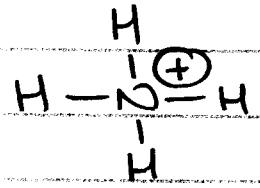
CO_3^{2-}

d) $NH_4^{\oplus}$ - AMMONIUM CATION



$9e^-$ in VALENCE SHELL
- violates OCTET rule

So, get rid of it ⟹



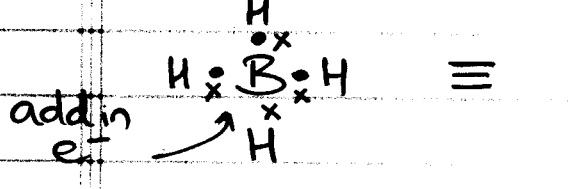
(3) FORMAL CHARGES

- Draw LEWIS structure

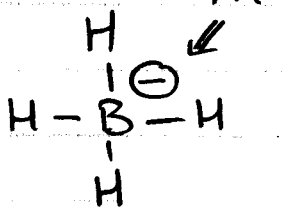
For each atom:

$$\text{FORMAL CHARGE} = \#\text{ VALENCE ELECTRONS IN ISOLATED NEUTRAL ATOM} - \left(\#\text{ OF NON-BONDING } e^- + \tfrac{1}{2}\#\text{ BONDING } e^-\right)$$

a) $BH_4^{\ominus}$ ⟸ ADD CHARGES AT END

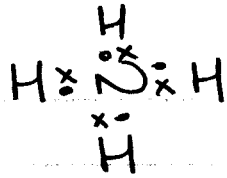


$\equiv$

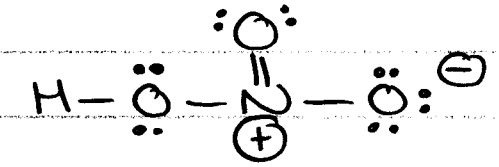


$(3 - 8/2) = -1$

ADD CHARGES AT END

b) NH_4^+  $(5 - 8/4) = +1$

c) HNO_3 (nitric acid)

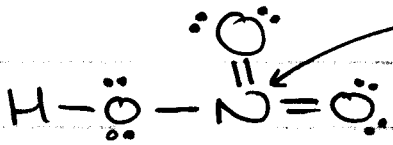


FILL OCTETS (ADD CHARGES AT END)

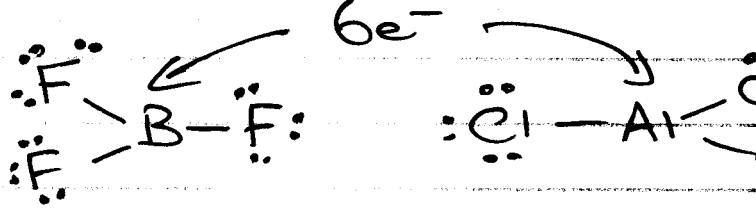
N $(5 - 8/2) = +1$

O $(6 - (6 + 2/2)) = -1$

other O's $(6 - (4 + 4/2)) = 0$

Note: not  10e⁻ violates OCTET rule.

- Note There are exceptions to the octet rule

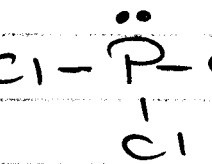
GROUP (3) 

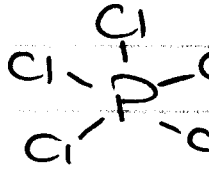
6e⁻

usually quite reactive species

3RD ROW ELEMENTS (P, S)

d orbitals ⇒ EXPAND OCTET

 PCl_3 8e⁻

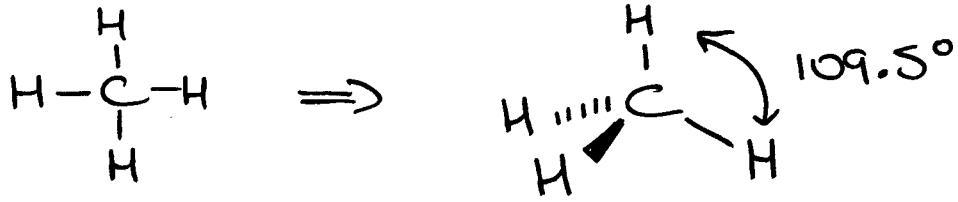
 PCl_5 10e⁻

(4) SHAPES of MOLECULES

Valence Shell Electron Pair Repulsion Theory (VSEPR) – SIMPLIFIED MODEL

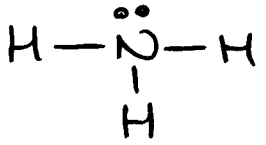
Geometry determined by valence shell electron pairs (BONDED & NONBONDED) arranging to minimise electrostatic repulsion

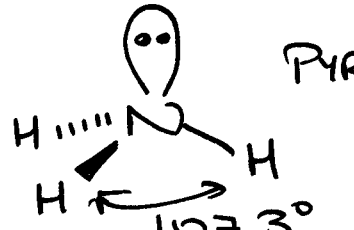
e.g.



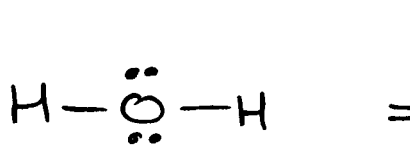
tetrahedral

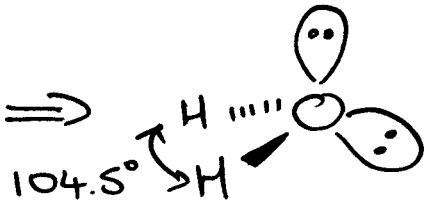
DISTINGUISH BETWEEN "SHAPE of MOLECULE" VERSUS GEOMETRY AROUND AN ATOM





PYRAMIDAL (compressed)





BENT (more compressed)

closer to nucleus ⇑

WHY? lonepair/lonepair > lone pair/bond.ng pair > bonding pair / bonding pair

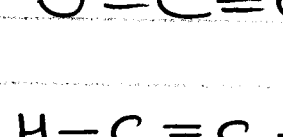
Also, $A \equiv B > A = B > A - B$

BASIC GEOMETRIES

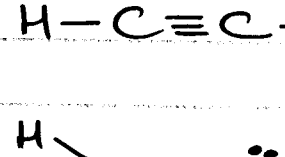
- for sake of geometry, treat multiple bonds as single bonds

- when considering the geometry of a given atom, add the number of other atoms bonded to it, to the number of lone pairs it has ⇒

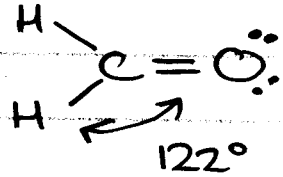
2 LINEAR
3 TRIGONAL PLANAR
4 TETRAHEDRAL
5 TRIGONAL BIPYRAMIDAL
6 OCTAHEDRAL



O=C=O LINEAR

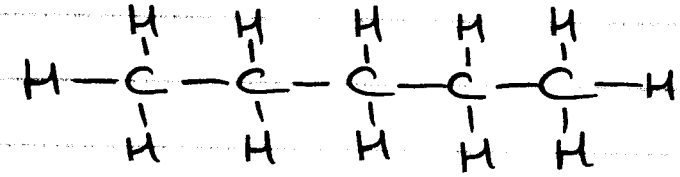


H−C≡C−H LINEAR



TRIGONAL PLANAR (BASICALLY)

(5) DRAWING ORGANIC STRUCTURES



PENTANE

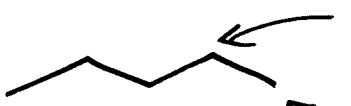
STRUCTURAL FORMULA

CONDENSED FORMULA

$CH_3CH_2CH_2CH_2CH_3$ or $CH_3(CH_2)_3CH_3$

LINE FORMULA

- draw CHAINS as ZIGZAGS
- leave out any H attached to C
- draw nonbonded electrons (lone pairs)



this is a C atom with 2 Hs on it

This is a C atom with 3 Hs on it

Do <u>NOT</u> WRITE