LEC (2) CHEM 30A Jan 10th

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

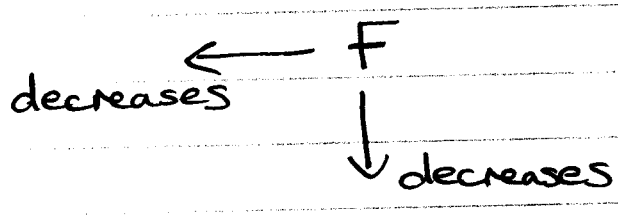
(1) CHEMICAL BONDING

Valence electrons (outer shell electrons)
⟹ these are what form bonds

1	2		3	4	5	6	7	8	# Valence electrons
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 at 4.0



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

ORGANIC CHEMISTRY – mainly concerned with COVALENT BONDS
⇓
EN Differences < 2

So, consider

Na F (3.1) → NaF ($Na^+ F^-$)
0.9 4 ionic salt

O H (1.4) → $O^{\delta-}-H^{\delta+}$ 
3.5 2.1 polar covalent

C C (ϕ) → C–C 
2.5 2.5 nonpolar covalent

EN difference < 0.5 ≅ NONPOLAR

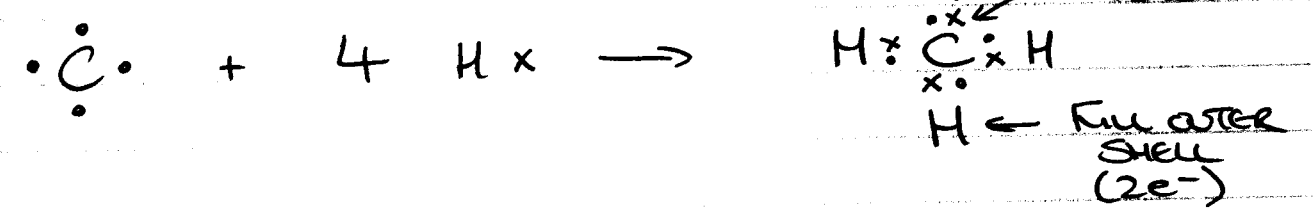
C–H
2.5 2.1

check out Table 1.5 on page 7, know values for common elements as well as trends

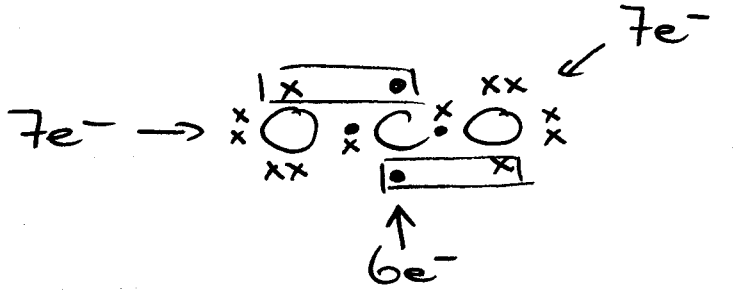
(2) LEWIS STRUCTURES

- # VALENCE electrons 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)



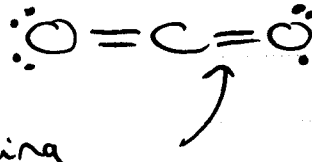
Single BONDS, but octets not full

SHARE MORE⁻ ELECTRONS

- redraw

ALL ATOMS have full octets

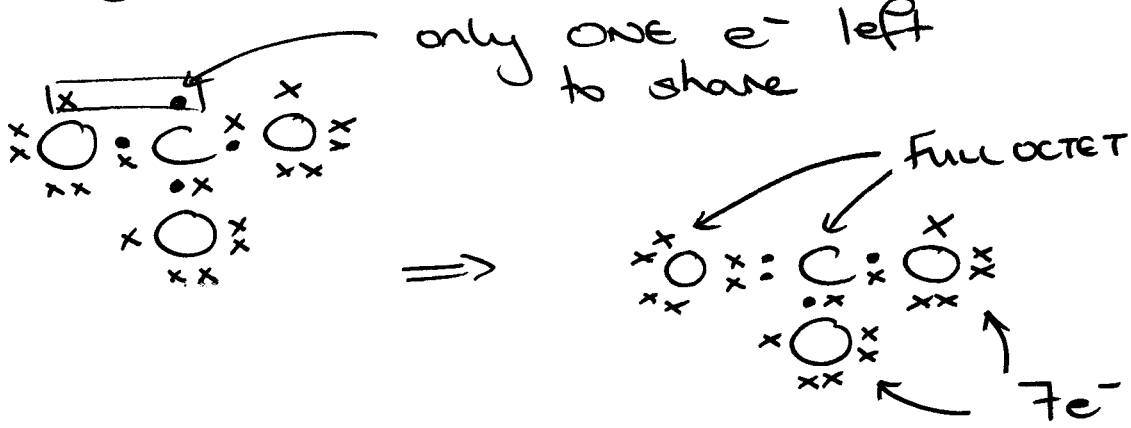
⇒



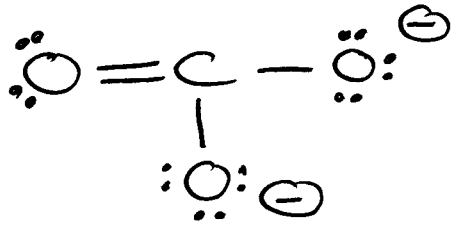
bonding pairs.

lone pair (nonbonded electron pair)

c) CO_3^{2-} (ANION)

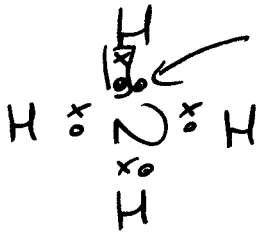


So, add in 2 electrons to fill octets. (DRAW THEM IN ABOVE)



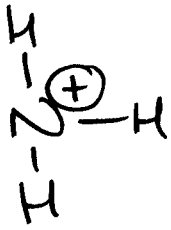
CO_3^{2-}

d) NH_4^+ (CATION)



– vidates octet rule

So, get rid of it! ⇒



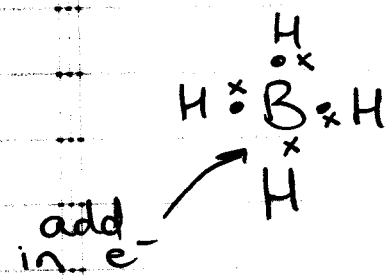
(3) FORMAL CHARGES

– Draw LEWIS structure

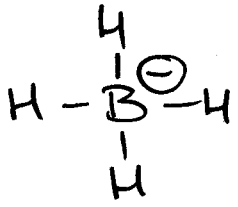
For each atom:

$$\text{FORMAL CHARGE} = \left(\begin{array}{c}\#\text{ VALENCE ELECTRONS IN ISOLATED NEUTRAL ATOM}\end{array}\right) - \left(\begin{array}{c}\#\text{ of NON BONDING ELECTRONS} \\ + \tfrac{1}{2}\#\text{ BONDING ELECTRONS}\end{array}\right)$$

a) $BH_4^{\ominus}$

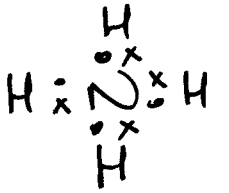


$\equiv$

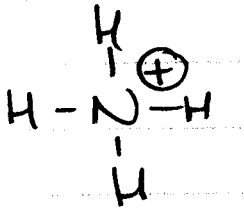


$(3 - 8/2) = \underline{\underline{-1}}$

b) NH_4^+

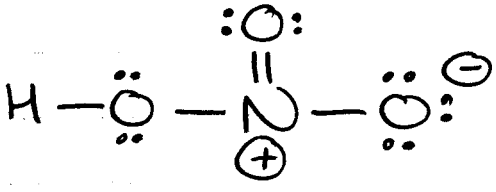


$\equiv$



$(5 - 8/4) = \underline{\underline{+1}}$

c) HNO_3 (nitric acid)

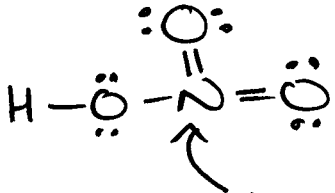


N $(5 - 8/2) = +1$

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

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

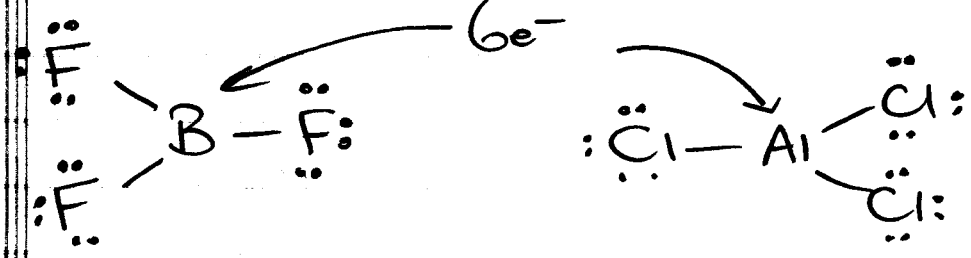
Note not



10e⁻ VIOLATES OCTET RULE

Note There are exceptions to the OCTET rule.

GROUP 3

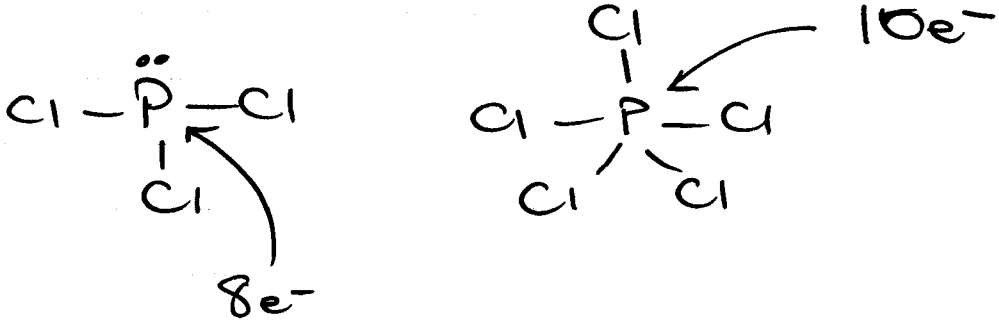


usually quite reactive species

3RD ROW ELEMENTS (P & S)

- d orbitals ⇒ EXPAND OCTET

eg. PCl_3 and PCl_5

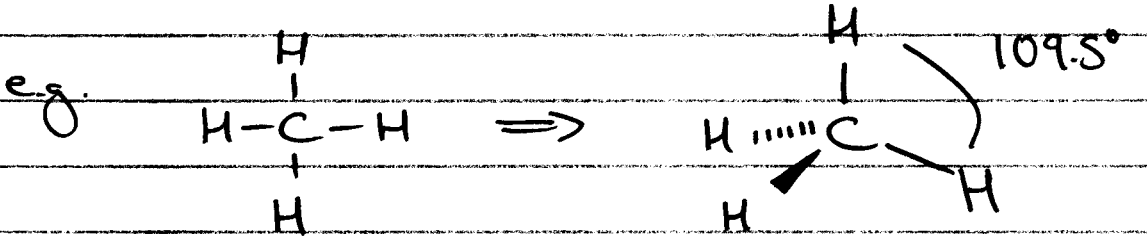


④ SHAPES of MOLECULES

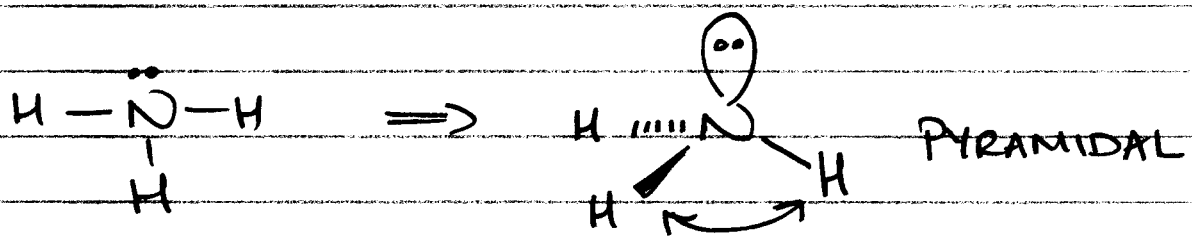
Valence Shell Electron Pair Repulsion Theory

VSEPR (Simplified model)

Geometry determined by valence shell electron pairs (BONDED & NON BONDED) arranging to minimize electrostatic repulsions

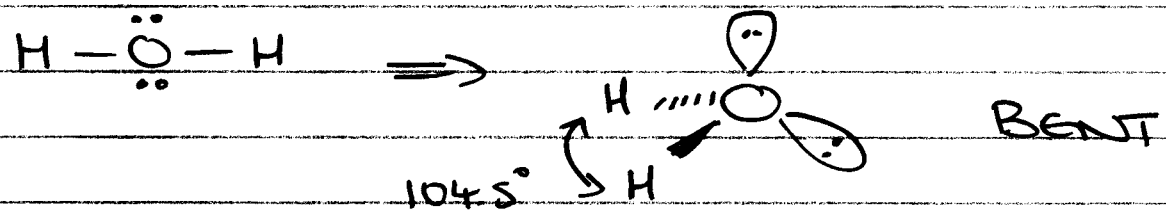
e.g. 

tetrahedral



PYRAMIDAL

(compressed)



BENT

(more compressed)

WHY?

lonepair/lone pair > lone pair/bonding pair

> bonding pair/bonding pair

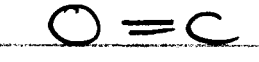
ALSO, $A \equiv B > A = B > A - B$

BASIC GEOMETRIES

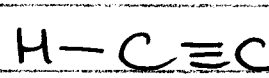
- for sake of geometry, treat multiple bonds as single bonds

- 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 =>

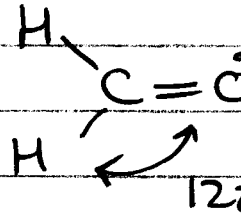
2 LINEAR
3 TRIGONAL PLANAR
4 TETRAHEDRAL
5 TRIGONAL BIPYRAMIDAL
6 OCTAHEDRAL



LINEAR

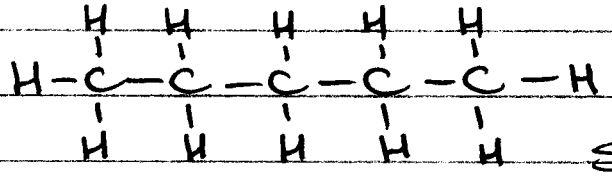


LINEAR



TRIGONAL PLANAR (BASICALLY)

(5) DRAWING ORGANIC STRUCTURES



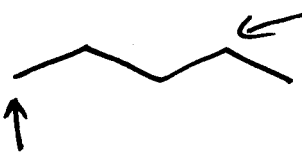
PENTANE STRUCTURAL FORMULA

- 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)

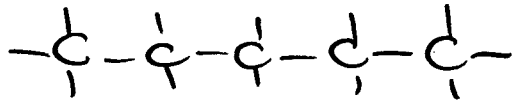


← This is a C atom with 2 Hs on it

↑ This is a C atom, it has 3 Hs on it

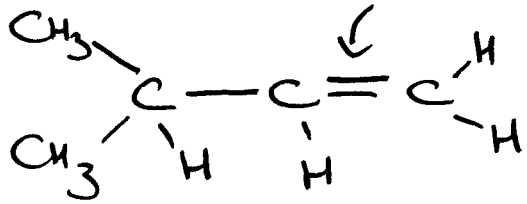
DO NOT WRITE

or

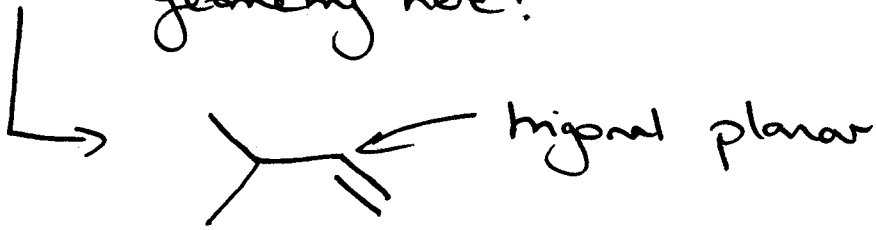


WRONG

b) $(CH_3)_2CHCHCH_2$ →



← what is the geometry here?



← trigonal planar

more examples next time.