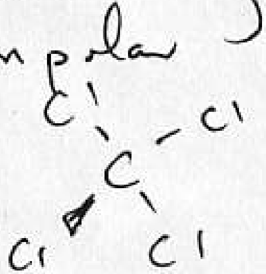
#1

Ranking bond polarity

need to identify whether a bond + a molecule are

Ionic
covalent
polar
nonpolar

} for both bond + molecule

ex.  ⇐ 4 polar covalent bonds in a non-polar molecule

$\Sigma \Delta EN = 0$ nonpolar molecule

$\Delta EN = 0$ " bond

$\Sigma \Delta EN \neq 0$ polar molecule

$\Delta EN = 0$ nonpolar bond

$\Delta EN > \sim 1.5$ ionic bond

$\Delta EN < \sim 1.5$ covalent bond

Assigning molecule polarity from VSEPR

Apply ideas in problem #1 to a molecule.
Basically following W.S. 6 to its conclusion

I give you a chemical formula
you draw a 3D Lewis structure
and if symmetrical ($\Sigma \Delta EN = 0$) then nonpolar
asymmetrical ($\Sigma \Delta EN \neq 0$) then polar

3 Assigning molecule polarity from VSEPR

oh, do it twice

Hint, I will probably give you multiple molecules and you have to see which are correctly or incorrectly labeled as Polar or nonpolar

Hint. Symmetry is a good way to do it fast.

4 Bond angles from VSEPR

First draw a 3D Lewis structure

Then count # of e^- rich regions.

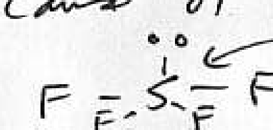
# e^- rich	
2	180
3	120
4	109.5
5	120, 180, 90
6	180, 90

memorize.

But. Hint!!

I will probably want you to recognize distorted angles (not 120 or 109.5°) because of nonbonding pairs

not 109.5°



isn't truly 120, 180, 90 because of nonbonding pairs

5 VB theory of hybrid orbits

I will make a bunch of statements. You have to know which true or false. In this case about hybrid orbitals.

Theory states ~~the~~ that A.O. like s, p, d don't explain degeneracy in spectra, so hybridization is needed in which fraction of A.O.s used form an equal # of hybrid orbitals.

$s, p, p, p \longrightarrow 4\ sp^3$ orbitals that are 25% s, 75% p

6 Electronic geometry from VSEPR

Draw those Lewis structures

Count the # of e^- rich regions

Assign electronic geometry

Hint: Don't confuse electronic geometry w/ molecular geometry (you will if you don't think about it)

$\left.\begin{array}{ll} 2 & \text{linear} \\ 3 & \text{trig. planar} \\ 4 & \text{tetrahedral} \\ 5 & \text{trig. bipyr.} \\ 6 & \text{octahedral} \end{array}\right\}$ memorize

7 Molecular geometry from VSEPR

write down Lewis structure
count e^- rich region
determine # that are :B vs :U,
use memorized table

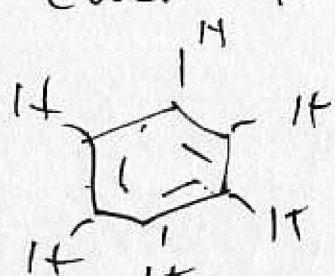
AB_2	linear	AB_5	trig. bi-pyr.
AB_3	trigonal planar	AB_4U	see saw
AB_2U	bent angular	AB_3U_2	T-shaped
AB_4	tetrahedral	AB_2U_3	linear
AB_3U	pyramidal	AB_6	octahedral
AB_2U_2	bent or angular	AB_5U	sq. pyr.
		AB_4U_2	sq. planar

8 Number of σ and π bonds in molecule

write down Lewis structure

then

- count # of first bonds (these are σ)
- count # of π bonds (double, triple, resonance)



12 σ bonds
3 π bonds

9 AOs that comprise MOs in a bond

Write down ~~#~~ the Lewis structure.

I will ask you about a particular bond or bonds.

- first tell me if it is σ or π
- Then $\underbrace{\sigma \ \square - \square \quad \text{or} \quad \pi \ \square - \square}$ Hint π are always 2p or 3p

tell me the 2 A.O. that fill in the boxes

Hint σs almost always are s or hybridized

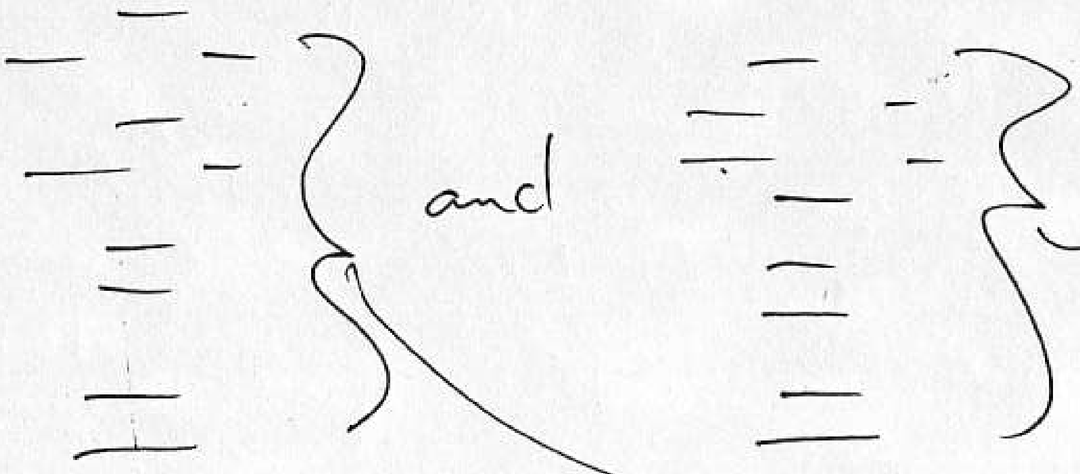
MO theory

10 Dr. Laude will write down 3 or 4 statements. Some are true, some are not. You tell me which are which

MO theory is the use of Q.M to create math. eqns that describe the overlap of e^- density for 2 A.O. function (chapter 1). The overlap is represented as σ or π bonds and then 180° out of phase antibonds. They are filled much as you fill atomic orbitals following Hund, Aufbau, Pauli.

11 Filling MOs of diatomic molecules

Be able to explain the order of orbitals for



label these as

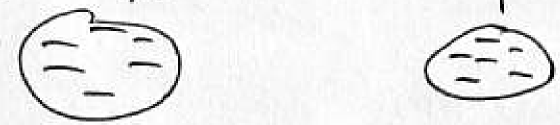
$\sigma_{1s}, \sigma^*_{1s}, \sigma_{2s}, \sigma^*_{2s} \ldots\ldots$

12 Calculating bond order from MO

This is just like filling A.O.

#1 count the # of e^- in the diatom or ion

#2. Draw George or Guy Hint: remember use all e^- not just valence e^-



#3 Fill the M.O. following Hund, Aufbau + Pauli

#4 Do the calculation

$$B.O. = \frac{\#\text{ of bonding } e^- - \#\text{ of antibonding } (*)}{2}$$

13 Assigning paramagnetism from MO

- count # of e^- in diatom
- create correct M.O. configuration
- fill it following Aufbau, Hund, Pauli
- look for half filled orbit $\uparrow$
- This is paramagnetism
- Diamagnetism is when everything is $\uparrow\downarrow$

14 Ranking bond length from bond order

Do the same routine for filling M.O. as in # 11–13, then calculate B.O. as in #12.

rule of thumb

As B.O. $\uparrow$, the bond energy $\uparrow$ and bond length $\downarrow$

as B.O. $\downarrow$, the bond energy $\downarrow$ and bond length $\uparrow$

15 Identifying delocalization (resonance)

I will give you a collection of molecules you tell me which have resonance and how many π bonds or resonance structures exist.

$CO_3^{=}$ one π, 3 structures

NO_2^{-} one π, 2 structures

benzene 3 π, 2 structures

Hint. I may ask you to consider formal charge in deciding if a molecule has resonance ∴ $SO_4^{=}$ has resonance but SO_2 does not (because of d orbitals)

16 Ideal gas law history

Know those old guys who gave us $PV = nRT$

I will make several statements some of which are true + some false. Know Boyle, Charles, Avogadro, Gay Lussac, Dalton. Also know kinetic theory relates to their work

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Gas law change of state calculation

Plug + chug. Easy

$P_1V_1 = P_2V_2$ or $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

I give all but one variable, you solve for the unknown.

Hint: make your units the same and you will get the answer easily.

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Calculating MW, M or ρ from PV=nRT

Plug + Chug.

$PV = nRT$, ∴ $P = MRT$, ∴ $MW = \frac{g\,PV}{RT}$ ∴ $\rho = \frac{MW\,P}{RT}$

I will give ~~#~~ the eqns. You make sure you cancel units and solve for ~~#~~ the unknown.

Hint, make ~~#~~ sure you have done a M, MW, ρ calculation.

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Reaction stoichiometry and PV=nRT

I will give you a balanced chemical reaction for which you can work between n, g, # of molecules.

You will then convert to n for the quantity desired and since $n = \frac{PV}{RT}$, you can solve for either P, V, or T as asked.

20

Calculation of relative ratio of gas speeds

since $E_k = \frac{1}{2}kT = mv^2$

and at constant T, E is constant

i.e. in looking at two gases of different mass

$m_1 v_1^2 = m_2 v_2^2$. So plug + chug for unknown.

Hint, this $m_1 e_1^2$ or $m d_1^2$ relationship exists for diffusion + effusion as well

21

Ranking non-ideality of gases

b term ≡ simply ranking based on mass & volume estimate

so $He < CO_2 < SF_6$

a term ≡ rank based on attractive forces just like what you do in # 27, 28

so create bins based on attractive forces

$\boxed{\text{inst. dipole}} < \boxed{\text{perm. dipole}} < \boxed{\text{H bonds}}$

22

Gas non-ideality theory

k.m.t. says

V term { • gas are infinitely small (false)
 • spheres (false)

p term { • elastic collisions (false)

So to fix $PV \neq nRT$, we use correction factors

$$\left(P + \underset{\text{for attraction}}{\text{a term}}\right)\left(V - \underset{\text{size of gas is corrected}}{nb}\right) = nRT$$

23

IMF theory

I will give you 3 or 4 true or false statements. you figure out which is which.

In fact, molecules do have attractions to each other based on Coulombic forces between 2 molecules. So collisions are inelastic and at high P or low T the collisions form liquids + solids. There are 3 basic kinds of INMF. They are

Have to know this

24 {Inst. dipole ~1kJ / London / van der waals / dispersive} < permanent dipoles ~5kJ < H-bonding ~20kJ

Assigning IMF to molecules

I will give you several molecules. you tell me which are

inst. dipole | perm. dipole | H-bond | ionic

inst. dipole → apply question #2 concepts and if ΣΔEN = 0 then you have inst. dipoles

perm. dipole → if ΣΔEN ≠ 0 perm. dipole

H-bond → ΣΔEN = 0 and H attached to N, F, O then H-bond!

ionic → salts, duh

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Assigning IMF to molecules

Do it twice

26

Defining physical properties

I dont want a lot of work here, but be able to explain

- what a property is + • something interesting about the property

The properties in question?

viscosity, S.T., c.a., evap, b.p.

27
Ranking physical properties by IMF

Do it 3 times

28
Ranking physical properties by IMF

Do it 3 times

29

Ranking physical properties by IMF

3 times I will give you a collection of molecules. You will rank them based on the

 That as IMF ↑ b.p. s.t. c.a. ΔH vap m.p. visc. ↑ and evap v.p. ↓.

Make sure you create 4 bins

30 inst. dipoles nonpolar rank by mw < dipole moment rank by size of ΔEN < H-bond $NH_3 < HF < H_2O$ < salts rank by charge density

Assigning type of solid to compounds

There are 4 kinds of solid bonds. I will give you a collection of molecules + their solid bond type. Some are right, some are wrong. You figure it out.

short for 29/30

molecular bonds (IMF forces in molecules like H_2O)
metallic bonds (metals)
covalent network bonds (SiO_2, graphite, etc)
Ionic bonds (salts)

Hint, if you listened in class on Thurs, this is easy. If you didn't,