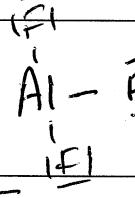
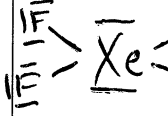
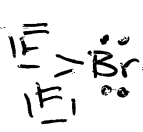
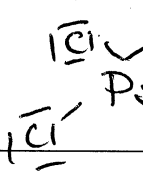
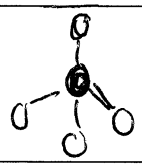
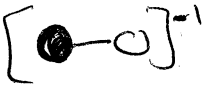
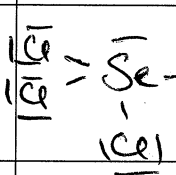
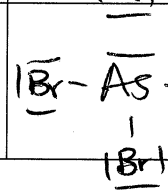
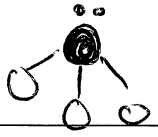
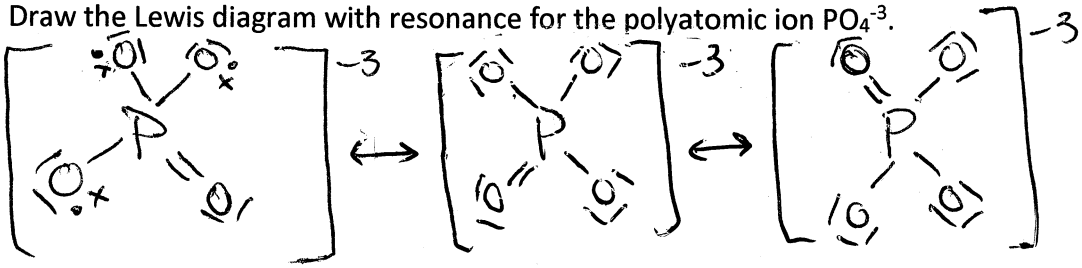
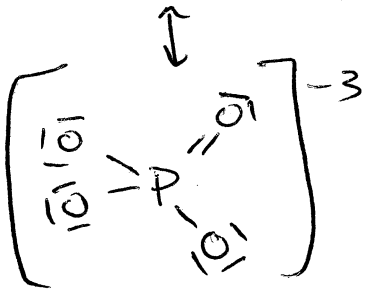
1. Fill in the following table:

Molecule	Lewis Diagram	VSEPR + Hybridization	Shape	Draw	Molecular Polarity/ PAI/Ionic
AlF_3		AX_3 sp^2	trigonal planar		NP
XeF_4		AX_4E_2 sp^3d^2 w/ 2e⁻ pairs	Square planar		NP
BrF_3		AX_3E_2	T-shape		P
$POCl_3$		AX_4 Sp^3	tetrahedral		P
OH^-		AX S	linear		PAI
$SeCl_4$		AX_4E sp^3d with e pair	see-saw		P
$AsBr_3$		AX_3E sp^3 w/ e	trigonal pyramidal		P

2. Draw the Lewis diagram with resonance for the polyatomic ion PO_4^{-3}.





If you had a diff structure (diff = # - bonds) you should check formal charge to evaluate which is most stable

3. Explain each in terms of intermolecular forces (IMF's) and/or intramolecular forces (bonds) and structure.

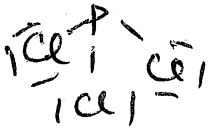
a. ICl has a boiling point of 97°C whereas NaCl has a boiling point of 1400°C.

NaCl is ionic and held together by Ionic Bonds while ICl is a polar molecule held in the liquid phase by dipole-dipole IMF's. IMF's are weaker than bonds.

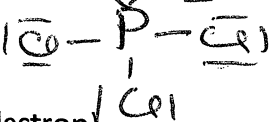
b. KI is very soluble in water, whereas $I_2(s)$ has a solubility of 0.03 g/ 100 g H_2O.

KI is an ionic cmpd with whole charges which attract to H_2O's partial charges, while I_2 is a NP Molecule with no partial charges to attract to H_2O.

c. PCl_3 has a dipole moment, whereas PCl_5 does not.



PCl_3 is trigonal pyramidal, while PCl_5 is trigonal bipyramidal. That makes PCl_5 a NP Molecule while PCl_5 is polar.



4. Which species would be classified as a free radical? (has an unpaired single electron) Show all work.

a. N_2O b. NO_2^- c. NO_2^+ d. OH e. CO

16e- 18e- 16e- 9e- 10e-

odd # e-

5. If commercially prepared sulfuric acid, H_2SO_4, has a density of 1.84 g/mL and a mass percent of solute of 95.0%. Calculate the Molarity and Molality of this concentrated acid.

$\frac{95\text{ g } H_2SO_4}{100\text{ g soln}}$

$$M = \frac{\text{mol solute}}{\text{L soln}} = \frac{\left(\frac{95\text{ g } H_2SO_4}{1} \times \frac{1\text{ mol } H_2SO_4}{98\text{ g } H_2SO_4}\right)}{\left(\frac{100\text{ g soln}}{1} \times \frac{1\text{ mL}}{1.84\text{ g}} \times \frac{1\text{ L}}{1000\text{ mL}}\right)}$$

$$= \frac{0.969\text{ mol } H_2SO_4}{0.0543\text{ L}} = \boxed{17.8\text{ M}}$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}} = \frac{0.969\text{ mol } H_2SO_4}{\left(\frac{100\text{ g soln} - 95\text{ g solute}}{1}\right) \times \frac{1\text{ kg}}{1000\text{ g}}}$$

$$= \boxed{193.8\text{ m}}$$

6. Which has a stronger lattice energy: Na_2O or SrO and why?

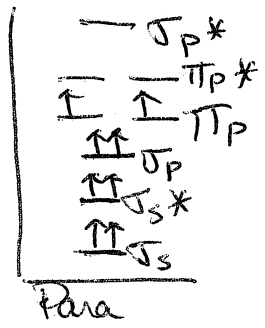
Even though Na^{+1} has a slightly smaller charge compared to Sr, it's much smaller and therefore would have a stronger LE.

7. Using the MO theory, show whether each of the following diatomic species are diamagnetic or paramagnetic and calculate the bond order.

a. HCl 8e⁻

$BO = \frac{b-*}{2}$

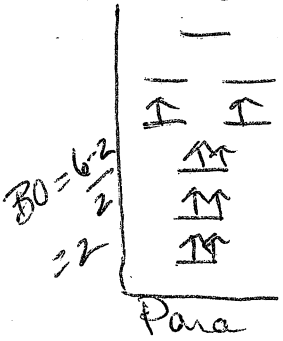
$\frac{6-2}{2} = 2$



Para

b. OH^- 8e⁻

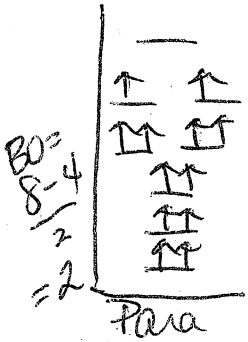
$BO = \frac{6-2}{2} = 2$



Para

c. NO^- 12e⁻

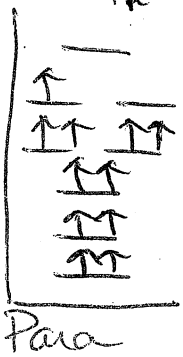
$BO = \frac{8-4}{2} = 2$



Para

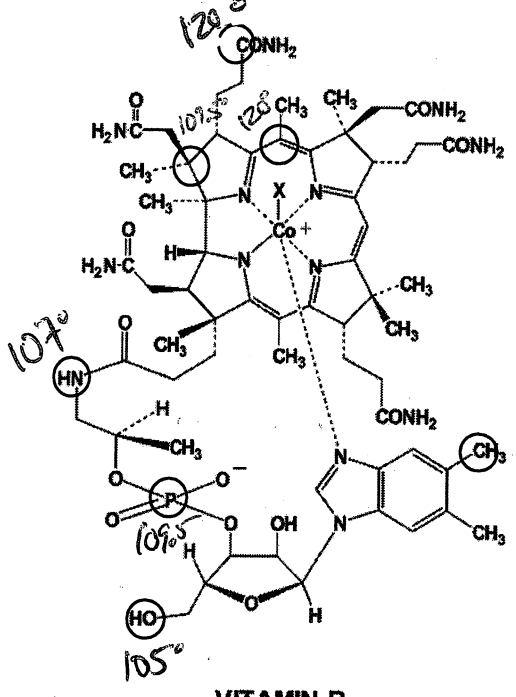
d. NO 11e⁻

$BO = \frac{8-3}{2} = 2.5$



Para

8. Using the molecule below identify the hybridization of all of the carbon, oxygen and nitrogen atoms (you can use colors), determine the bond angles around the atoms that are circled and determine the number of sigma and pi bonds present.



VITAMIN B_{12}

$\sigma = 185$

$\pi = 18$

} see diagram at the end of this answer key

53 sp^3 hybridized atoms

27 sp^2 hybridized atoms

9. For each of the following, use appropriate chemical principles to explain the observation.

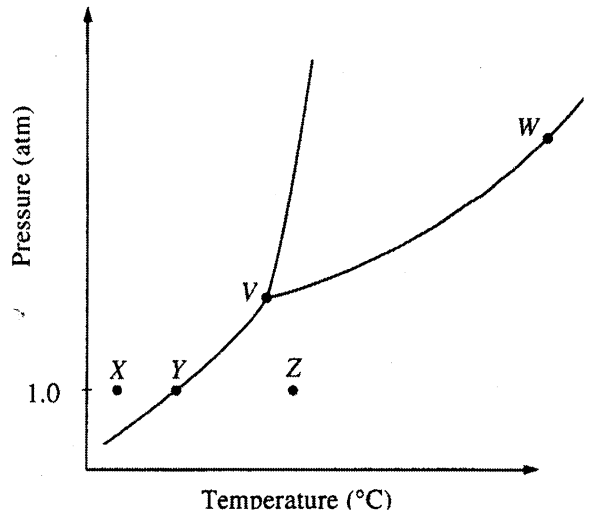
   a. At room temperature, NH_3 is a gas and H_2O is a liquid, even though NH_3 has a molar mass of 17 grams and H_2O has a molar mass of 18 grams.

H + O have a bigger diff in electronegativity than H + N.

   b. C (graphite) is used as a lubricant, whereas C (diamond) is used as an abrasive.

Graphite is a network solid made of sp^2 hybridized C atoms with resonance. Its very flat → so it can slip in between other molecules easily. Diamonds have sp^3 hybridized C atoms that are rigid and tetrahedral (not flat)

10. The phase diagram for a pure substance is shown below. Use this diagram and your knowledge about changes of phase to answer the following questions.



   a. What does point *V* represent? What characteristics are specific to the system only at point *V*? The triple point – all 3 phases exist at the same time

   b. What does each point on the curve between *V* and *W* represent?

boiling / condensation

   c. Describe the changes that the system undergoes as the temperature slowly increases from *X* to *Y* to *Z* at 1.0 atmosphere.

sublimation. (s → g)

   d. In a solid-liquid mixture of this substance, will the solid float or sink? Explain.

It will sink because the melting/freezing line has a positive slope which means that the solid is more dense than the liquid.

8.

Vitamin B-12