Chem 1A Final Exam
Dec. 14, 2005

1) For all elements in the second period draw **Lewis structures** for the simplest compounds of these elements with hydrogen. In each case, indicate the **geometries and bond angles** using VSEPR theory. Also say whether the molecules are **polar or nonpolar.**

chemical formula?	Lewis structure?	VSEPR geometry?	bond angles?	hybridization?	polar?

2) For each of the following **covalent compounds** and **polyatomic ions**, draw a valid **Lewis structure**, indicating **geometry** around central atoms, hybridization, **bond angles**, and whether the species is **polar or not**. (20 pts)

chemical formula	Lewis structure (include bond angles)	geometry around each central atom?	each central atom hybridization?	polar?
CO_3^{2-}				
HCN				
N_2				
CH_3OH				
C_6H_6				
CS_2				
PF_3				
PF_5				

3) **Consider molecules from the previous problem**. Draw an orbital overlap diagram (showing sigma and pi bonds) for **an above molecule of your choice** which contains at least one multiple bond.

Draw resonance structures for **two molecules above** in which resonance structures are required.

4) What is the difference between **electronegativity** and **electron affinity**? Describe the general trends for each in the periodic table.

What is **ionization energy**? Describe **and explain** the general trend in the periodic table for the IE.

5) Ethanol, CH_3CH_2OH (or C_2H_6O) is being developed as an alternative fuel since it can be produced from renewable resources like corn or sugar cane.

a) Write a balanced equation for the complete combustion of ethanol.

b) Suppose you have a 70.0 L (typical fuel tank size) of ethanol (density 0.7893 g/cc) and unlimited oxygen. Calculate the number of moles (theoretical yield) of carbon dioxide produced.

c) What volume will be occupied by the CO_2 at STP?

d) Calculate the percent composition by mass of the elements in ethanol.

6) A solution is prepared by dissolving 2.50 g NaCl in 550.0 g H_2O. The density of the resulting solution is 0.997 g/mL.

a) **What is the molarity of NaCl** in the solution?

b) **What is the molality of NaCl** in the solution?

c) **What is the mole fraction of NaCl** in the solution?

d) **What is the mass % of NaCl** in the solution?

7) A chemist wanted to prepare hydrazine, N_2H_4, (a type of rocket fuel) by the reaction: $2NH_3 + OCl^- \rightarrow N_2H_4 + Cl^- + H_2O$ which essentially goes to completion. To do this she mixed 5.0 mol NH_3 with 3.0 mol OCl^-.

a. **What is the limiting reactant?**

b. **How many moles of hydrazine will be obtained?**

c. **Assign oxidation numbers.** Is this a redox reaction?

d. If so, **what is being oxidized**? And **what is being reduced**?

8) Suppose you have a job in the Laney chemistry stockroom and your boss asks you to prepare 2.0000 L of a 0.250 M solution of ammonium fluoride. (Assume you have an analytical balance and 2.0000L, 1.0000L, 500.00mL, and 250.00mL volumetric flasks.) **Describe in detail with the correct amounts how you would make this solution:**

a) starting with the solid salt.

b) starting with a stock solution which is 1.000 M in ammonium fluoride.

9) Phase Diagrams:
   a) Draw a phase diagram for water (up to 2 atm), labeling the phase fields, triple point, normal melting point, and normal boiling point.

   b) **What is the vapor pressure at 100°C of a 2.0 molal aqueous solution of glucose, $C_6H_{12}O_6$?** Hint: Determine the mole fraction of glucose and use Raoult's Law. (You don't need to know the molar mass of glucose to solve this problem.)

   c) Now use dotted lines to modify the above phase diagram for water by superimposing the new phase boundaries for the 2.0 molal solution of glucose.

10) Calculate the reaction enthalpy for the formation of anhydrous aluminum chloride,
$2\ Al(s) + 3\ Cl_2(g) \rightarrow 2\ AlCl_3(s)$ from the following data:

$2\ Al(s) + 6\ HCl(aq) \rightarrow 2\ AlCl_3(aq) + 3\ H_2(g)$ $\quad \Delta H^o_{rx} = -1049$ kJ

$HCl(g) \rightarrow HCl(aq)$ $\quad \Delta H^o_{rx} = -74.8$ kJ

$H_2(g) + Cl_2(g) \rightarrow 2\ HCl(g)$ $\quad \Delta H^o_{rx} = -185$ kJ

$AlCl_3(s) \rightarrow AlCl_3(aq)$ $\quad \Delta H^o_{rx} = -323$ kJ

Would you expect the equilibrium constant to rise or fall with increasing temperature for this reaction?

11) **Draw valid Lewis structures** for each of the following compounds: $CH_3CH_2CH_2OH$ (propanol), $CH_3CH_2CH_2CH_3$ (butane), and $CH_3CH_2OCH_3$ (methyl-ethyl-ether) indicating for each molecule which Van der Waals forces are important.

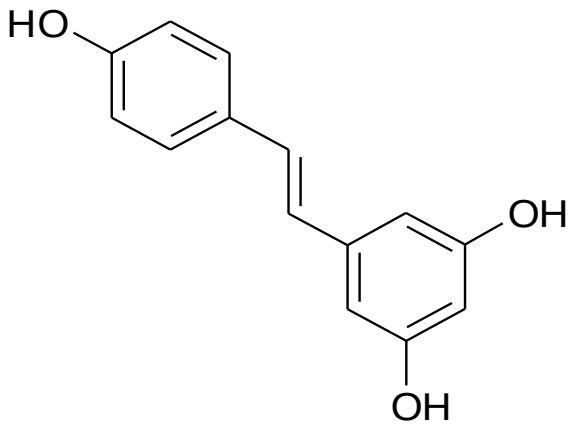
a) Rank the molecules in order of increasing vapor pressure at fixed temperature.

b) Rank the molecules in order of increasing normal boiling point.

c) Which molecule has the highest vapor pressure? Which has the lowest vapor pressure?

d) Which molecule has the highest boiling point? Which has the lowest boiling point?

12) The following molecule, **resveratrol**, is found in red wine and is thought to have beneficial health effects.



a) Draw in all the remaining implied hydrogens.
b) Draw in the missing lone pairs of electrons.
c) Write the molecular formula for the compound.
d) Label each central atom with appropriate geometry, bond angles, and hybridization scheme. (Note that the oxygens are also central atoms.)

13) Balance the following redox reactions: (Note: the chlorate ion has 3 oxygens and a -1 charge.)
   a) $Cl_2\ (g) \rightarrow ClO_3^-\ (aq) + Cl^-\ (aq)$ (chlorine dissolved in basic solution)

   b) $As_2S_3(s) + ClO_3^-(aq) \rightarrow H_3AsO_4(aq) + SO4^{2-}(aq) + Cl^-(aq)$ (arsenicIIIsulfide reacts with chloric acid soln.)

14) Write balanced **"molecular", complete ionic, and net ionic chemical equations** for the following reactions:
   a) The neutralization of HCl by calcium carbonate to give calcium chloride, water, and carbon dioxide (TUMS reaction).

   b) The precipitation of lead iodide when a KI solution is added to a solution of $Pb(NO_3)_2$.