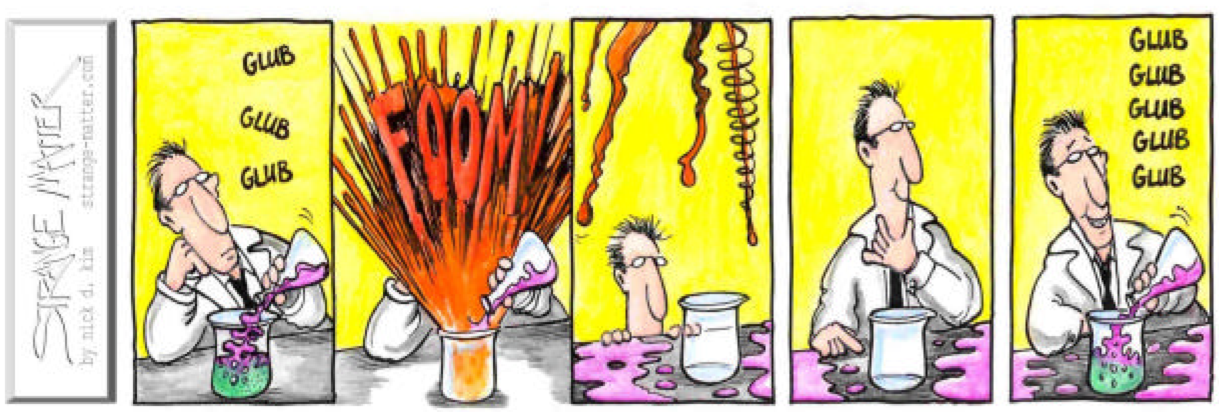
CHEM 36
General Chemistry
EXAM #1

February 13, 2002

Name:___________________________

<u>**INSTRUCTIONS:**</u> Read through the entire exam before you begin. Answer all of the questions. For questions involving calculations, show **all** of your work -- **HOW** you arrived at a particular answer is **MORE** important than the answer itself! Circle your final answer to numerical questions.

The entire exam is worth a total of 150 points. Attached are a periodic table and a formula sheet jam-packed with useful stuff. Good Luck!



Page	**Possible Points**	***Points Earned***
2	20	
3	15	
4	20	
5	25	
6	15	
7	30	
8	25	
TOTAL:	***150***	

1. ***[10 pts]*** The sap in a maple tree can be described approximately as a 3.0% (by mass) solution of sucrose ($C_{12}H_{22}O_{11}$ - MW = 342.2948 g/mol) in water. If the density of the sap is 1.010 g/mL, and assuming that sap consists only of sucrose and water, calculate the molarity of sucrose in the sap.

2. ***[10 pts]*** The rising of sap in trees is caused largely by osmosis; the concentration of dissolved sucrose in sap is higher than that of the groundwater outside the tree. Calculate the osmotic pressure of a sap solution at 25.0 ^{o}C.

3. ***[15 pts]*** Maple syrup is the concentrated sap solution that results when most of the water is boiled off. If 40.0 liters of sap is boiled down to a volume of 1.00 liters (of syrup), what is the normal boiling point of the resultant syrup solution? (You may assume that the boiling process removes only water and that the sucrose does not react chemically during the boiling process. Recall, also, from problem #1 that sap is 97% water!)

4. ***[10 pts]*** Arrange the following substances in order of *increasing* normal boiling points and explain your reasoning: He, H_2O, Ar, KNO_3, O_2.

5. ***[10 pts]*** The Henry's law constant at 25 ^oC for oxygen dissolved in water is 7.68×10^2 atm-L/mol. If the partial pressure of O_2 in the atmosphere is 0.20 atm, calculate the number of moles of O_2 dissolved in a liter of water.

6. ***[15 pts]*** At 20 ^{o}C, the vapor pressure of toluene is 0.0289 atm and the vapor pressure of benzene is 0.0987 atm. Equal chemical amounts (equal number of moles) of toluene and benzene are mixed and form an ideal solution. Calculate the mole fraction of benzene and toluene ***in the vapor*** in equilibrium with this solution.

7. ***[10 pts]*** Benzene and toluene are both mainly non-polar compounds. If instead of toluene, an equivalent chemical amount of a polar compound like benzoic acid were dissolved in benzene, how would you expect the partial pressure of benzene above the solution to deviate from the partial pressure of benzene above an ideal solution (if at all)? Explain.

8. ***[15 pts]*** Mercury is the only metallic element that is a liquid at room temperature. Calculate the boiling point of mercury (^oC). Some thermodynamic data that you might find helpful:

ΔH^o_f [Hg(g)] = 61.40 kJ/mol
S^o [Hg(l)] = 75.9 J/mol-K
S^o [Hg(g)] = 175.0 J/mol-K

9. Ammonium nitrate can decompose to form dinitrogen oxide:

$$NH_4NO_3\ (s) \rightarrow N_2O\ (g) + 2H_2O\ (g)$$

Some thermodynamic data that you might find helpful:

Compound	DH^o_f (kJ/mol)	DG^o_f (kJ/mol)
NH_4NO_3 (s)	-365.6	-183.9
N_2O (g)	82.1	104.2
H_2O (g)	-241.8	-228.6

a. ***[10 pts]*** Using the thermodynamic data provided, calculate the standard molar enthalpy change (ΔH^o) for this reaction.

b. ***[5 pts]*** Based on the ΔH^o_{rxn} that you calculated above, is this process exothermic or endothermic?

exothermic **endothermic** (Circle One)

c. ***[10 pts]*** Calculate the change in standard molar free energy (ΔG^o) at 25 ^{o}C for this process.

d. ***[5 pts]*** Based on the ΔG^o_{rxn} calculated in *part c*, is this reaction spontaneous process at 25 ^{o}C?

spontaneous **not spontaneous** (Circle One)

e. ***[5 pts]*** Would you expect ΔS^o for this reaction to be positive or negative? (Don't do any calculations! Base your answer only on inspection of the reaction equation.) Briefly explain.

positive **negative** (Circle One)

f. ***[10 pts]*** Now, using the thermodynamic data provided, calculate the standard molar entropy change (ΔS^o) for this reaction.

g. ***[10 pts]*** Over what range of temperature (if any) is this reaction spontaneous?

Extra Credit! -- 5 pts

You take a bottle of a soft drink out of your refrigerator. The contents are liquid and stay liquid, even when you shake them. Thirsty, you remove the cap, and the liquid freezes solid! Offer a possible explanation for this observation.