Chemistry 1212 Name_____
Monday 30, 2012
Exam #1

Write very clearly and **show all of your work** for partial credit. A list of equations and constants as well as a periodic table are on the last two pages of your exam.

1.(20 points) Fill in the space with the correct response.

(a) Which lattice possesses the largest number of atoms simple, body-centered, or face-centered cubic? face-centered cubic

(b) Name this law: $P_{\text{soln}} = X_{solvent} P^{\circ}_{solvent}$. Raoult's

(c) What type of intermolecular force leads to the high boiling point of water? $H-bonding$

(d) Circle the species which is **most** miscible with water.

HBr He CCl_4 CH_3COCH_3 All the same

(e) Circle the gas which experiences the **strongest** intermolecular force.

HF BF_3 O_2 $CH_3CH_2CH_2CH_2CH_2OH$

(f) Circle the species with the **lowest** vapor pressure.

NO I_2 *HF* CH_4 All the same

(g) Circle the species which is has the **highest** viscosity.

H_2S HF H_2O_2 NH_3 All the same

(h) Circle the species which has the **lowest** heat of vaporization.

H_2CO CH_3CH_3 CH_4 Xe All the same

(i) Circle the species which has the **largest** amount of hydrogen bonding.

H_2CO CH_3CH_3 CH_4 Xe All the same

(j) What is the ppm of a solution with 1L of water and 75mg of a solute? 75 *ppm*

2. (20 points) Benzene had a vapor pressure of 400 mm Hg at 60.6°C and a normal boiling point of 80.1°C. What vapor pressure will the species have at 100°C?

Similar to Chapter 10 In Class Exercise #3

$$\ln\left(\frac{P_1}{P_2}\right)=\frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)\rightarrow \Delta H_{vap}=R\ln\left(\frac{P_1}{P_2}\right)\Big/\left(\frac{1}{T_2}-\frac{1}{T_1}\right) \quad (2\,pts)$$

$$T_1=60.6+273.15=333.75K \quad (2\,pts)$$

$$T_2=80.1+273.15=353.25K \quad (2\,pts)$$

$$\Delta H_{vap}=8.3145\frac{J}{mol\bullet K}\ln\left(\frac{400}{760}\right)\Big/\left(\frac{1}{353.25}-\frac{1}{333.75}\right) \quad (2\,pts)$$

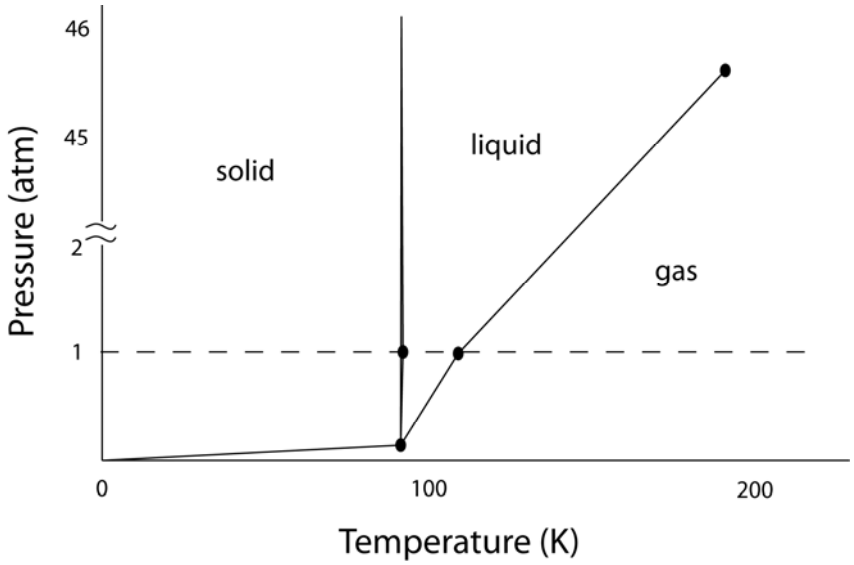
$$\Delta H_{vap}=32,266\frac{J}{mol}\rightarrow \boxed{32.3\frac{kJ}{mol}} \quad (3\,pts)$$

$$P_1=P_2\ mm\ Hg\times e^{\frac{\Delta H_{vap}}{R}\left(\frac{1}{T_2}-\frac{1}{T_1}\right)} \quad (3\,pts)$$

$$P_1=760.\ mm\ Hg\times e^{\frac{32266\frac{J}{mol}}{8.3145\frac{J}{mol\bullet K}}\left(\frac{1}{353.25}-\frac{1}{373.15}\right)} \quad (3\,pts)$$

$$\boxed{P_1=1370\ mm\ Hg} \quad (3\,pts)$$

3. (20 points) Draw the phase diagram for methane. Label the axes, each phase, the triple point (90.5 K, 0.12 atm), the critical point (191 K, 45.8 atm), and the normal boiling and melting points are 111.7 K and 90.6 K, respectively.



2pts for each phase (*6pts* total), *2pts* for each axis label (*4pts* total), *2pts* ea. for bpt and fpt (*4pts* total), *2pts* ea. for cpt and tpt (*4pts* total), *2pts* for attempting to draw the figure to scale.

4. (30 points) The boiling points of 1.000 m solutions of ammonium chloride, ammonium sulfate, and ammonium phosphate solutions are 101.0°C, 101.4°C, and 101.8°C atm, respectively. What are the van't Hoff factors for each of these salts? What are their percent dissociations?

Similar to In Class Exercise Chapter 11 problem 3

$$\Delta T_b = T_f - 100^\circ C = imk_b \quad (3pts)$$

$$NH_4Cl \rightarrow NH_4^+ + Cl^- \quad i_{theoretical} = 2 \quad (3pts)$$

$$(NH_4)_2 SO_4 \rightarrow 2NH_4^+ + SO_4^{2-} \quad i_{theoretical} = 3 \quad (3pts)$$

$$(NH_4)_3 PO_4 \rightarrow 3NH_4^+ + PO_4^{3-} \quad i_{theoretical} = 4 \quad (3pts)$$

$$i_{NH_4Cl} = \frac{\Delta T_b}{mk_b} = \frac{101^\circ C - 100^\circ C}{1.000 \frac{mol}{kg} \bullet 0.51 \frac{^\circ C \bullet kg}{mol}} = \boxed{1.96} \quad (3pts)$$

$$i_{(NH_4)_2 SO_4} = \frac{101.4^\circ C - 100^\circ C}{1.000 \frac{mol}{kg} \bullet 0.51 \frac{^\circ C \bullet kg}{mol}} = \boxed{2.74} \quad (3pts)$$

$$i_{(NH_4)_2 SO_4} = \frac{101.8^\circ C - 100^\circ C}{1.000 \frac{mol}{kg} \bullet 0.51 \frac{^\circ C \bullet kg}{mol}} = \boxed{3.92} \quad (3pts)$$

$$\%\ dissociation = \frac{i_{actual}}{i_{theoretical}} \times 100\% \quad (3pts)$$

$$\%NH_4Cl\ dissociation = \frac{1.96}{2} \times 100\% = \boxed{98.0\%} \quad (2pts)$$

$$\%(NH_4)_2 SO_4\ dissociation = \frac{2.94}{3} \times 100\% = \boxed{91.5\%} \quad (2pts)$$

$$\%(NH_4)_3 PO_4\ dissociation = \frac{3.20}{4} \times 100\% = \boxed{88.2\%} \quad (2pts)$$

5. (10 points) What is the vapor pressure of a solution containing 20g of $CaCl_2$ and 100g of water? $P^\circ_{H_2O} = 23.8$ torr at 25°C

Similar to Chapter 11 Hmwk problem 11.82 part B

Raoult's Law: $P_{tot} = X_{H_2O} P_{H_2O} + \cancel{X_{CaCl_2} P_{CaCl_2}}$ (0 since $CaCl_2$ is nonvolatile) $(1pts)$

$$n_{CaCl_2} = 20\ g \times \frac{1\ mol\ CaCl_2}{110.98\ g} = 0.1802\ moles\ CaCl_2 \quad (1pts)$$

$$n_{H_2O} = 100g \times \frac{1\ mol\ H_2O}{18.01\ g} = 5.5525\ moles\ H_2O \quad (1pts)$$

$$i = 3 \quad (2pts)$$

$$X_{H_2O} = \frac{n_{H_2O}}{n_{H_2O} + i * n_{CaCl_2}} \quad (2pts)$$

$$X_{H_2O} = 0.9115 \quad (1pts)$$

$$P_{tot} = X_{H_2O} P_{H_2O} = 0.9115 \bullet 23.8\ torr = 21.7\ torr \quad (2pts)$$