

Name: _____

(4 points)

Chemistry 114 Second Hour Exam

Remember- Show all work for partial credit

1 (12 points) In each of the following groups of substances, circle the substance that has the given property. Write a short justification for your answer below each set.

Greatest intermolecular forces: CO₂ or OCS

Justification: polar molecule more intermolecular force

Highest boiling point : HBr, Kr, Cl₂

Justification: Polar molecule, strongest intermolecular force highest B.P.

Lowest vapor pressure at 25°C: H₂CO, CH₃CH₃, CH₄

Justification: Polar molecule, strongest intermolecular forces, strongest pull to stay in liquid form so will have fewest molecules in vapor phase

Greatest viscosity: H₂S, HF, H₂O₂

Justification: HF and H₂O₂ will both form hydrogen bonds, but H₂O₂ can form twice as many hydrogen bonds to give it a higher intermolecular attraction and a higher viscosity.

2. (12 points) A topaz crystal has an interplanar spacing (d) of 1.36 Å. Calculate the wavelength of an X ray that would give a reflection at an angle 15.0° (Assume n = 1)

$$n\lambda = 2d \sin \theta$$

$$1X = 2(1.36) \sin(15.0^\circ)$$

$$X = 2.72(.2588)$$

$$X = .704 \text{ \AA}$$

3. (12 points) What type of solids will each of the following substances form:



Molecular



Atomic network



Molecular



Ionic

graphite

Atomic Network



Atomic Group 8A

4. (12 points) The normal boiling point of acetone is 56.5 °C. What is the boiling point we would observe for this solvent when we have a pressure of .87 atm in the lab? (The ΔH_{vap} for acetone is 32.0 kJ/mol)

$$\ln\left(\frac{VP_1}{VP_2}\right) = \frac{\Delta H}{R} \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$\ln\left(\frac{1}{.87}\right) = \frac{32000}{8.314} \left(\frac{1}{X} - \frac{1}{273.15 + 56.5}\right)$$

$$\ln(1.149) = 3848.7 \left(\frac{1}{X} - .003034\right)$$

$$\frac{.1389}{3848.7} = \frac{1}{X} - .003034$$

$$.00003609 + .003034 = \frac{1}{X}$$

$$X = \frac{1}{.003395} = 325.8 K = 52.6^\circ C$$

5 (12 points) I'm going to mix 10 grams of acetone (CH_3COCH_3) with 90 grams of water (H_2O). The resulting solution has a volume of 96 mls.

What is molarity of acetone in solution?

$$\begin{aligned} \text{Moles acetone} &= 10\text{g} \times (1 \text{ mole}/58.08\text{g}) = .1722 \text{ moles} \\ \text{molarity} &= \text{mole/liter solution} = .1722 \text{ mol}/.096 \ell = 1.79\text{M} \end{aligned}$$

What is molality of acetone in solution?

$$\text{Molality} = \text{mole/kg solvent} = .1722 \text{ moles}/.09 \text{ kg water} = 1.92\text{m}$$

What is mole fraction of acetone in this solution?

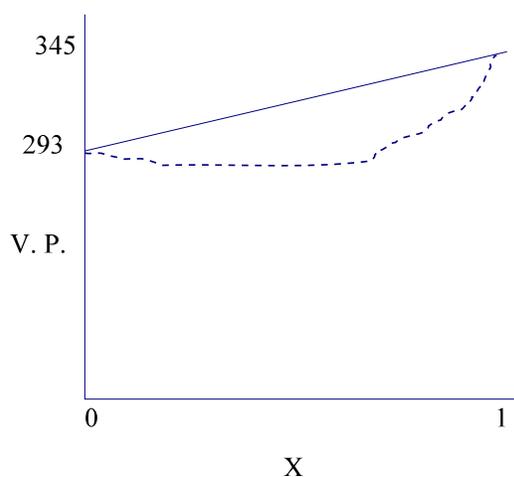
$$\begin{aligned} \text{Moles water} &= 90 \text{ g} \times (1 \text{ mole}/18.016\text{g}) = 5.00 \text{ moles} \\ X_{\text{acetone}} &= .1722/ (.1722+5.00) = .033 \end{aligned}$$

6A (6 points) I am going to mix acetone and chloroform together in a solution. At 35°C the vapor pressure of pure acetone is 345 torr, while that of chloroform is 293 torr. Make a rough graph of the vapor pressure of this solution (Y) as a function of mole fraction acetone (X), assuming the solution follows Raoult's law. Make sure you include the points where mole fraction of acetone = 0 and 1 on your graph. (Note: you do NOT have to make any calculations!)

When $X = 0$, then solution contains only chloroform and $\text{VP} = 293$

When $X = 1$, then solution contains only acetone and $\text{VP} = 345$

Plot these two points and connect them with a line



6B. (6 points) It is observed that when you mix acetone and chloroform the solution gets hotter. Would this correspond to a positive or negative deviation from Raoult's law?

Negative

In the graph above (6A) use a dashed line to propose how you would adjust your line to show this deviation.

7. (12 points) Benzene has a boiling point of 80.1°C and a freezing point of 5.5 °C. It has a K_b of 2.53 °C·kg/mol and a K_f of 5.12 °C·kg/mol. After I dissolve a solute into pure benzene, the resulting solution has a boiling point of 85 °C. What is the freezing point of this solution?

Calculate molality from boiling point depression, and then use that to calculate freezing point

$$\Delta T = K_b m$$

$$85 - 80.1 = 2.53m$$

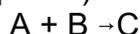
$$4.9 / 2.53 = m; m = 1.937m$$

$$\Delta T = K_f m$$

$$\Delta T = 5.12(1.937); \Delta T = 9.92^\circ\text{C}$$

$$T_{\text{freezing}} = 5.5 - 9.9 = -4.4^\circ\text{C}$$

8 (12 points) I wish to determine the form of the integral rate law for the reaction :



When I follow the rate of disappearance of A under different concentrations of A and B I observe the following rates

[A] (M)	[B] (M)	Rate (mole/l·sec)
.4	.4	1.20
.4	1.1	7.41
1.1	1.1	20.37

What are the order parameters for A and B and the k of this reaction?

$$\text{rate} = k[A]^m[B]^n$$

divide eqn2 by eqn1

$$\frac{7.41}{1.20} = \frac{k[.4]^m[1.1]^n}{k[.4]^m[.4]^n}; 6.175 = \left(\frac{1.1}{.4}\right)^n = 2.75^n$$

$$\ln(6.175) = n \ln(2.75); 1.820 = n(1.012)$$

$$n = 1.820 / 1.012 = 1.8$$

Divide eqn3 by eqn2

$$\frac{20.37}{7.41} = \frac{k[1.1]^m[1.1]^{1.8}}{k[.4]^m[1.1]^{1.8}}; 2.75 = \left(\frac{1.1}{.4}\right)^m = 2.75^m; m = 1$$

choose any equation and solve for k

$$1.20 = k[.4]^1[.4]^{1.8}$$

$$k = 120 / ([.4]^1[.4]^{1.8}) = 15.6$$