Chemistry 114
Third Hour Exam

Name:____________

Gas Constants (R): 0.08206 L·atm/K·mol -or- 8.31451 J/K· mol

1. (6 points) Which of the following solutions will have the **lowest** total vapor pressure at 25° C. The **highest** total vapor pressure? (Assume all solutions are ideal)

_____A. Pure water (Vapor pressure = 23.8 torr at 25° C)

__L__B. A solution of sodium chloride in water with χ_{NaCl} =.01

__H__C. A solution of methanol in water with $\chi_{Methanol}$ = 0.1 (Vapor pressure of the methanol = 143 torr at 25° C.)

(Calculations may not be necessary)

V.P of B < A because X_{h20} <1 so VP must be less than 23.8

VP of C mut be >A because it contains a second component with a VP higher than water, so the summ of these vapor pressures must be higher, no mater what the mole fractins are

2. (10 points) What happens to the vapor pressure of a solution when the solution has a positive deviation from Raoult's Law? What is a reasonable physical explanation for this phenomena? A positive deviation for Raoult's law means that the vapor pressure is higher than calculated. The most likely explanation is that the solute and solvent do not interact with each other and the solution has a negative $\Delta H_{solution}$

3. (10 points) The osmotic pressure of blood is 7.7 atm at 25 °C. What concentration of sodium chloride in water is needed to produce a solution with the same osmotic pressure? Assume that the van't Hoff factor for NaCl at this concentration is 1.9.

π = iM R T

7.7 = 1.9 M .08206 L·atm/K·mol 298K

7.7/(1.9·.08206·298) = M

=.166 M

4. (15 points) I have a reaction in which A +2B ⇄2C. I have obtained the following data using the method of initial rates.

[A](M)	[B] (M)	Initial Rate (mol/L·sec)
0.1	0.1	$1.7x10^{-2}$
0.2	0.1	$4.8x10^{-2}$
0.2	0.2	$19.2x10^{-2}$

What is the order parameter for A?

$$\frac{.048}{.017} = \frac{k(.2)^a(.1)^b}{k(.1)^a(.1)^b} = \frac{.2^a}{.1^a} = \left(\frac{.2}{.1}\right)^a$$

$$2.824 = 2^a; \log(2.824) = a\log(2)$$

$$a = \log 2.824 / \log(2) = .451/.301 = 1.5$$

What is the order parameter for B?

$$\frac{.192}{.048} = \frac{k(.2)^a(.2)^b}{k(.2)^a(.1)^b} = \frac{.2^b}{.1^b} = \left(\frac{.2}{.1}\right)^b = 2^b$$

$$4 = 2^b; b = 2$$

What is K ?

$19.2x10^{-2} = k(.2)^{1.5}(.2)^2$

$.192=k(.0894).04$; $k = .192/(.0894 \cdot .04) = 53.7\ (l/mol)^{2.5}sec^{-1}$

What is the overall rate expression for this reaction?

Rate $=53.7\ (l/mol)^{2.5}sec^{-1}\ [A]^{1.5}[B]^2$

5. (12 points) I am doing an experiment where I see how fast a protein degrades a certain substance. I can monitor the course of the reaction by watching the disappearance of the substance from the solution, as seen in the following table:

T (min)	Conc (M)
0	1.0
1	.794
2	.630
3	.503
4	.397

Describe how you would use graphic analysis to determine the order and rate of this reaction.

Try the following 3 plots, use the data from the plot that is linear:

[M] vs t - if the plot is linear the reaction is zero order and the slope of the line = -k
ln[M] vs t - if the plot is linear, the reaction is 1st order, and the slope of the line = -k
1[M] vs t - if the plot is linear, the reaction is 2nd order, and the slope of the line =+k

6. (12 points) I have a reaction that has a half-life of 90 seconds when my initial concentration is 0.1 M .

A. What is a half-life?

The time it takes for the reactant concentration to reach ½ of its original value

B. What is the K for this reaction if this is a first order reaction?

$t_{1/2} = .693/k$; $90 = .693/k$; $k = .693/90$; $k = .0077\ sec^{-1}$

C. What is the K for this reaction if this is a second order reaction?

$t_{1/2} = 1/k[A]$; $90 = 1/k(.1)$; $k = 1/(90 \cdot .1) = .11$ L/mol·sec

D. What is the K for this reaction if this is a zero order reaction?

$t_{1/2} = [A]/2k$; $90 = 0.1/(2k)$; $k = .1/(2 \cdot 90)$ $k = .00056$ mol/L·sec

7. (9 points) Two elementary steps in the reaction of nitrogen dioxide with carbon monoxide are:

$NO_2 + NO_2 \rightarrow NO_3 + NO$

$NO_3 + CO \rightarrow NO_2 + CO_2$

What is the overall balanced reaction?

$NO_2 + CO \rightarrow NO + CO_2$

What would you expect the rate law to be for this reaction if

A. The first reaction is rate limiting?

$Rate = k[NO_2]^2$

B. The second reaction is rate limiting?

$Rate = k\,[NO_3][CO]$

8. (10 points) Write the equilibrium expression for the following reaction:

$$16\ H^+\ (aq) + 2\ Cr_2O_7^{2-}\ (aq) + C_2H_5OH(aq) \rightleftharpoons 4\ Cr^{3+}\ (aq) + 11\ H_2O(l) + 2\ CO_2(g)$$

$$K = \frac{[Cr^{3+}]^4[CO_2]^2}{[H^+]^{16}[Cr_2O_7^{-2}][C_2H_5OH]}$$

9. (14 points) The solubility product, K_{sp}, for BaF_2 is 2.4×10^{-5}. As I discussed in class the solubility product describes the equilibrium reaction that occurs when the ionic solid dissolves in solution:

$$BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2\ F^-(aq)$$

What is the mathematical equation that relates product and reactant concentrations to the solubility product for the above reaction.

$$K_{sp} = [Ba^{2+}][F^-]^2$$

Use the reaction quotient corresponding to the above equation to predict if the following solutions will move toward the formation of reactant (solid BaF_2), toward the formation of product (dissolved ions), or are at equilibrium.

$Ba^{2+}(aq)$	$F^-(aq)$	Q	Reaction favors solid or ions or is at equilibrium?
0.24 M	0.01 M	$(.24)(.01)^2 = 2.4 \times 10^{-5}$	Q=K at equilibrium
0.01 M	0.24 M	$(.01)(.24)^2 = 5.76 \times 10^{-4}$	Q>K too many products, reaction will favor reactant, solid will form
0.001 M	0.1 M	$(.001)(.01)^2 = 1 \times 10^{-5}$	Q<K not enough product, will move toward product, solid will dissolve