CHEMISTRY 128 EXAM I FEBRUARY 22, 2008

Name _____ **Section** _____

Signature _____ **TA** _____

PLEASE READ THE FOLLOWING INSTRUCTIONS

DO NOT begin the exam until asked to do so.

There are 10 numbered pages, and a periodic table in this exam. Check to see that they are all here before you begin the exam. Return all these papers when you are finished. Write your name on every page. Use a pen with blue or black ink for the entire exam.

Exams done in pencil, erasable ink, or where white-out, liquid paper, etc. have been used are *ineligible for regrades*.

Be sure to follow the directions in answering all questions. Write your final answers in the blanks provided. In working problems and the BONUS, you must **SHOW ALL WORK**. No credit will be given unless all work is clearly shown and the method of solution is logically correct. Use correct units and significant figures.

DO NOT WRITE BELOW THIS LINE

_____

Page	Total	Grader
1	_____ /14	
2	_____ /11	
3	_____ /40	
4	_____ /18	
5	_____ /8	
6	_____ /12	
7	_____ /10	
8	_____ /20	
9	_____ /17	
10(Bonus)	_____ /15	

Chem 128, EXAM I NAME _____
February 22, 2008

I. (37 points)

A. (12 points) Consider two beakers: Beaker A contains 1.00 mol Compound P and Beaker B contains 1.00 mol Compound Q. Each beaker has an equal mass of identical, nonvolatile solute dissolved in it.

	Compound P	Compound Q
Vapor pressure at 35°C	0.250 atm	0.115 atm
Boiling Point	55.22°C	88.22°C
K_b	2.25	6.10
Molar mass (g/mol)	85	107

Answer the questions below, using **LT** (for *is less than*), **GT** (for *is greater than*), **EQ** (for *is equal to*), or **MI** (for *more information required*) in the blanks provided.

_____ **1.** The vapor pressure of the solvent over beaker B ___ the vapor pressure of the solvent over beaker A.

_____ **2.** The boiling point elevation of beaker B __ the boiling point elevation of beaker A.

_____ **3.** The vapor pressure of pure compound Q ___ the vapor pressure of the solvent in beaker B

_____ **4.** The mole fraction of solvent in beaker A __ the mole fraction of solvent in beaker B.

B. (5 points) In the laboratory you dissolve 17.6 g of barium chloride (MM = 208.2 g/mol) in a volumetric flask and add water to a total volume of 500 mL. What is the molarity of the solution?

_____

_____

C. (12 points) An aqueous solution of a nonelectrolyte (M = 100.0 g/mol) has an osmotic pressure of 22 atm at 25°C.

1. What is the molarity of the solution?

_____

2. If the molality of this solution is 0.59 m, what is the density of this solution?

_____

D. (8 points) If 13.25 grams of nonvolatile, nonelectrolyte DDT, $C_{14}H_9Cl_5$ (MM = 354.5 g/mol) are dissolved in 225.1 grams of benzene. (k_f = 5.12°C/m and the freezing point of pure benzene = 5.50°C)

1. What is the molality of the solution?

_____

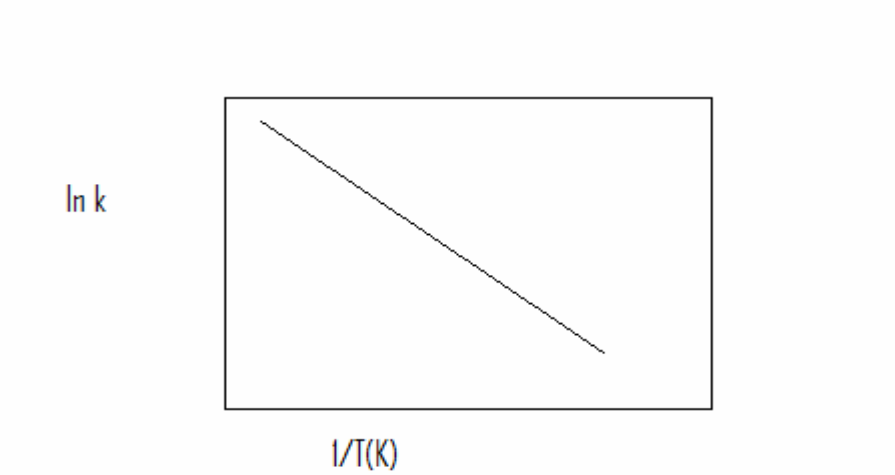
2. What is the freezing point of the solution?

_____

NAME _____

II. (45 points)

A. (15 points) Answer the following questions by writing the appropriate answer in the blank provided.



_____ **1.** The slope of the plot above is equal to _____

_ _____ **2.** The order of a reaction for which the half-life is independent of the initial concentration is _____.

_____ **3.** For a zero-order reaction, starting with 2.0 M of reactant A, the concentration at 20.0 min is 1.0 M. What is the concentration of A at t = 40.0 min?

_____ **4.** The greatest increase in the reaction rate for a reaction between P and Q, where Rate = $k[P]^2[Q]^{1/2}$ will come from

a. Doubling [P] b. Halving [Q] c. doubling [P] and [Q]

d. halving [Q]

_____ **5.** Consider three first-order reactions and their activation energies in kJ:

Reaction	A	B	C
E_a (kJ)	40	89	112

Which reaction has the shortest half-life?

_____

B. (8 points) For the decomposition of ammonia on a platinum surface at 856°C

$2NH_3(g) \rightarrow N_2(g) + 3H_2(g)$

the average rate of disappearance of NH_3 over the time period from t = 0 s to t = 2164 s is found to be 1.50×10^{-6} M s^{-1}. What is the average rate of formation of H_2 over the same time period?

_____

C. (10 points) In a study of the gas phase decomposition of dinitrogen pentoxide at 335 K

$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

the concentration of N_2O_5 was followed as a function of time. It was found that a graph of $\ln[N_2O_5]$ versus time in seconds gave a straight line with a slope of -7.19×10^{-3} s^{-1} and a y-intercept of 2.45. Based on this plot,

1. what is the order of the reaction with respect to N_2O_5?

_____

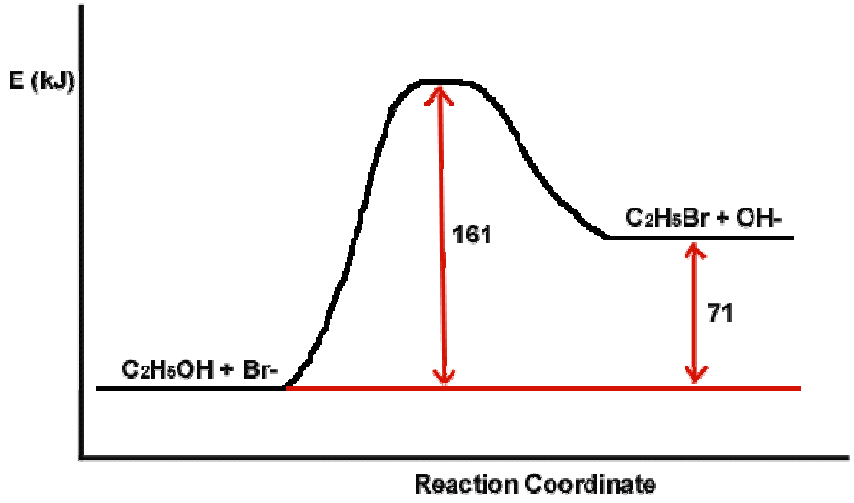
2. what is the rate constant for the reaction ?

_____

NAME _____

D. (8 points) Consider the reaction profile (not to scale!) for the reaction

$C_2H_5OH + Br^- \longrightarrow C_2H_5Br + OH^-$



Answer the following statements true or false.

_____ The value of Ea in the presence of a catalyst would be larger than 161 kJ.

_____ The energy of the products is higher than the energy of the reactants.

_____ The magnitude of Ea for the reverse reaction is smaller than 161 kJ.

_____ The value of ΔH in the reaction is 161 kJ.

_____

E. (12 points) The following gas phase is second order:

$$2C_2H_4(g) \rightarrow C_4H_8(g)$$

It takes 2.11 min for the concentration of C_2H_4 to go from 0.187 M to 0.0915 M.

1. What is k for the reaction?

_____

2. What is the half life of the reaction when C_2H_4 is 0.250 M?

_____

3. How long will it take to react 40% of a 0.450 M solution?

_____

4. What is the rate of the reaction when the $[C_2H_4]$ is 0.335 M?

_____

III. (45 points)

A. (10 points) Answer the questions below in the blanks provided.

The following reaction is carried out in a sealed flask.

$$2HI\,(g) \rightleftharpoons H_2\,(g) + I_2\,(g) \quad \Delta H > 0$$

_____ **1.** What effect (increase, decrease, no change) will a decrease in temperature have on K?

_____ **2.** What effect (increase, decrease, no change) will removing H_2 have on, equilibrium constant, K?

_____ **3.** In which direction will the reaction shift if gaseous H_2 is removed from the system?

_____ **4.** Introduction of a catalyst (a gold surface) (increases, decreases, does not change) the value of K.

_____ **5.** The reaction will shift (left, right, no change) when 0.5 atm of Ar (g) is added to the system.

B. (8 points) Consider the decomposition of ammonium hydrogen sulfide

$$NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$$

In a sealed flask at 25°C are 10.0 g NH_4HS, ammonia with a partial pressure of 0.692 atm, and H_2S with a partial pressure of 0.0532 atm. When equilibrium is established, it is found that the partial pressure of ammonia has increased by 12.4%. Calculate K for the decomposition of NH_4HS at 25°C.

_____

_____

C. (8 points) For the system

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

At 300°C equilibrium constant, K, for this reaction is 26. In a 5.0 L flask a gaseous mixture consists of $P_{PCl_5} = 0.012\ \text{atm}$ $P_{Cl_2} = 0.45\ \text{atm}$ and $P_{PCl_3} = 0.90\ \text{atm}$. Calculate the reaction quotient, Q. In which direction the reaction will proceed? Circle one.

Q _____ LEFT RIGHT REMAINS SAME

D. (8 points) For the system

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H° = -9.4\ \text{kJ}$$

The equilibrium constant for this reaction is 62.5 at 800 K. What is the equilibrium constant at 606 K?

_____

E. (11 points) Nitrogen dioxide can decompose to nitrogen oxide and oxygen.

$$2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g) \qquad K = 0.87$$

A 5.0 L flask at equilibrium is determined to have a total pressure of 1.25 atm and oxygen to have a partial pressure of 0.515 atm. What are the equilibrium partial pressures of nitrogen dioxide (NO_2) and nitrogen oxide (NO) at equilibrium?

P_{NO} = _____ P_{NO_2} = _____

_____

IV. (15 points)

A. (15 points) The following initial rate data are for the reduction of nitric oxide with hydrogen:

$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$

Experiment	$[NO]_o$, M	$[H_2]_o$, M	Initial Rate, mol/L·s
1	0.149	0.374	1.10×10^{-2}
2	0.298	0.374	4.42×10^{-2}
3	0.149	0.748	2.21×10^{-2}
4	0.298	0.748	8.83×10^{-2}

1. What is the order of the reaction with respect to NO(g)?

_____

2. What is the order of the reaction with respect to $H_2(g)$?

_____

3. What is the rate constant for the reaction? **(Include units)**

_____

BONUS (15 points) All or nothing.

The bonus should be done only after you have completed the main part of this exam and checked your work for errors. The time allotted for this exam does not include time for the bonus. *Trial* and *error solutions will not be accepted.*

At a certain temperature the reaction

$Xe(g) + 2F_2(g) \rightleftharpoons XeF_4(g)$

gives a 50.0% yield of XeF_4, starting with Xe ($P_{Xe} = 0.20$ atm) and F_2 ($P_{F_2} = 0.40$ atm). What must the initial pressure of F_2 be to convert 75.0% of the xenon to XeF_4?

_____