CHEMISTRY 4A
Professor Richard A. Mathies

October 20, 1993

SECOND MIDTERM

Name: _____

TA: _____

Begin by writing your name on all pages. You must **show all your work** in the space provided for each question. Look over all the problems and **do the ones that you know first.** Then go back to work on the more difficult ones in the time remaining. Relevant tables and constants will be found on the last page of the exam. Good Luck!

(1) _____ / 30

(2) _____ / 25

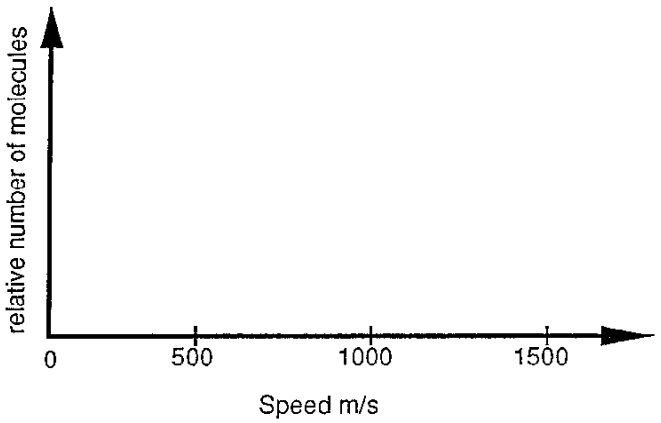
(3) _____ / 20

Total / 75

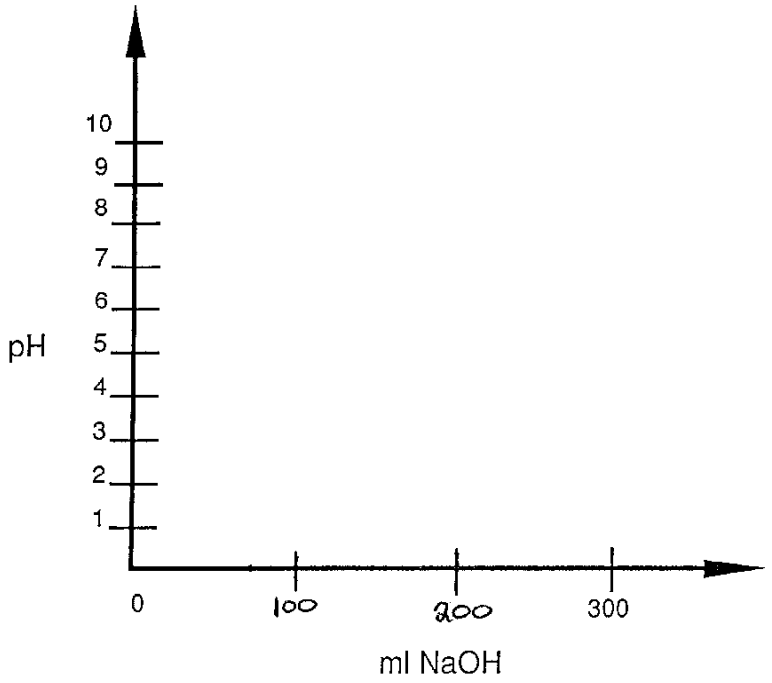
Page 1/5 Name _____

1. Answer the following short questions:

(5) (a) Sketch the Maxwell-Boltzmann speed distribution for N_2 gas at a temperature of 300 K and at 1300 K.



(5) (b) Sketch the titration curve for 100 ml of a 0.10 *M* diprotic acid H_2A when it is titrated with 0.10 *M* sodium hydroxide. The K_a's of this acid are $K_1=1 \times 10^{-3}$ and $K_2=1 \times 10^{-7}$. Clearly indicate the pH (1) of the initial H_2A solution; (2) at the midpoint of both buffer regions; (3) at the first equivalence point and (4) at the second equivalence point.



(4) (c) In a recent newspaper article, it was stated that an etching solution involved in a fatal industrial accident was a mixture of HCl, NaOH, and NaCN. Does this reporter know any chemistry? Explain.

(4) (d) Consider the reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. Based on just this information, what reaction conditions would you employ to optimize the production of ammonia and why?

(4) (e) It is found empirically that it takes 5000 seconds for the first trace of a toxic gas to diffuse halfway across a test chamber. How much additional time will elapse before the gas is detected at the other end of the chamber? Circle the correct answer.

5000 s $\sqrt{5000}$ s 2.5×10^7 s 20,000 s

 Name _____

(8) (f) Consider the reaction

$$CO(g) + H_2O(g) \rightleftharpoons H_2(g) + CO_2(g) \qquad K = 136 \text{ @ } 500 \text{ K}$$

If you combine 1 atm of each of the four gases in a closed vessel at 500 K, what are the final pressures of each species once equilibrium is achieved at 500 K?

 Name _____

2. (a) What is the pH of a solution prepared by dissolving 12.43 g of tris (121.14 g/mole) plus 4.67 g of tris-hydrochloride (157.60 g/mole) in 1 L of water? Tris-hydrochloride is the conjugate acid of tris and has a pKa of 8.075. (10)

(b) What does the pH of the solution in part **a** become if enough water is added to increase the total volume of our buffer to 10 L? (7)

(c) What does the pH of the solution in part **a** become if you add 50 ml of 1 *M* HCl? (8)

3. Two chambers having the same volume are separated by a thin wall with a 0.0005 cm^2 hole. The first chamber is filled with H_2 at an average temperature of 300 K and a pressure of 1 atm. The second chamber is filled with Ar with an average temperature of 500 K and a pressure of 2 atm.

(6) (a) What are the relative kinetic energies of the gas particles in the two samples? Circle the best answer.

KE_{H2}/KE_{Ar} = 500/300, 300/500, $\sqrt{500/300}$, $\sqrt{300/500}$, not listed

(6) (b) Calculate the relative mean speed of the gas particles in the two chambers.

u_{H2}/u_{Ar}

(8) (c) What is the relative rate of effusion ($rate_{H2}/rate_{Ar}$) of molecules through the hole?