Final Exam Review

Complete the following AP Problems. There are due after christmas break. Just 3 problems :)

Periodic Trends/Bonding:

1. Answer the following questions about the element selenium, Se (atomic number 34).

(a) Samples of natural selenium contain six stable isotopes. In terms of atomic structure, explain what these isotopes have in common, and how they differ.

(b) Write the complete electron configuration (*e.g.*, $1s^2\ 2s^2$... etc.) for a selenium atom in the ground state. Indicate the number of unpaired electrons in the ground-state atom, and explain your reasoning.

(c) In terms of atomic structure, explain why the first ionization energy of selenium is
   (i) less than that of bromine (atomic number 35), and
   (ii) greater than that of tellurium (atomic number 52).

(d) Selenium reacts with fluorine to form SeF_4. Draw the complete Lewis electron-dot structure for SeF_4 and sketch the molecular structure. Indicate whether the molecule is polar or nonpolar, and justify your answer.

Kinetics:

1.

$$2\ ClO_{2(g)} + F_{2(g)} \rightarrow 2\ ClO_2F_{(g)}$$

The following results were obtained when the reaction represented above was studied at 25°C.

Experiment	Initial $[ClO_2]$, $(mol \cdot L^{-1})$	Initial $[F_2]$, $(mol \cdot L^{-1})$	Initial Rate of Increase of $[ClO_2F]$, $(mol \cdot L^{-1} \cdot sec^{-1})$
1	0.010	0.10	2.4×10^{-3}
2	0.010	0.40	9.6×10^{-3}
3	0.020	0.20	9.6×10^{-3}

(a) Write the rate law expression for the reaction above.

(b) Calculate the numerical value of the rate constant and specify the units.

(c) In experiment 2, what is the initial rate of decrease of $[F_2]$?

(d) Which of the following reaction mechanisms is consistent with the rate law developed in (a). Justify your choice.

I. $ClO_2 + F_2 \leftrightarrow ClO_2F_2$ (fast)
   $ClO_2F_2 \rightarrow ClO_2F + F$ (slow)
   $ClO_2 + F \rightarrow ClO_2F$ (fast)

II. $F_2 \rightarrow 2\ F$ (slow)
   $2\ (ClO_2 + F \rightarrow ClO_2F)$ (fast)

Acid-Base Equilibrium

$$CH_3CH_2COOH(aq) + H_2O(l) \rightleftarrows CH_3CH_2COO^-(aq) + H_3O^+(aq)$$

2. Propanoic acid, CH_3CH_2COOH, is a carboxylic acid that reacts with water according to the equation above. At 25°C the pH of a 50.0 mL sample of 0.20 *M* CH_3CH_2COOH is 2.79.

   (a) Identify a Brønsted-Lowry conjugate acid-base pair in the reaction. Clearly label which is the acid and which is the base.

   (b) Determine the value of K_a for propanoic acid at 25°C.

   (c) For each of the following statements, determine whether the statement is true or false. In each case, explain the reasoning that supports your answer.

      (i) The pH of a solution prepared by mixing the 50.0 mL sample of 0.20 *M* CH_3CH_2COOH with a 50.0 mL sample of 0.20 *M* NaOH is 7.00.

      (ii) If the pH of a hydrochloric acid solution is the same as the pH of a propanoic acid solution, then the molar concentration of the hydrochloric acid solution must be less than the molar concentration of the propanoic acid solution.

   A student is given the task of determining the concentration of a propanoic acid solution of unknown concentration. A 0.173 *M* NaOH solution is available to use as the titrant. The student uses a 25.00 mL volumetric pipet to deliver the propanoic acid solution to a clean, dry flask. After adding an appropriate indicator to the flask, the student titrates the solution with the 0.173 *M* NaOH, reaching the end point after 20.52 mL of the base solution has been added.

   (d) Calculate the molarity of the propanoic acid solution.

   (e) The student is asked to redesign the experiment to determine the concentration of a butanoic acid solution instead of a propanoic acid solution. For butanoic acid the value of pK_a is 4.83. The student claims that a different indicator will be required to determine the equivalence point of the titration accurately. Based on your response to part (b), do you agree with the student's claim? Justify your answer.

Kinetics Answer Key:

a) four points

rate = k [ClO_2] [F_2]

one point - rate equation form, k

one point - F_2 order

two points - ClO_2 order

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b) two points

k = rate / ([ClO_2] [F_2])

= 2.4 x 10^{-3} mol L^{-1} sec^{-1} / ((0.010 mol/L) (0.10 mol/L))

= 2.4 L mol^{-1} sec^{-1}

one point - value consistent with equation in (a)

one point - units consistent with equation in (a)

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c) one point

2 ClO_2 + F_2 ---> 2 ClO_2F

- d[F_2] / dt = 1/2 (d[ClO_2F] / dt)

= 1/2 (9.6 x 10^{-3})

= 4.8 x 10^{-3} mol L^{-1} sec^{-1}

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d) two points

mechanism I

defense:

slow step is first order

three equations add to proper stoichiometry

Note: if ClO_2 order in rate equation of part (a) is zero, mechanism II must be chosen to obtain credit.
