Chemistry 210 • Fall 2005 • LAB Exam #1 Name: _____

Directions: Answer the following questions in the spaces provided. Show all work and units to receive full credit. Pay attention to significant digits!

1. (10 points) A one-liter bottle of $KMnO_4$ stock solution with a concentration of 4.00×10^{-3} *M* is available in the lab. A dilution is prepared based on the information in the table below. Determine the $[KMnO_4]$ in the dilution.

Volume of stock solution used (mL)	Total volume of dilution (mL)	$[KMnO_4]$ in the dilution (*M*)
3.00	50.0	2.40×10^{-4}

$M_1V_1=M_2V_2$

$\frac{3.00 \text{ mL} \times 4.00\times10^{-3}}{50.0 \text{ mL}} = 2.40 \times 10^{-4}$ -1 for 2 sig figs only

2. (15 points) Potassium aluminum sulfate dodecahydrate (Alum) can be prepared by treating aluminum metal (in the form of aluminum foil) with potassium hydroxide, acidifying the product with sulfuric acid, heating the mixture, then cooling it in an ice bath to precipitate the alum. This multi-step process can be represented by the balanced equation below:

$$2\ Al_{(s)} + 2\ KOH_{(aq)} + 4\ H_2SO_{4(aq)} + 10\ H_2O_{(l)} \rightarrow 2\ KAl(SO_4)_2 \bullet 12\ H_20_{(s)} + 3\ H_{2(g)}$$

The following data were collected for the reaction:

Mass of aluminum foil (g)	0.753 g
Mass of alum isolated (g)	10.911 g

Calculate the ***theoretical yield*** and ***percent yield*** of alum for the reaction.

.753 g x 1 mole Al/26.98 g x 1 m product/1 mole Al x 474.5 g/mole product = 13.24 g product

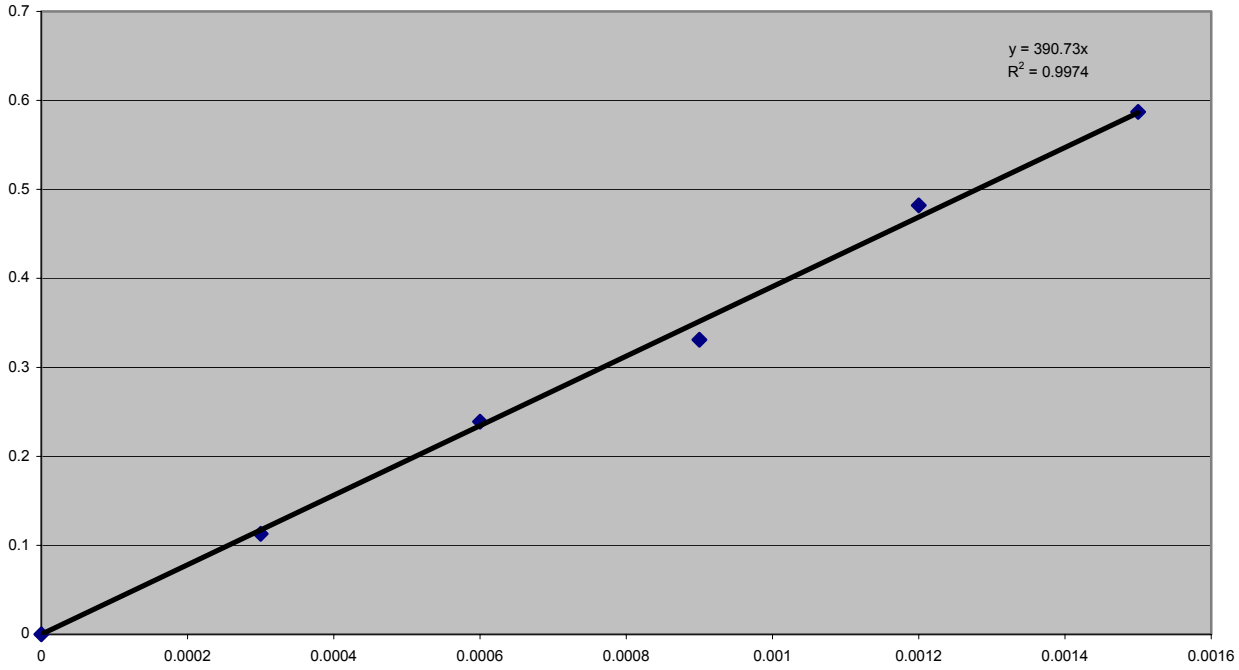
10.911 /13.24 x 100% = 82.4%

3. (25 points) Iron thiocyanate is a brightly colored complex ion with the formula: **$FeNCS^{2+}_{(aq)}$.** Iron thiocyanate has a λ_{max} = 447 nm.

The data to the right is gathered for the [$FeNCS^{2+}$] vs. Absorbance measured at 447 nm.

Absorbance	[$FeNCS^{2+}$] in $^{mol}/_{L}$
0	0
0.113	3.0×10^{-4}
0.239	6.0×10^{-4}
0.331	9.0×10^{-4}
0.482	1.2×10^{-3}
0.587	1.5×10^{-3}

A) Make a Beer's law plot of the data (follow the rules of good graphing):



B) Choose 2 appropriate points from the graph to calculate k (including units) from the graph. Circle the points you chose to use.

If you use = (.587-0)/(1.5x10-3 – 0) =391

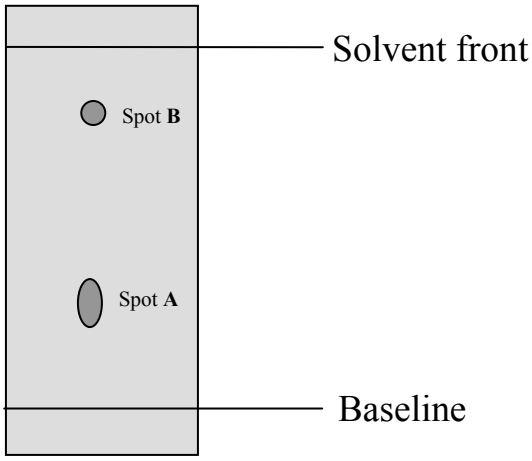
C) A solution of iron thiocyanate with an unknown concentration is found to have an absorbance of 0.185 Determine the equilibrium [$FeNCS^{2+}$].

.185/391 = 4.73×10^{-4} mole/liter

4. (10 points) Four metal ion samples were analyzed by paper chromatography and the R_f values in the table below calculated. An unknown solution was then analyzed by paper chromatography under the same conditions and the chromatogram below was the result. Using R_f determine the composition of the unknown.

Calculate the R_f values for the unknown. Clearly show on the diagram the values you have measured. Measure to the full precision of your ruler and use a metric scale. Identify the unknowns.

Metal ion	R_f
Fe^{3+}	0.551
Ni^{2+}	0.843
Cr^{2+}	0.115
Mn^{2+}	0.274



1.40/4.80 = .292 Mn^{2+}

3.90/4.80 = .813 Ni^{2+}

5. (15 points) You clean a test tube and find its mass by heating it to a constant mass. You put in a sample of an unknown metal sulfate hydrate and mass the test tube with the sample. You then heat the test tube, with the sample in it, until it reaches a constant mass.

You collect the following data:

Mass of test tube (heating to a constant mass)	1st: 12.875 g 2nd: 12.713 g 3rd: 12.712 g
Mass of test tube + sample	16.835g
Mass of test tube + sample (heating to a constant mass)	1st: 16.411 g 2nd: 16.033 g 3rd: 15.518 g 4th: 15.519 g

Based on these data, Calculate the percent of water in the unknown metal sulfate hydrate.

Hydrate 16.835-12.712 = 4.123 H2) = 16.835-15.518 = 1.317 1.317/4.123 x 100% = 31.94%

(25 points) ***Determination of the molar mass of a triprotic acid.***

- A solution of potassium hydroxide (KOH) is standardized using oxalic acid dihydrate and found to have a concentration of 0.173 *M*.
- The standardized solution is then used to find the molar mass of the unknown triprotic acid, "**H_3A**".
- Four samples of the unknown were massed out and each dissolved in approximately 25 mL of water. They were then were titrated with the standardized solution using phenolphthalein as an indicator.
- Use the information tabulated below to find the molar mass for the unknown acid for each trial and an average value for the molar mass.
- Extra lines are for you to organize any additional information you may calculate. You need not use them all if you choose not to.
- ***Note that on one trial, the student made an error in titrating, and that trial should be omitted. Based on your calculation for each trial you will need to determine which trial is in err and omit it from all further calculations.***

Standardization of KOH	Trial 1	Trial 2	Trial 3	Trial 4
Mass of unknown acid (g)	0.455	0.446	0.462	0.252
Final Volume of KOH (mL)	32.67	48.00	37.75	19.05
Initial Volume of KOH (mL)	0.12	15.65	0.55	0.64
Volume KOH	32.55	32.35	37.20	18.41
Moles acid	.001877	.001866	.002145	.001062
MW	242.4	239.1	215.4	237.4
			Bad trial	

A) Write the balanced equation for the reaction of KOH and the unknown acid "H_3A".

3 KOH + H_3A → K_3A + 3 H_2O

B) Calculate the molar mass of the unknown acid for each trial. Clearly indicate the trial that had an error by crossing out that trial above. Determine the average molar mass of the unknown acid.

.173 x 32.55/1000 x 1 moleacid/3 moles base = moles acid

.455 grams/.002816 = MW

Determination of the molar mass of a triprotic acid. (#6 continued)

C) For the bad trial, based on your calculation for molar mass, was too much or too little KOH added? ***Explain.*** (Assume the sample of the acid was properly massed and prepared for titration.)

Too much KOH as the moles of acid are high, which translates to a low molecular mass

D) The unknown triprotic acid has an accepted molar mass of 248.2 g/mol. Based on the results of your calculations and this information, calculate the student's ***relative range*** and ***percent error***. Briefly discuss the ***accuracy*** and ***precision*** of the student in this experiment, relating appropriately to those calculations.

Relative range = 242.4-237.4/239.6 x 100% = 2.1%

% error = [248.2 – 239.6] / 248.2 x 100 % = 3.46

Discuss; The MW is less than the accepted value, which could come from an overestimated KOH moles. I would suspect carbon dioxide reacting with the KOH, decreasing it's concentration. The relative range is "OK" but not great, the % error is higher than it should.

$$\text{Relative range} = \frac{\text{high} - \text{low}}{\text{average}} \times 100\% \qquad \text{Percent error} = \frac{|\text{experimental} - \text{accepted}|}{\text{accepted}} \times 100\%$$