General Chemistry Laboratory
Written Exam

You will be given two hours for this exam. This is an open book exam, but you may only use materials that you have authored, such as your lab notebook, lab reports (including grading comments by your TA), and personal handwritten or typed notes. You may ***NOT*** use books, the lab manual, copies of the web pages, photocopied material, or guides created by your TA.

Question	Score
I (14 pts)	
II (16 pts)	
III (5 pts)	
IV (12 pts)	

Question	Score
V (15 pts)	
VI (24 pts)	
VII (14 pts)	
TOTAL (100 pts)	

Question I

A. What was your Unknown Acid Number from the *Preparation of NaOH Solution* experiment?

B. What was the molecular weight of your Unknown Acid from the *Preparation of NaOH Solution* experiment?

C. True or False

_____1. Phenolphthalein, like litmus paper, turns pink in acidic solutions.

_____2. A plot of ln *K* on the y-axis *vs* 1/T on the x-axis will have a positive slope for an exothermic reaction.

_____3. When using a Spectronic 20, the control test tube, or "blank", is used to set the 0 % Transmittance.

_____4. When weighing by difference, you should use a spatula to remove the suggested amount of solid from a weighing bottle to a beaker or flask.

Question II

Assume that a nickel weighs exactly 5.038650 g. For the sets of weights listed below, obtained by a single weighing on an analytical balance similar to the type you used, indicate in the space provided which statement best describes the set of data:

if the data are accurate and precise, write **AP**

if the data are accurate but not precise, write **A**

if the data are precise but not accurate, write **P**

if the data are neither accurate nor precise, write **NAP**

Set 1: 5.0365g, 5.0371 g, 5.0388 g _____

Set 2: 5.0378 g, 5.0401 g, 5.0385 g _____

Set 3: 5.0387 g, 5.0384 g, 5.0383 g _____

Set 4: 5.0377 g, 5.0373 g, 5.0375 g _____

Question III

Ammonium ferric sulfate dodecahydrate ($NH_4Fe(SO_4)_2 \bullet 12\ H_2O$) is synthesized via the two step process shown below. In the first step an acidic solution of iron (II) ions are oxidized to iron (III) ions with nitric acid. And in the second step the ammonium ions, and sulfate ions crystallize iron (III) ions to produced the desired product as a solid.

(1) $2\ H^+\ (aq) + NO_3^-\ (aq) + Fe^{2+}(aq) \rightarrow Fe^{3+}\ (aq) + NO_2\ (aq) + H_2O\ (l)$

(2) $NH_4^+\ (aq) + Fe^{3+}\ (aq) + 2\ SO_4^-\ (aq) + 12\ H_2O\ (l) \rightarrow \square_4Fe(SO_4)_2 \bullet 12\ H_2O\ (s)$

If a student starts with 1.2702 g of $FeSO_4 \bullet 7H_2O$ (the limiting reagent) and obtained 1.0353 g of $NH_4Fe(SO_4)_2 \bullet 12\ H_2O$ solid. Calculate the theoretical yield from this data. Show your work. (MW $FeSO_4 \bullet 7H_2O$ = 278.02 g/mol, and MW $NH_4Fe(SO_4)_2 \bullet 12\ H_2O$ = 482.15 g/mol)

Question IV

In order to reduce the amount of chemicals used in the teaching laboratory, there is an effort to convert existing experiments to "micro-scale" experiments. Listed below are the data obtained from a "micro-scale" standardization of sodium hydroxide (NaOH) with potassium hydrogen phthalate (KHP). The analytical balance used has an absolute uncertainty of ± 0.00005 g per weighing, and the micro-buret has an absolute uncertainty of ± 0.002 mL per reading. For each trial, calculate the molarity (*M*) of the NaOH solution. Include an uncertainty analysis for each trial, and show your work.

	Trial 1	Trial 2	Trial 3
Initial weight of KHP vial	11.89870 g	11.88319 g	11.86847 g
Final weight of KHP vial	11.88319 g	11.86847 g	11.85217 g
Final buret reading	0.986 mL	0.889 mL	0.845 mL
Initial buret reading	0.204 mL	0.144 mL	0.055 mL
Molarity (mol/L)			
Molarity - Upper Limit			
Molarity - Lower Limit			

Question V

G. Will Akers, a student taking general chemistry Whatsamatter U., was given an unknown chloride sample to analyze . This sample has the empirical formula $M^{+}Cl^{-} \bullet x\ H_2O$. The *Water of Crystallization*, and *Metal Ion* analysis were performed using the same techniques you used in the *Formula of a Mineral* experiment. The amount of chloride was determined by gravimetric analysis with silver ions. The reaction is shown below:

$$Ag^{+}\ (aq)\ +\ Cl^{-}\ (aq) \rightarrow AgCl\ (s)$$

Will obtained the following data:

Flame Test: The flame test did not show the presence of sodium or potassium.

Table of G and M values:

	Value	***Upper Limit***	***Lower Limit***
G_{water}	0.4054	0.4059	0.4054
M_{water} (mol/g)	2.250×10^{-2}	2.253×10^{-2}	2.247×10^{-2}
$G_{chloride}$	0.2659	0.2663	0.2655
$M_{chloride}$ (mol/g)	7.500×10^{-3}	7.511×10^{-3}	7.489×10^{-3}
M_{metal} (mol/g)	7.501×10^{-3}	7.505×10^{-3}	7.497×10^{-3}

Suggest a formula for this double chloride that is consistent with Will's data. Show your work.

Question VI

In the *Formula of a Mineral* experiment there are several types of errors possible. Indicate, with a letter from the table below, the consequences of the error in the space provided.

A. G_{water} will be too high	B. G_{water} will be too low
C. $G_{sulfate}$ will be too high	D. $G_{sulfate}$ will be too low
E. M_{metal} will be too high	F. M_{metal} will be too low
G. no change	H. there will be an error but you cannot tell which way

i. During the sulfate analysis concentrated HCl was not added to the mineral solution before adding the $BaCl_2$. _____

ii. The eluate from the ion-exchange column was left for a week before titrating. _____

iii. Some of the precipitate was spilled when filtered during the sulfate analysis. _____

iv. When titrating the eluate from the ion-exchange column with NaOH, excess distilled water was added to the flask. _____

v. When weighing the KHP for the NaOH standardization, the KHP was transferred from a weighing vial to a 250 mL flask with a spatula, and a small amount of KHP adhered to the spatula. _____

vi. The heated crucible became red hot during the water of crystallization determination.
_____

Question VII:

The reaction of thiocyanate (HSCN) with Fe^{3+} produces a 1:1 colored complex with a maximum absorbance at 447 nm. The reaction is shown below.

$$Fe^{3+} + HSCN \rightleftharpoons FeNCS^{2+} + H^+$$

The equilibrium was monitored with a Spectronic 20 using a setup similar to the one used in *Determination of an Equilibrium Constant* experiment. Exactly 5.00 mL sample of 1.02 x10^{-3} *M* solution of buffered HSCN was mixed with a 5.00 mL of a 1.96 x10^{-3} *M* buffered solution of Fe^{3+}. The solution was buffered at a pH = 0.30. A transmittance of 31.1% was measured for this mixture at room temperature.

A. Assuming the extinction coefficient for the $FeNCS^{2+}$ complex is 4700 L/cm-mol and a path length of 0.90 cm, calculate the value of the equilibrium constant for this reaction at room temperature.