

Spring 1997

Time: 2 hours



Thursday, June 19, 1997

Prof. Ayssar Nahlé

Chemistry 206

Quantitative Analysis

Final

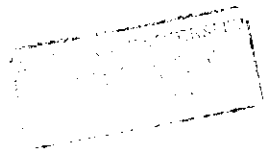
Name: .....  
                    Family                    First name

I.D. number: .....\_ .....

Section number (please circle)                      1                      2                      3

Grade

I	/ 15
II	/ 20
III	/ 15
IV	/ 14
V	/ 14
VI	/ 22
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<b>total</b>	<b>/100</b>



**Good luck**

I. One milliliter of 0.100 M KCl is added to 25.00 mL of 0.100 M AgNO<sub>3</sub> solution. A silver indicator electrode and a reference electrode are immersed in the resulting solution and the emf of the cell is found to be +0.4982 V. After the addition of another 29.00 mL of the KCl solution, the emf becomes +0.1037 V. Calculate the solubility product of AgCl.

Solubility product of AgCl = .....

**II.**

**A)**

A sample consisting of only NaCl and NaI contains chlorine and iodine in a weight ratio of Cl:I = 2:1. Calculate the per cent content of sodium in the sample.

**% Na in the sample = .....**

**B)**

The meniscus of the liquid contained in a 1.000-mL microburet can be read with an accuracy of 0.001 mL. What is the smallest volume, in milliliters, that should be used in a titration in order to insure that the volumetric error is not to exceed 0.5%?

**Volume = ..... mL**

C)

Calculate the absolute and the percent relative standard deviations ( $S_y$  and  $\frac{S_y}{y}$  respectively) of the following computations, and round the results to the appropriate significant figures. (The numbers in parentheses refer to absolute standard deviations).

a)

$$y = 3.12(\pm 0.04) \times \log_{10} \sqrt{17.973(\pm 0.006) - 6.13(\pm 0.03)} = 1.674600\dots$$

$$S_y = \dots\dots\dots$$

$$\frac{S_y}{y} = \dots\dots\dots$$

$$y = \dots\dots\dots \pm \dots\dots\dots$$

b) 
$$y = \frac{12.673(\pm 0.005)[21.39(\pm 0.03) - 8.342(\pm 0.007)]}{73.12(\pm 0.01) + 18.7(\pm 0.8)} = 1.800885\dots\dots$$

$$S_y = \dots\dots\dots$$

$$\frac{S_y}{y} = \dots\dots\dots$$

$$y = \dots\dots\dots \pm \dots\dots\dots$$

- III. a) How many grams of  $\text{NaHCO}_3$  should be added to 3.18 g of  $\text{Na}_2\text{CO}_3$  to prepare with water 500 mL of buffer of pH 10.68?

Weight of  $\text{NaHCO}_3$  = ..... g

- b) What will be the pH of the above buffer, if 1.00 mL of 1.00 M HCl solution is added to it?

pH = .....

- c) How many milliliters of 1.00 M NaOH solution should be added to 2.52 g of  $\text{NaHCO}_3$  to prepare with water 500 mL of buffer of pH 10.20?

Volume of NaOH = ..... mL

- IV. The potential of a nitrate-selective electrode in a  $2.50 \times 10^{-3}$  M  $\text{NaNO}_3$  solution is +0.1194 V vs. SCE. If solid  $\text{NaNO}_3$  is added to 500 mL of this solution until the potential becomes +0.0826 V, what will the new nitrate concentration be and what is the quantity of  $\text{NaNO}_3$  added? Assume negligible volume change upon the addition of the  $\text{NaNO}_3$ .

New nitrate concentration = .....

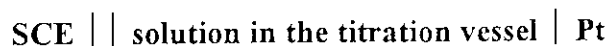
Amount of sodium nitrate added = ..... g

- V. The metal ion  $M^{n+}$  and the ligand L form the colored complex  $[ML]^{n+}$ . Solution B, in which  $C_M = 4.00 \times 10^{-4} \text{ M}$  and  $C_L = 3.12 \times 10^{-4} \text{ M}$ , has an absorbance of 0.375, exactly equal to the absorbance of solution D, which has  $C_M = 6.00 \times 10^{-4} \text{ M}$  and  $C_L = 3.04 \times 10^{-4} \text{ M}$ . All measurements are made at 550 nm, at which only the complex absorbs, in a 1.00-cm cell. Calculate the molar absorptivity  $\epsilon_{550}$  and the instability constant of the complex.

Molar absorptivity  $\epsilon_{550} = \dots\dots\dots$

The instability constant of the complex =  $\dots\dots\dots$

- VI. a) Calculate the potentials read on the potentiometer dial if 100.00 milliliters of 0.1000 M  $\text{Fe}^{2+}$  solution are titrated with 0.1000 M  $\text{Ce}^{4+}$  solution (both solutions are 1.0 M in  $\text{H}_2\text{SO}_4$ ). The volumes of  $\text{Ce}^{4+}$  solution added to the  $\text{Fe}^{2+}$  solution are shown in the table below. The electrochemical cell is:



Enter the calculated values in the corresponding boxes

$V_{\text{Ce}^{4+}}, \text{mL}$	Potential, E, observed on meter, volts	$\frac{\Delta E}{\Delta V}$	$V'$	$\frac{\Delta^2 E}{\Delta V^2}$	$V''$
12.50					
25.00					
40.00					
50.00					
75.00					
99.00					
100.00					
101.00					
125.00					
150.00					
175.00					
200.00					

- b) On one of the provided graph papers, plot the resulting titration curve.
- c) Calculate the first and the second derivatives ( $\frac{\Delta E}{\Delta V}$  and  $\frac{\Delta^2 E}{\Delta V^2}$  respectively), and the corresponding volumes ( $V'$  and  $V''$ ).
- d) Plot on the second graph paper the second derivative.