Spring 1997 Thursday, June 19, 1997

Time: 2 hours 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
total	/100

Good luck

I. One milliliter of 0.100 M KCl is added to 25.00 mL of 0.100 M $AgNO_3$ 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)

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

S_y = ...

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

y = ... ± .....

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

S_y = ...

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

y = ... ± .....

III. a) How many grams of $NaHCO_3$ should be added to 3.18 g of Na_2CO_3 to prepare with water 500 mL of buffer of pH 10.68?

Weight of $NaHCO_3$ = ... 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 $NaHCO_3$ 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 2.50×10^{-3} M $NaNO_3$ solution is +0.1194 V vs. SCE. If solid $NaNO_3$ 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 $NaNO_3$ added? Assume negligible volume change upon the addition of the $NaNO_3$.

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 $C_M = 4.00 \times 10^{-4}$ M and $C_L = 3.12 \times 10^{-4}$ M, has an absorbance of 0.375, exactly equal to the absorbance of solution D, which has $C_M = 6.00 \times 10^{-4}$ M and $C_L = 3.04 \times 10^{-4}$ M. All measurements are made at 550 nm, at which only the complex absorbs, in a 1.00-cm cell. Calculate the molar absorptivity ε_{550} and the instability constant of the complex.

Molar absorptivity ε_{550} = ...

The instability constant of the complex = ...

VI. **a)** Calculate the potentials read on the potentiometer dial if 100.00 milliliters of 0.1000 M Fe^{2+} solution are titrated with 0.1000 M Ce^{4+} solution **(both solutions are 1.0 M in H_2SO_4)**. The volumes of Ce^{4+} solution added to the Fe^{2+} solution are shown in the table below. The electrochemical cell is:

SCE | | solution in the titration vessel | Pt

Enter the calculated values in the corresponding boxes

$V_{Ce^{4+}}, mL$	**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.