



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
END OF SEMESTER TWO EXAMINATIONS – MAY 2005
ANALYTICAL CHEMISTRY I – SCH 1206
TIME: 3 HOURS

INSTRUCTION TO CANDIDATES

Answer ALL questions from Section A and ANY THREE from Section B
Section A carries 40 marks and Section B carries 60 marks
Total Marks – 100

SECTION A

- (a) Derive the Henderson-Hasselbalch equation for acetic acid? [5 marks]
(b) What is a buffer and what do you understand by buffer capacity? [3 marks]
- (a) Calculate the concentration of all the species present in the dissociation of 0.5M $H_2C_2O_4$ given that $K_1 = 5.6 \times 10^{-2}$ and $K_2 = 5.42 \times 10^{-5}$. [10 marks]
(b) Which form of EDTA is used in preparing a titration solution? Why is a solution containing a metal ion buffered before titration with EDTA? [4 marks]
3. Define common-ion effect. Calculate the molar solubility of $Ba(IO_3)_2$ in a solution that is 0.0200M in $Ba(NO_3)_2$. [10 marks]
- (a) What is the ionic strength of a solution that is 0.05 M in KNO_3 and 0.1 M solution of Na_2SO_4 ? [3 marks]
(b) Explain why the solubility of $BaSO_4$ is almost double when about 0.05 M concentration of KNO_3 is added to the sparingly soluble salt. [5 marks]

SECTION B

- (a) A 0.1 M solution of acid was used to titrate 10 mL of 0.1 M solution of alkali and the following volumes of acid were recorded:
9.88 10.18 10.23 10.39 10.21 mL
Calculate the 95% confidence limits of the mean and use them to decide whether there is any evidence of systematic error. [5 marks]

- (b) A standard sample of pooled human blood serum contains 42.0 g of albumin per liter. Five laboratories (A-E) each do six determinations (on the same day) of the albumin concentration, with the following results (g/L throughout):

A	42.5	41.6	42.1	41.9	41.1	42.2
B	39.8	43.6	42.1	40.1	43.9	41.9
C	43.5	42.8	43.8	43.1	42.7	43.3
D	35.0	43.0	37.1	40.5	36.8	42.2
E	42.2	41.6	42.0	41.8	42.6	39.0

Comment of the bias, precision and accuracy of each of these sets of results. [5 marks]

- (c) In a series of experiments on the determination of tin in foodstuffs, samples were boiled with hydrochloric acid under reflux for different times. Some of the results are shown below:

Refluxing time (min)	Tin found (mg/kg)					
30	55	57	59	56	56	59
75	57	55	58	59	59	59

Does the mean amount of tin found differ significantly for the two boiling times?

[10 marks]

6. (a) A 0.4755g sample containing $(\text{NH}_4)_2\text{C}_2\text{O}_4$ and inert compounds was dissolved and made alkaline with KOH. The liberated NH_3 was distilled into 50.0 mL of 0.1007N H_2SO_4 . The excess H_2SO_4 was back-titrated with 11.13 mL of 0.1214 N NaOH. Calculate the percentage of N (14.007g/mol) and of $(\text{NH}_4)_2\text{C}_2\text{O}_4$ (124.10 g/mol) in the sample.

[10 marks]

- (b) Calculate the pH and percentage protonation of a 0.20 M aqueous solution of methylamine, CH_3NH_2 . The K_b for CH_3NH_2 is 3.6×10^{-4} .

[10 marks]

7. Generate a curve for the titration of 50.0 mL of a solution in which the analytical concentration of HClO_4 is 0.1000M and that for formic acid is 0.0800 M. Calculate the pH after addition of 0.00, 10.00, 20.00, 24.00, 25.00, 26.00, 35.00, 44.00, 45.00, 46.00 and 50.00 mL of 0.200 M KOH. $K_a \{ \text{HCOOH} \} = 1.8 \times 10^{-4}$ [20 marks]
8. (a) Give at least four properties of activity coefficients. [4 marks]
- (b) A 1.509 g sample of Pb/Cd alloy was dissolved in acid and diluted to exactly 250.0 mL in a volumetric flask. A 50.0 mL aliquot of the diluted solution was brought to a pH of 10.0 with an $\text{NH}_4^+/\text{NH}_3$ buffer. The subsequent titration involved both cations and required 28.89 mL of 0.06950 M EDTA. A second 50.0 mL aliquot was brought to a pH of 10.0 with an HCN/NaCN buffer, which also served to mask Cd^{2+} ; 11.56 mL of the EDTA solution was needed to titrate the Pb^{2+} . Calculate the percentage of Pb and Cd in the sample. [8 marks]
- (c) Calculate the pAg of the solution during the titration of 50.0 mL of 0.0500M NaCl with 0.10000M AgNO_3 after addition of the following volumes of the reagent: (a) 0.00 mL, (b) 24.50 mL, (c) 25.0 mL, (d) 25.50 mL [8 marks]
9. Give a detailed account of the applications of neutralization titrations. [20 marks]

End of question Paper!!!