THE OPEN UNIVERSITY OF SRI LANKA
B.Sc. Degree Programme / Stand alone courses in Chemistry
Level 5 – FINAL EXAMINATION –Model paper
CMU 3123/CME 5123 –ANALYTICAL CHEMISTRY

Duration: Two hours

Instructions to students

This question paper consists of six questions. Answer any four questions only.

1. (a) Compare and contrast the principles of acid- base titrations with those of EDTA titrations. (30 marks)

(b) Give three conditions that make direct titration by EDTA unsuccessful. (15 marks)

(c) The pH of a 50.00 cm^3 of sample solution containing Fe(III) and Al(III) was buffered at 2 and 2 cm^3 of salicilic acid in methanol was added. The solution was titrated with 0.02 M EDTA and the end point was 26.90 cm^3. The end point was detected as the point at which red colour of the iron (III) salicilate was vanished. Another 50.00 cm^3 of the same EDTA solution was added and boiled to ensure the complete formation of aluminium EDTA complex. After adjusting the pH to 5 the solution was back titrated with 0.02 M iron (III) solution and the end point reading was 43.90 cm^3.

(i) Explain the reason having different pH levels for the two titrations.
(ii) Calculate the concentrations of Fe (III) and Al (III) in the original sample.(give the answer to the correct number of significant figures)

(55 marks)

2. (a) Write down the expression for the partition coefficient and distribution ratio for acetic acid in water and in benzene. Acetic acid dissociates into its anion and hydrogen cation in water and polymerizes to $(CH_3COOH)_2$ in benzene. (20 marks)

(b) A solution (100 cm^3) containing 0.50 g of I_2 is extracted as follows.
(i) with 30cm^3 of CCl_4.
(ii) with three 10 cm^3 portions of CCl_4
Calculate the percentage of I_2 extracted in each case. (The partition coefficient of I_2 in CCl_4/H_2O is 85) (30 marks)

(c) Explain how the chromatographic data can be used for qualitative and quantitative analysis. (30 marks)

(d) Write an equation for the selectivity factor of two components A and B, in chromatography. When a mixture of two components was injected to a GC column, the two peaks for the two components were obtained at 180 s and 250 s and the dead time was 50 s. Calculate the selectivity factor of the two components. (20 marks)

3. (a) Draw a schematic diagram of an Atomic Absorption Spectrophotometer. (10 marks)

(b) Give two major differences of UV/ Visible spectroscopy compared to Atomic Absorption Spectroscopy. (20 marks)

(c) Explain how you carry out the standard addition method giving a sketch of calibration curve of a standard addition method. What is the use of this method? (30 marks)

(d) The substances both A and B absorbs light at 450 nm and 540 nm. A solution containing substances A and B gave absorption of 0.450 at 450 nm and 0.65 at 540 nm at a path length of 1 cm. Find the concentration of A and B separately. Molar absorptivities ($dm^3mol^{-1}cm^{-1}$) of pure A and B was as follows.

Wave length (nm)	A	B
450	500	3000
540	2100	210

(40 marks)

4. (a) A 25.00 cm^3 of a solution containing an equimolar mixture of Sn^{2+} and Fe^{2+} in 0.1 M H_2SO_4 was titrated with 0.02 M $KMnO_4$ solution.

$E^\circ (MnO_4^-/Mn^{2+}) = 1.51$ V $E^\circ (Sn^{4+}/Sn^{2+}) = 0.15$ V $E^\circ (Fe^{3+}/Fe^{2+}) = 0.77$ V

(i) Comment on the feasibility of the above titration.

(ii) Sketch and explain the titration curve for the above titration.

(iii) The first end point reading was observed at 20.00 cm^3 of 0.02 M $KMnO_4$. Calculate the concentration of Sn^{2+} and Fe^{2+}. What is the expected second end point reading?

(60 marks)

(b) A 0.02 M solution of a weak acid HX ($K_a = 6.0 \times 10^{-8}$) and a weak base YOH ($K_b = 5.2 \times 10^{-5}$ is given to a student.

(i) Write an expression for the conditional formation constant of the reaction between HX and YOH using K_a and K_b.

(ii) Is it possible to carry out a titration between the two? Explain your answer.

(40 marks)

5. (a) Draw a schematic diagram to show the DTG curve for the decomposition of pure $CaCO_3$. Give reasons for the shape of this curve. (30 marks)

(b) A mixture containing calcium oxide (CaO) and $CaCO_3$ only was analysed by thermogravimetry. The resultant curve indicates only the decomposition between 600 °C and 900 °C. In this temperature range the weight of sample decreases from 250.6 mg to 190.8 mg. What is the percentage by weight of $CaCO_3$ in the mixture? (20 marks)

(c) Explain the principle behind conductometric titrations and how you detect the end point giving an example of a titration curve. (30 marks)

(d) Give one advantage and one disadvantage of conductometric titrations compared to classical titrimetry. (20 marks)

6. (a) Explain "Post precipitation" and "Co-precipitation" in gravimetry. (30 marks)

(b) State three major disadvantages of gravimetry compared to other methods of analysis. (15 marks)

(c) Comment on the following statement.
"The particles size of the precipitate affects the accuracy of gravimetric analysis. " (25 marks)

(d) To a 0.6000 g of an impure sulphate (molecular weight = 102.58 g), 0.01 M barium chloride was added and 1.062 g of barium sulphate was obtained. Calculate the percentage of sulfer in the dry sample (Ba =137.33, S= 32.06). (give the answer to the correct number of significant figures) (30 marks)