JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCES)

1ST YEAR SECOND SEMESTER 2023/2024 ACADEMIC YEAR

MAIN REGULAR

COURSE CODE: SPB 9112

COURSE TITLE: BASIC ANALYTICAL CHEMISTRY

EXAM VENUE: **DATE:**

TIME: **EXAM SESSION:**

STREAM:

INSTRUCTIONS:

1. **Answer question 1 (Compulsory) in section A and ANY other 2 questions in Section B.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

## Question (30 marks)

a. Describe the various steps in analytical analysis (6 marks)

b. Desribe the various types of sampling methods (10 marks)

c. Describe the categories of separation methods alongside the principle behind each separation method (7 marks)

d. Outline the steps in gravimetric analysis (7 marks)

e. Explain the following terms; (2 marks)
    i)   Precision and accuracy
    ii)   spectroscopy

SECTION B

Question 2

a. Calculate the mass in grams of Na^+ (22.99 g/mol) in 25.0 g of Na_2SO_4 (142.0 g/mol) (5 marks)

b. Describe the preparation of 500 mL of 0.0740 M Cl^- solution from solid $BaCl2.2H2O$ (244.3 g/mol) (5 marks)

c. By titration you find that 15.0 cm^3 of hydrochloric acid neutralise 25.0 cm^3 of a 0.100 mol dm^{-3} solution of sodium hydroxide. What is the concentration of hydrochloric acid? (5 marks)

d. A standard solution is prepared by dissolving 1.185g of potassium dichromate(VI) and making up to 250 cm^3 of solution. This solution is used to find the concentration of a sodium thiosulphate solution. A 25 cm^3 portion of the oxidant was acidified and added to an excess of potassium iodide to liberate iodine:

$$Cr_2O_7{}^{2-}(aq) + 6I^-(aq) + 14H^+(aq) \rightarrow 3I_2(aq) + 2Cr^{3+}(aq) + 7H^2O(l)$$
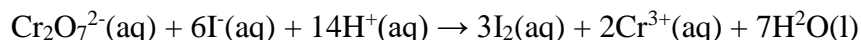
When the solution was titrated against sodium thiosulphate solution, 17.5cm^3 of 'thio' was required. Find the concentration of the thiosulphate solution. (5 marks)

Question 5

a. Solute A has a $K = 3$ for an extraction between water (phase 1) and benzene (phase 2).

If 100 mL of a 0.01M solution of A in water is extracted one time with 500 mL benzene, what fraction will be extracted? (5 marks)

b. The retention volume of a solute is 76.2 mL for a column with $V_m = 16.6$ mL and $V_s = 12.7$ mL. Calculate the capacity factor and the partition coefficient for this solute. (5 marks)

c. Two compounds with partition coefficients of 15 and 18 are to be separated on a column with $V_m/V_s = 3.0$ and $t_m = 1.0$ min. Calculate the number of theoretical plates needed to produce a resolution of 1.5. (5 marks)

d. What mass of Ag_2CO_3 275.7 g/mol is formed when 25.0 mL of 0.2 M $AgNO_3$ are mixed with 50.0 mL of 0.0800 M Na_2CO_3? (5 marks)

Question 5

a. What will be the molar analytical concentration of Na_2CO_3 in the solution produced when 25.0 mL of 0.200 M $AgNO_3$ is mixed with 50.0 mL of 0.08 M Na_2CO_3 (5 marks)

b. In a sample with an absorbance of 1 at a specific wavelength, what is the relative amount of light that was absorbed by the sample (5 marks)?

c. Guanosine has a maximum absorbance of 275 nm, $\epsilon_{275} = 8400 M^{-1} cm^{-1}$ and the pathlenght is 1. Using a spectrophotometer, you find the that $A_{275} = 0.70$. What is the concentration of guanosine (5 marks)?

d. There is a substance in a solution (4 g/liter). The length of cuvette is 2 cm and only 50% of the certain light beam is transmitted. What is the extinction coefficient (5 marks)?

Question 5

a. The absorption coefficient of a glycogen-iodine complex is 0.20 at light of 450 nm. What is the concentration when the transmission is 40 % in a cuvette of 2 cm (5 marks)?

b. The following results were obtained in the replicate determination of the lead content of a blood sample: 0.752, 0.756, 0.752, 0.751, and 0.760 ppm Pb. Find the mean and the standard deviation of this set of data. (5 marks)

c. An iron ore was analyzed by dissolving a 1.1324g sample in concentrated HCl. The resulting solution was diluted with water and the iron(III) was precipitated as the hydrous oxide $Fe_2O_3.xH_2O$ by the addition of NH_3. After filtration and washing, the residue was ignited at a high temperature to give 0.5394g of pure Fe_2O_3 (159.69 g/mol). Calculate;

i. The % Fe (55.847 g/mol) (5 marks)

ii. The %Fe_3O_4 (231.54 g/mol) (5 marks)