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University Examinations 2023/2024

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE AND BACHELOR OF SCIENCE (CHEMISTRY)

SCH 3453: ANALYTICAL CHEMISTRY II

DATE: APRIL 2024 **TIME: 2 HOURS**

INSTRUCTIONS: *Answer question **one** and any other **two** questions*

QUESTION ONE (30 MARKS)

(a) (i) What is monochromatic light? (1 mark)

(ii) State two types of dispersing elements found in monochromators. (2 marks)

(b) Give three properties of an ideal transducer. (3 marks)

(c) Explain the role of computers in analytical chemistry. (3 marks)

(d) (i) Explain the difference between Flame atomic emission spectrometry and Flame atomic absorption spectrometry. (2 marks)

(ii) State the major limitation of flame atomic absorption spectrometry. (1 mark)

(e) Explain enzyme-linked immunosorbent assay (ELISA) technique. (3 marks)

(f) The penicillin in a mixture was determined by adding 1.0 mg of the ^{14}C labeled compound having a specific activity of 5000 cpm. After equilibrium, 4.1 mg of pure crystalline penicillin was isolated. This material had a net activity of 340 cpm.

(i) Calculate the mass of penicillin in the sample. (2 marks)

(ii) Name the technique. (1 mark)

(g) Draw a general diagram of differential thermal analysis thermogram. (3 marks)

(h) (i) Show the schematic representation of saturated calomel electrode. (1mark)

(ii) Explain the terms in (i) above. (4 marks)

(iii) Write the electrode reaction in calomel half-cell. (1 mark)

(i) The potential of a glass membrane is given by:

$$E_{glass\ (cell\ unk)} = K - \frac{2.303RT}{F} \log \frac{a_{H+\ int}}{a_{H+\ unk}}$$

where $K = E_{cell\ std} + \frac{2.303RT}{F} pH_{\ std}$

Show that $pH_{\ unk} = pH_{\ std} + \frac{E_{cell\ std} - E_{cell\ unk}}{2.303RT/F}$ (3 marks)

QUESTION TWO (20 MARKS)

(a) Describe the operation of flame photometer. (10 marks)

(b) What are the limitations of flame photometry? (4 marks)

(c) Describe the internal-standard calibration method. (6 marks)

QUESTION THREE (20 MARKS)

(a) Explain the following terms: (4 marks)

(i) Activity
(ii) Ion selective electrode (ISE)

(iii) Direct potentiometry

(iv) Acid error

(b) Use a suitable diagram to explain the features of a reduction voltammogram. (10 marks)

(c) The table below shows potentiometric data for titration of 20 cm^3 chloride ion with 0.1 M silver nitrate standard. Use the data to answer the questions that follow.

Volume $AgNO_3$ (mL)	E (V)
5.0	0.06
15.0	0.08
20.0	0.11
24.0	0.17
24.5	0.34
25.0	0.37

25.5	0.38
26.0	0.39

(i) Plot a graph of E value (V) against value of $AgNO_3$ (3 marks)

(ii) From the graph, determine the end point of the titration. (1 mark)

(iii) Calculate the concentration of the chloride ion in g/L. (2 marks)

QUESTION FOUR (20 MARKS)

(a) Describe the main components of optical instruments. (10 marks)

(b) Describe the instrumentation of a double pH probe. Include diagram. (10 marks)