



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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## University Examinations 2023/2024

FIRST YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN BIOCHEMISTRY, BACHELOR OF SCIENCE IN BIOTECHNOLOGY, BACHELOR OF SCIENCE IN ENVIRONMENTAL SCIENCE AND BACHELOR OF EDUCATION SCIENCE

### SCH 3153: ANALYTICAL CHEMISTRY I

DATE: APRIL 2024

TIME: 2 HOURS

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

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#### QUESTION ONE (30 MARKS)

- (a) (i) State two classes of analytical methods. (2 marks)
- (ii) What elements comprise this sample of stainless steel? Indicate whether this would be a qualitative or quantitative analysis. (1 mark)
- (b) Explain the following terms. (3 marks)
- (i) True
- (ii) Accuracy
- (iii) Error
- (c) The following values were obtained for the nitrate concentration ( $\text{mgL}^{-1}$ ) in a sample of river water. (3 marks)
- 0.403, 0.410, 0.401, 0.380, 0.413, 0.400, 0.408
- The 0.380 measurement is suspect: should it be rejected?

Table 1. Critical values of  $Q$  (95% confidence).

Sample size	Critical value
4	0.831
5	0.717
6	0.621
7	0.571

- (d) (i) What is volumetric analysis? (1 mark)
- (ii) Describe two types of volumetric analysis. (2 marks)
- (e) The concentration of sodium hydroxide solution is 0.5% (mass/volume). What is the molarity of this solution? Na = 23, O = 16, H = 1 (3 marks)
- (f) What are the important properties of supercritical fluids as compared to other mobile phases? (3 marks)
- (g) (i) What is chromatography? (1 mark)
- (ii) Differentiate between adsorption and partition chromatography. (2 marks)
- (h) Describe how Completeness of the precipitation is tested. (3 marks)
- (i) State three disadvantages of gravimetric analysis. (3 marks)
- (j) (i) Draw a sketch diagram for a vacuum distillation set up. (2 marks)
- (ii) Why is vacuum distillation not recommended for collecting the filtrate? (1 mark)

### QUESTION TWO (20 MARKS)

- (a) (i) Describe the features of a titration curve of a strong acid versus a strong base. Include a diagram. (7 marks)
- (ii) In a titration, 15 mL of 0.5 M HCl is added to 20.0 mL of 0.5 M KOH. Calculate the pH of the solution after the reaction. (3 marks)
- (b) (i) Describe the main steps followed in precipitation gravimetry. (7 marks)
- (ii) Zinc weighing 0.25 g is determined by precipitating and weighing as  $Zn_2Fe(CN)_6$ . Calculate the weight of the precipitate. Zn = 65, Fe = 56, C = 12, N = 14 (3 marks)

### QUESTION THREE (20 MARKS)

- (a) (i) A solute, S has a  $K_D$  between water and chloroform of 5. A 50 mL sample of a 0.025 M aqueous solution of the solute is extracted with four 10 mL of chloroform. Determine the extraction efficiency for this separation. (4 marks)
- (ii) What are the limitations associated with liquid–liquid extractions. (3 marks)
- (b) Give the three types of solid phase extraction methods. (3 marks)
- (c) Describe the Soxhlet extraction process. Include a diagram. (10 marks)

**QUESTION FOUR (20 MARKS)**

- (a) (i) Draw a schematic diagram of a GC instrument. (5 marks)
- (ii) Describe the working principle of GC. (5 marks)
- (b) (i) Draw a set up for TLC developing chamber. (4 marks)
- (ii) Describe the steps followed in TLC. (6 marks)