



# MURANG'A UNIVERSITY OF TECHNOLOGY

## SCHOOL OF PURE, APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PHYSICAL AND BIOLOGICAL SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2021/2022 ACADEMIC YEAR

**THIRD YEAR FIRST SEMESTER EXAMINATION FOR, BACHELOR OF  
SCIENCE IN ANALYTICAL CHEMISTRY**

**ACH 304: SEPARATION TECHNIQUES**

DURATION: 2 HOURS

**Instructions to candidates:**

1. Answer question **one** and **any other two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

## SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION

### QUESTION ONE (30 MARKS)

- a) Define the following terms. (6 marks)
- i) Chromatogram (1 mark)
  - ii) Co-precipitation (1 mark)
  - iii) Absorption chromatography (1 mark)
  - iv) Solvent extraction (1 mark)
- b) The distribution constant  $k$ , for compound  $x$  between  $h$ - hexane and water is 8.9. A 50 ml solution of 0.2 M of compound  $x$  is to be extracted using a single extraction with 40ml and five position of 5 ml hexane respectively. Calculate the percent extracted in each case. Which extraction is more efficient? (6 marks)
- c) Explain why separation is important in analytical chemistry. (6 marks)
- d) Impurities in precipitation occur as a result of co-precipitation. List and explain four ways which impurities are introduced to a precipitate. (8 marks)
- e) Aluminium in 2g of an ore sample is determined by dissolving it and then precipitating  $Al(OH)_3$  and igniting to  $Al_2O_3$  which was weighed. What % of aluminium was in the sample if 1g of ignited precipitate weighed 0.2385g ( $A1 = 27, O = 16, H = 1$ ) (4 marks)
- f) What are the ways in which extraction of metals using solvent extraction can be improved? Explain two ways. (4 marks)

## SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION

### QUESTION TWO (20 MARKS)

- 2.a). Explain three factors that influence column efficiency in column chromatography. (6 marks)
- b) Compare and contrast paper chromatography and thin layer chromatography. (5 marks)
- c) A chromatogram of a mixture of two compound X and Y give the following data.
- | Solute | Retention time (min) | Peak width at base (min) |
|--------|----------------------|--------------------------|
| X      | 6                    | 0.9                      |
| Y      | 15                   | 0.75                     |

If the column length was 25 cm. Calculate

- i) The number of theoretical plates for each compound. (4 marks)

- ii) Theoretical plate height for each peak. (2 marks)
- iii) Resolution of the column. (2 marks)
- iv) The selectivity factor of the column. (1 mark)

### QUESTION THREE (20 MARKS)

3. a). What factors influence motilities of ions and thus separation in capillary electrophoresis? (5 marks)
- b) A certain inorganic cation has electrophoretic mobility of  $5.13 \times 10^{-4} \text{ cm}^2 \text{ V}^{-1}$ . This ion has a diffusion coefficient of  $9.1 \times 10^{-6} \text{ cm}^2 \text{ s}^{-1}$ . If the iron is separated by capillary zone electrophoresis with a 50 cm capillary.
- i. Calculate the expected plate count, N at applied voltage of 20KV. (4 marks)
- ii. Under the separation conditions, the electroosmotic flow rate was  $0.65 \text{ mm s}^{-1}$  toward the cathode. If the detector was placed 40 cm from the injection end of the capillary. Determine the time it will take in minutes for analyte to reach detector after applied field. (5 marks)
- c) Define the following terms (6 marks)
- Elution
  - Reverse chromatography
  - Retention volume

### QUESTION FOUR (20 MARKS)

4. a). Explain ways of reducing impurities in a precipitate. (6 marks)
- b) A 500ml solution containing  $\text{Ba}^{2+}$  was analysed by adding excess oxalate. The precipitate was washed filtered and dried. It was then weighed and found to be 0.0253g. Calculate the original concentration of  $\text{Ba}^{2+}$  in the original solution. (4 marks)
- c) Explain ways of increasing severity of an extraction in solvent extraction. (6 marks)
- d) Why is ion exchange chromatography a better separation method for metals ions than chemical methods? (4 marks)