



**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND
TECHNOLOGY**

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

**UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF
SCIENCES, BIOLOGICAL SCIENCES**

2ND YEAR SECOND SEMESTER RESIT

MAIN REGULAR

COURSE CODE: SPB 9202

COURSE TITLE: 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 must hand in their answer booklets to the invigilator while in the examination room.**

SECTION 1

Question 1 (30 marks)

- a) What does the work of an analytical chemist entail (1 mark)**
- b) What are the steps in a chemical analysis (5 marks)**

- c) Describe how you can go about sampling soils from a farm that has been polluted with lead (5 marks).
- d) What are the components of typical analytical equipment? Explain the uses of each component. (5 marks)
- e) 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. (3 marks)
- f) What is gravimetric analysis (1 marks)
- g) Explain what is meant by a gravimetric precipitation method and a gravimetric volatilization method (2 marks).
- h) A bottle of metal hydrate $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ is mixed with an unknown amount of KCl. In order to find the purity of the $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$, we heat 9.51g of the metal hydrate mixture to remove water from the sample. After heating, the sample has a reduced mass of 9.14g.
- i) calculate change in sample mass (1 mark) iv) calculate mass of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ in grams (1 mark)
- ii) Calculate the moles of evaporated water (1 mark) v) calculate the mass percent of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ in the original sample (1 mark)
- iii) calculate moles of $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ (1 mark)
- i) The calcium in a 200.0-mL sample of a natural water was determined by precipitating the cation as CaC_2O_4 . The precipitate was filtered, washed, and ignited in a crucible with an empty mass of 26.6002 g. The mass of the crucible plus CaO (56.077 g/mol) was 26.7134 g. Calculate the concentration of Ca (40.078 g/mol) in water in units of grams per 100 mL of the water (3 marks)

SECTION B

Question 2 (20 marks)

- a) What is the difference between a lab sample and a gross sample (2 marks)
- b) What factors determine the mass of a gross sample (3 marks)
- c) what are the goals of a sampling process (4 marks)
- d) Explain the meaning of spectroscopy (1 marks)
- e) Describe the properties of electromagnetic radiation (10 marks)

Question 3

- a) Describe the various regions of the electromagnetic spectrum, the corresponding spectroscopy technique and the type of quantum transition (10 marks)
- b) Using a well labelled block diagram, discuss in detail the various components of a typical HPLC instrument. (10 marks)

Question 4 (20 Marks)

- a) Draw a diagram showing the various parts of a mass spectrometer (8 marks).
- b) Calculate;
 - i) the wavenumber of a beam of infrared radiation with a wavelength of $5.00\ \mu\text{m}$ (3 marks)
 - ii) the energy in joules of one photon of radiation with the above wavelength (3 marks)
- c) A $7.25 \times 10^{-5}\ \text{M}$ solution of potassium permanganate has a transmittance of 44.1% when measured in a 2.10 cm cell at a wavelength of 525 nm. Calculate
 - (i) the absorbance of this solution (3 marks)
 - (ii) the molar absorptivity of KMnO_4 . (3 marks)

Question 5 (20 Marks)

- a) Draw a diagram showing the various parts of a Gas chromatography instrument (7 marks).
- b) Explain the following with respect to Liquid chromatography
 - i) Partition chromatography (2 marks)
 - ii) Adsorption chromatography (2 marks)
 - iii) Ion-exchange chromatography (2 marks)
 - iv) Size-exclusion chromatography (2 marks)
- c) Explain the concept of mass spectrometry (2 marks)
- d) What are the various applications of mass spectrometry (3 marks)