WI-2-60-1-6

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS 2025/2026

EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE IN MEDICAL CHEMISTRY

TPS 3104: SPECTROSCOPIC METHODS

DATE: DECEMBER 2025 **TIME: 3 HOURS**

Instructions: Answer any FOUR of the SIX questions

QUESTION ONE

(a) The concentration of Cu^{2+} in a sample is determined by reacting it with the ligand cuprizone and measuring its absorbance at 606 nm in a 1.00 cm cell. When a 5.00 mL sample is treated with cuprizone and diluted to 10.00 mL, the resulting solution has an absorbance of 0.118. A second 5.00 mL sample is mixed with 1.00 mL of a 20.00 mg/L standard of Cu^{2+}, treated with cuprizone and diluted to 10.00 mL, giving an absorbance of 0.162. Report the mg Cu^{2+}/L in the sample. (10 marks)

(b) Draw the ^1H NMR of methyl t-butyl ether. (6 marks)

(c) Write short notes on the following in regards to NMR spectroscopy:

- Chemical shift (3 marks)
- Shielding (3 marks)
- Spin-spin splitting (3 marks)

QUESTION TWO

a. Calculate the vibrational mode of propane. (2 marks)

b. A sample has a percent transmittance of 50%. What is its absorbance? (3 marks)

c. A compound with the molecular formula $C_4H_4O_2$ has a strong sharp absorbance near 3300 cm^{-1}, absorbances in the 2800–3000 cm^{-1} region, and a sharp absorbance peak near 2200 cm^{-1}. It also has a strong broad absorbance in the 2500–3600 cm^{-1} region and a strong peak in the 1710–1780 cm^{-1} region. Propose a possible structure for the compound. (10 marks)

d. Sketch a predicted proton NMR spectrum for ethanol, showing signals in the expected chemical shift ranges (based on Table 9.1 provided below) and with the appropriate number of peaks in each. (10 marks)

QUESTION THREE

a. Discuss Mass Spectroscopy based on ion production, ion analysis, structural Information from EI mass spectra and fragmentation patterns. (12 marks)

b. What components make up Liquid Chromatograpy-Mass Spectroscopy (LC-MS) and Gas-Chromatograpy-Mass Spectroscopy (GC-MS)? (10 marks)

c. What are the advantages of Double-Beam Spectrophotometer over a Single-Beam Spectrophotometer. (3 marks)

QUESTION FOUR

Name, discuss and provide examples of the four basic components of spectroscopic instruments.

(25 Marks)

(25 marks)

QUESTION FIVE

Discuss Beers Law, derive the equation $A = \varepsilon bC$ and provide the application of this law.
(25 marks)

QUESTION SIX

Discuss UV/Vis and IR spectrometry based on the following:

(a) The different components of the instruments (with illustrations). (15 marks)
(b) The advantages and disadvantages of the two methods of analysis. (5 marks)
(c) The applications of the two methods. (5 marks)