



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.
Tel: +254 (0)799529958, +254 (0)799529959, +254 (0)712524293
Website: www.must.ac.ke Email: info@must.ac.ke

University Examinations 2023/2024

FIRST YEAR, FIRST SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF
SCIENCE CHEMISTRY

SCH 7111: ANALYTICAL TECHNIQUES

DATE: DECEMBER 2023

TIME: 3 HOURS

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

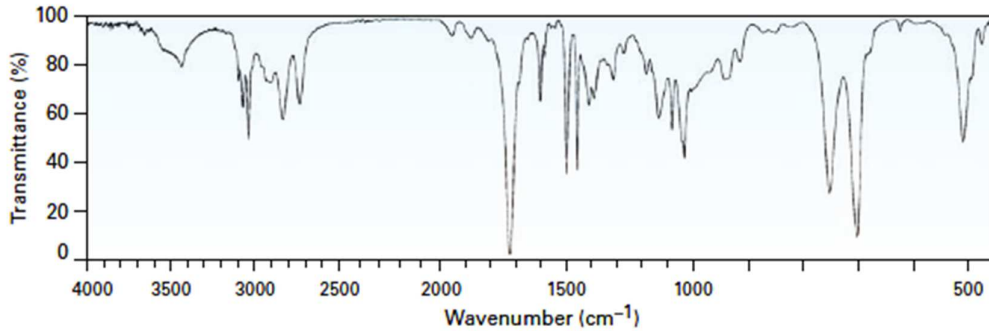
QUESTION ONE

- a) State whether the following instrumental methods of analysis could give you qualitative, quantitative or both. Also state whether the method is based on elemental or molecular analysis. (6 marks)

Method	Qualitative		Quantitative	
	Elemental	Molecular	Elemental	Molecular
Atomic absorption spectrometry				No
Atomic emission spectrometry				No
Capillary electrophoresis				Yes
Electrochemistry				Yes
Gas chromatography				Yes
ICP-mass spectrometry				No
Infrared spectroscopy				Yes
Ion chromatography				Yes
Liquid chromatography				Yes
Mass spectrometry				Yes
Nuclear magnetic resonance				Yes
Raman spectroscopy				Yes

- b) Draw a schematic block diagram of an FTNMR instrument (5 marks)
- c) Explain why spin-spin coupling occurs in NMR spectroscopy. (2 marks)
- d) What information does the COSY experiment provide? Explain how you interpret a COSY plot. (4 marks)

- e) Describe the principal behind the application of the instrumental methods of analysis listed below in qualitative molecular methods of analysis
- Infrared spectroscopy (IR) and Raman spectroscopy (3 marks)
 - Thermal analysis (TA) (3 marks)
- f) The IR spectrum of an unknown compound is shown below. What functional groups does the compound contain? (5 marks)



- g) List two applications of X-Ray spectroscopy (2 marks)

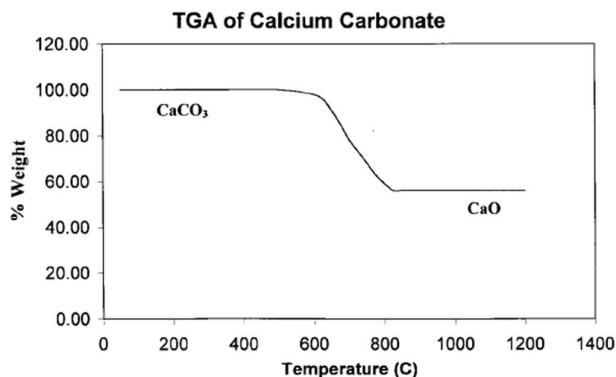
QUESTION TWO

- a) (i) What does a J coupling constant tell you? (2 marks)
- (ii) In an alcohol molecule with the formula C_2H_6O , protons B are coupled to the hydroxyl proton A with $J_{AB} = 5$, proton B is also coupled to proton C with $J_{BC} = 7$. Draw and explain the predicted splitting pattern for proton B. (8 marks)
- b) 2-methyl-3-pentanol does not undergo fragmentation via dehydration, but alpha cleavage fragmentations are observed. Show what fragments can you identify and draw a sketch spectrum of the compound. (5 marks)

QUESTION THREE

- a) Briefly describe three types of transitions that occur in most molecules, including the type of radiation involved in the transition. (9 marks)
- b) State the form of thermal analysis method you could apply to obtain results of a material for the following applications (4 marks)
- Glass transition
 - Stress relaxation
 - Viscoelastic properties
 - Thermal stability

- c) Heating $\text{CaCO}_3(\text{s})$ to $\text{CaO}(\text{s})$ and $\text{CO}_2(\text{g})$ at $850\text{ }^\circ\text{C}$ in TGA gives the following thermogram. If you start with $50\text{ g CaCO}_3(\text{s})$ calculate the percent mass loss due to CO_2 (2 marks)



QUESTION FOUR

- a) State three reasons why we use chromatography techniques (3 marks)
- b) Explain the following terminologies used in chromatography (4 marks)
- Elusion time
 - Retention factor
 - Eluate
 - Stationary phase
- c) Look at the IR spectra of 1-hexene, and 1-hexyne and hexane in figure (i) (ii) and (iii) below. Identify and explain which spectrum belongs to which compound (8 marks)

