



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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## University Examinations 2024/2025

### FIRST YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE MASTER OF SCIENCE IN CHEMISTRY

#### SCH 7111: ANALYTICAL TECHNIQUES

DATE: JANUARY 2025

TIME: 3 HOURS

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

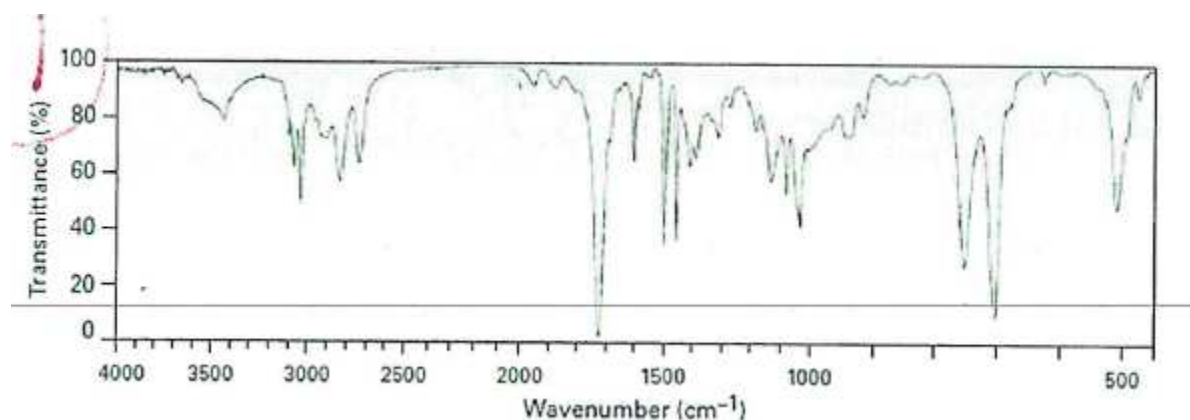
#### QUESTION ONE (30 MARKS)

- 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				
Atomic emission spectrometry				
Capillary electrophoresis				
Electrochemistry				
Gas chromatography				
ICP-mass spectrometry				
Infrared spectroscopy				
Ion chromatography				
Liquid chromatography				
Mass spectrometry				
Nuclear magnetic resonance				
Raman spectroscopy				

- b) Draw a schematic block diagram of an FTNMR instrument (5 marks)

- c) Explain why spin - spin coupling occurs in NMR spectroscopy. (5 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
- (i) Infrared spectroscopy (IR) and Raman spectroscopy (3 marks)
- (ii) 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)



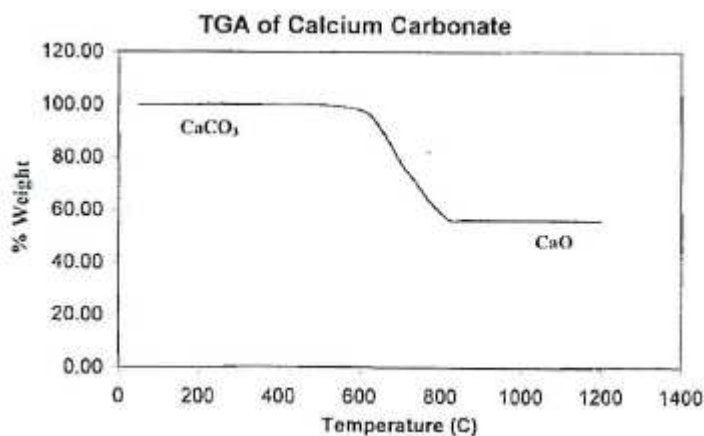
- g) List two applications of X-Ray spectroscopy (2 marks)

### QUESTION TWO (15 MARKS)

- 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 (15 MARKS)

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



#### QUESTION FOUR (15 MARKS)

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

