



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

**SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES**

**UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN  
BIOLOGICAL SCIENCES**

**4<sup>TH</sup> YEAR SEMESTER 2**

**2023/2024 ACADEMIC YEAR**

**REGULAR**

---

**COURSE CODE: SBB 1409**

**COURSE TITLE: PHYSICAL METHODS OF ANALYSIS**

**EXAMINATION VENUE:**

**EXAMINATION SESSION:**

**DATE OF EXAMINATION:**

**TIME: 2 HOURS**

---

**INSTRUCTIONS:**

- 1. Answer all questions in section A and any two questions in section B**
- 2. Candidates are advised not to write on question papers**
- 3. Candidates MUST hand in their answer booklets to the invigilator while in the examination rooms**

## SECTION A

### QUESTION 1 (30 MARKS)

- a) Describe the concept of spectroscopy as used in the identification of chemical analytes (3 marks)
- b) Using the general equation for radiation energies, illustrate the influence of radiation wavelength on the effective energy of interaction between radiations and matter (3 marks)
- c) Tabulate the various bands of the electromagnetic spectrum and the corresponding spectroscopic techniques applicable to chemical analysis (7 marks)
- d) Name and describe the three types of ions produced from a molecule sample subjected to Electron Impact Ionization (EI) mass spectrometry (6 marks)
- e) Differentiate between turbidometry and nephelometry (2 marks)
- f) Regarding chromatographic techniques of analysis, explain the meaning of the following terms;
  - i) Retention time (1 mark)
  - ii) Stationary phase (1 mark)
  - iii) Eluent (1 mark)
- g) Outline any two advantages of sedimentation techniques over spectroscopic techniques of chemical analysis (2 marks)
- h) Describe any two of the hyphenated techniques of chemical analysis (4 marks)

## SECTION B (40 MARKS)

### QUESTION 2: 20 MARKS

- a) What is mass spectroscopy? (2 marks)
- b) Discuss the three broad methods of ionization of samples applicable to mass spectroscopy (16 marks)
- c) Describe the working principle of the time-of-flight (TOF) mass spectrometers (2 marks)

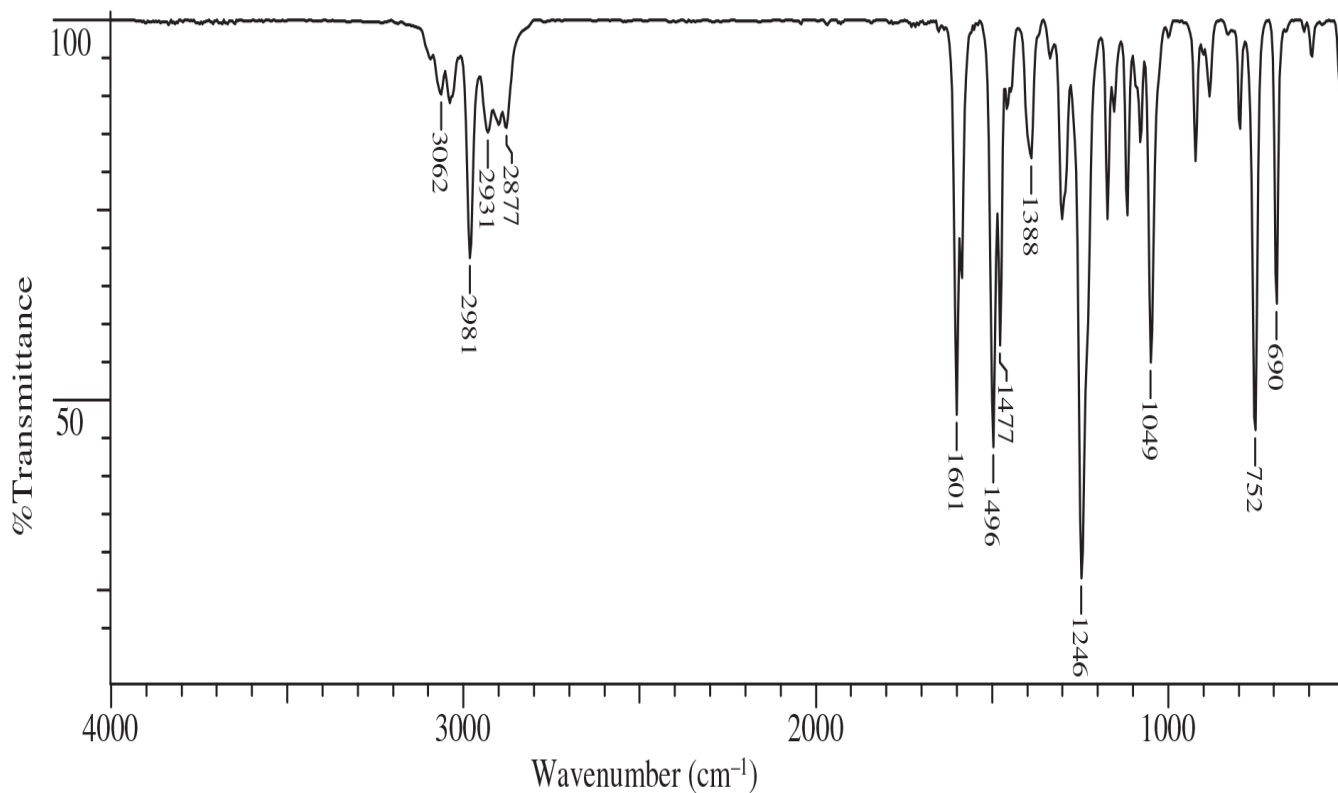
### QUESTION 3: 20 MARKS

- a) Describe the concept of infra-red (IR) spectroscopy (2 marks)
- b) Explain the effect of stretching and bending on the wavenumbers ( $\text{cm}^{-1}$ ) of organic molecules (2 marks)
- c) Give a reason why the molecules below may or may not show infrared absorption spectra: (8 marks)
  - (i) Ethane
  - (ii) Chloromethane
  - (iii) Nitrogen
  - (iv) Nitrobenzene
- d) A table of characteristic group absorptions is listed in Table 1 below. Use the information to study the attached Chart 1 and list all the functional groups that are present and absent. (8 marks)

Table 1:

Bond type	Absorption region (cm <sup>-1</sup> )
C - O	1300 – 800
C - C	1300 – 800
C - N	1250 – 1000
C = C (Double bond)	1900 – 1500
C = O	1850 – 1600
C ≡ C (Triple bond)	2150 – 2100
C - D (Deuterium)	2250 - 2080
C - H	3000 - 2850
O - H	3800 - 2700

Chart 1



#### QUESTION 4: 20 MARKS

- a) Differentiate between chromatography and nuclear magnetic resonance techniques of sample analysis (2 marks)
- b) Briefly describe the following chromatographic methods: (8 marks)
- (i) Paper chromatography
  - (ii) Thin layer chromatography
  - (iii) Gas chromatography
  - (iv) Ion exchange chromatography
- c) State and explain any two applications of chromatographic methods of sample analysis (4 marks)
- d) Explain the effect of the following aspects on the NMR coupling constants: (4 marks)
- (i) Solvents
  - (ii) Frequency of the NMR
- e) Explain the following terms as used in NMR spectroscopy: (2 marks)
- (i) Chemical shift
  - (ii) Multiplicity

**END**