



# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

*Faculty of Applied & Health Sciences*

DEPARTMENT OF PURE AND APPLIED SCIENCES

**DIPLOMA IN SCIENCE LABORATORY TECHNOLOGY (DSL09J)**

END OF SEMESTER EXAMINATION

**ACH 2310: INSTRUMENTATION III**

**SERIES: AUGUST/SEPTEMBER 2011**

**TIME: 2 HOURS**

**Instructions to Candidates:**

You should have the following for this examination

- *Answer booklet*

This paper consists of **FIVE** questions. Answer question **ONE (COMPULSORY)** and choose any other **TWO** questions

This paper consist of **FOUR** printed pages

$$H = 6.62 \times 10^{-34} \text{ J/s}$$

### QUESTION ONE (COMPULSORY)

- a) (i) Explain the term chromatography (2 marks)
- (ii) How are the flow rates achieved in HPLC? (1 mark)
- b) State **THREE** conditions that a sample cell should fulfill for analysis in NMR spectroscopy (3 marks)
- c) Give three reasons why HPLC is a better tool than GLC (3 marks)
- d) Explain the principle of mass spectroscopy (3 marks)
- e) State **THREE** ways in which the efficiency of the column can be improved in chromatography (3 marks)
- f) In gas chromatographic separation of benzene, toluene and xylene, the area under peak was noted to be  $31.0 \text{ cm}^2$ ,  $14.5 \text{ cm}^2$  and  $53.2 \text{ cm}^2$ , respectively. Calculate the percentage composition of the sample (3 marks)
- g) State the **THREE** major classes of chromatographic separation (3 marks)
- h) The frequency of radio waves lies between  $10^1$  and  $10^7 \text{ cm}$ . Calculate the maximum energy of the radio frequency (rf) radiation (3 marks)
- i) State any **THREE** types of ions produced in a mass spectrometer (3 marks)
- j) Give **THREE** reasons why TMS is used as internal standard in NMR (3 marks)

### QUESTION TWO

- a) List the main components of a mass spectrometer (7 marks)
- b) State **THREE** advantages of mass spectroscopy over other analytical methods. (3 marks)
- c) Give any **FIVE** applications of mass spectroscopy (5 marks)
- d) In the following mass spectrum of methane, identify species A – E (5 marks)

## Absorbance

### QUESTION THREE

- a) Explain the principle of NMR (2 marks)
- b) Identify all the symbols in the equation below which provides the quantum description of
- $$M = Y \times [I(I + 1)]^{1/2} \cdot \frac{h}{2\pi}$$
- NMR: (4 marks)
- c) State the main components of an NMR instrument (5 marks)
- d) Give **FOUR** important features of the magnet used in NMR (4 marks)
- e) Explain why the oscillator coil has to be wound perpendicular to the magnetic field (2 marks)
- f) State **TWO** phenomena that occur when radio frequency radiation is passed through the magnetized sample. (2 marks)
- g) State most common material used to make the sample holder in NMR (1 mark)

### QUESTION FOUR

- a) Explain **FIVE** causes of band broadening in chromatography (5 marks)
- b) Define the following terms as used in chromatography
- (i) Elution
  - (ii) Retention time (4 marks)
- c) Briefly explain the principle behind the following:
- (i) Adsorption chromatography
  - (ii) Partition chromatography (4 marks)
- d) Differentiate between gas-liquid chromatography and gas-solid chromatography (2 marks)
- e) State **THREE** factors that are affected by the vacuum pumps in HPLC (3 marks)
- f) Give **TWO** most common packing materials in chromatography (2 marks)

### QUESTION FIVE

- a) State the role of each of the following components of a high performance liquid chromatography instrument:
- (i) Pre-column
  - (ii) Vacuum pump (2 marks)
- b) List **FOUR** requirements for the pumps used in high performance liquid chromatography (4 marks)
- c) Differentiate between isocratic and gradient elution (2 marks)
- d) Substances A and B have retention times of 16.40 and 17.63 minutes respectively on a 30.0 cm column. An unretained species passes the column in 1.30 minutes. The peak widths for A and B are 1.11 and 1.21 minutes, respectively. Calculate
- (i) The column resolution (2 marks)
  - (ii) Average number of theoretical plates (4 marks)
  - (iii) The plate height (2 marks)
  - (iv) The selectivity factor for species A and B (4 marks)