



# 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**

ACH 2320: INSTRUMENTATION III

**END OF SEMESTER EXAMINATION**

**SERIES: DECEMBER 2011**

**TIME: 3 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 any other two questions

Maximum marks for each part of a question are clearly shown

This paper consist of **THREE** printed pages

$$h = 6.62 \times 10^{-34} \text{J/S}$$

### Question one

- a) State any **THREE** applications of HPLC? (3 marks)
- b) State **THREE** conditions that a sample cell should fulfill for analysis in NMR spectroscopy (3 marks)
- c) Give **THREE** reasons why inorganic stationary supports are superior for use in HPLC (3 marks)
- d) Explain the principle of mass spectroscopy (3 marks)
- e) State **THREE** processes that cause band broadening in chromatography (3 marks)
- f) In gas chromatographic separation of benzene, toluene and xylene, the area under peak was noted to be 51.0, 15.5 and 28.2 cm<sup>2</sup>, respectively. Calculate the percentage composition of the sample (3 marks)
- g) State **THREE** most common pumps used in HPLC (3 marks)
- h) The frequency of radio waves lies between  $10^1$  and  $10^7$ cm. Calculate the maximum energy of the radio frequency (rf) radiation (3 marks)
- i) Explain what happens in an ion analyzer in mass spectrometer, and give two qualities of a good analyzer (3 marks)
- j) Explain why TMS is commonly used as internal standard in NMR (3 marks)

### Question two

- a) Outline the processes that take place in an ionization chamber in mass spectrometer (5 marks)
- b) Explain how a parent peak is produced in mass spectrum (3 marks)
- c) Draw a simple mass spectrum of methane (5 marks)
- d) State any **TWO** types of detectors employed in a mass spectrometer (2 marks)

### Question Three

- a) Explain the principle of NMR (3 marks)
- b) Explain briefly what takes place in a sweep generator in an NMR (4 marks)
- c) Give **FOUR** important features of the magnet used in NMR (4 marks)
- d) Explain how is maximum interaction of the radio frequency radiation with the sample achieved. (2 marks)
- e) Define the term 'state of resonance' of a nucleus as used in NMR (2 marks)

### Question Four

- a) Define the following terms as used in chromatography:
- (i) Resolution
  - (ii) Retention time
- (4 marks)
- b) State **FIVE** points to consider when choosing mobile phase solvents. (5 marks)
- c) Give any **FOUR** applications of HPLC (4 marks)
- d) State **TWO** main advantages of reciprocating pumps used in HPLC (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) Explain why chemically bounded supports are superior for use in HPLC (2 marks)
- c) Substances A and B have retention times of 18.40 and 21.63 minutes respectively on a 30.0cm column. An unretained species passes the column in 1.30 minutes. The peak widths for A and B are 2.13 and 2.27 minutes, respectively. Calculate:
- (i) Average number of theoretical plates (4 marks)
  - (ii) The plate height (2 marks)
  - (iii) The selectivity factor for species A and B (5 marks)