



Technical University of Mombasa

Faculty of Applied and Health Sciences

DEPARTMENT OF **PURE AND APPLIED SCIENCES**

DIPLOMA IN ANALYTICAL CHEMISTRY

(DAC 12S)

ACH 2209: INSTRUMENTAL METHODS OF ANALYSIS I

SPECIAL/SUPPLEMENTARY: EXAMINATIONS

SERIES: OCTOBER 2013

TIME: 2 HOURS

INSTRUCTIONS:

You should have the following for this paper

- *Answer booklet*

This paper consists of **FIVE** questions.

Answer Question **ONE (compulsory)** and any other **TWO** questions

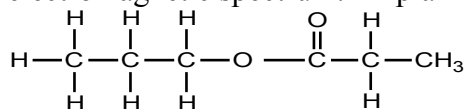
This paper consists of 4 PRINTED pages

Question ONE

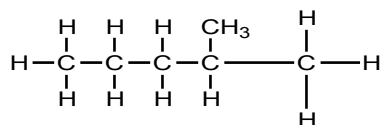
- a) Using suitable examples where possible briefly discuss each of the following
- (i) Dual properties of electromagnetic radiation
 - (ii) Interferometer wavelength selector
 - (iii) The display unit in a spectrophotometer
 - (iv) Resolution of spectra
 - (v) Spectroscopy
- (10marks)**
- b) Differentiate between
- (i) Absorbance and emission spectrum **(4marks)**
 - (ii) Hume and plasma sources of thermal energy **(4marks)**
- c) Describe the preparation and use of a calibration curve for UV/Vis analysis **(7marks)**
- d) The wavelength of sodium D line is 589nm. Determine the frequency and energy of this radiation? ($c = 3.0 \times 10^8 \text{ m/s}$, $h = 6.63 \times 10^{-34} \text{ J.s}$ and $1 \text{ nm} = 1.0 \times 10^{-9} \text{ m}$). **(5marks)**

Question TWO

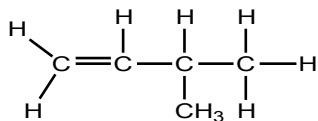
- a) Some molecules absorb electromagnetic radiation in the UV/Vis region of the electromagnetic spectrum.
- (i) Define UV/Vis spectroscopy and explain what process goes on in a molecule when it absorbs UV/Vis radiation. **(5marks)**
 - (ii) From the list below select the molecules that will absorb light in the UV/Vis region of the electromagnetic spectrum. Explain your choice



A



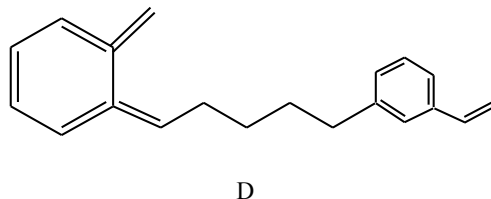
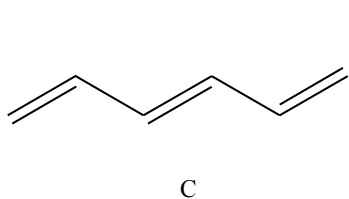
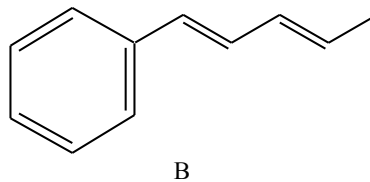
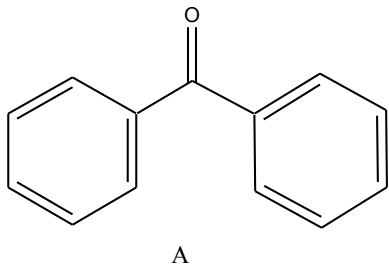
B



C

(4marks)

b) The following molecules absorb UV/Vis radiation. Study them and answer the questions that follow:



- (i) Identify the number of conjugated double bonds in each of the molecules labelled A to D **(4marks)**
- (ii) Rank the molecules in order of increasing wavelength of absorption of UV/Vis radiation. **(4marks)**
- (iii) Explain why an increase in conjugation increases the wavelength of absorption of UV/Vis radiation **(3marks)**

Question THREE

a) The relationship between incident and transmitted radiation during spectrophotometric analysis is given by Beer – Lambert law. Beer-Lambert law can simply be written as

$$\text{Log} \left(\frac{I_0}{I} \right) = A = \epsilon C l$$

- i) Define the terms I_0 , I , A , ϵ , C and l in the Beer-Lambert **(6marks)**
 - ii) State Beer-Lambert law and give its mathematical representation **(3marks)**
- b) Discuss the working principle of the following photo-detectors.
- (i) Photo – tube **(4marks)**
 - (ii) Photo-multiplier tube **(7marks)**

Question FOUR

Discuss the use of the following wavelength selectors for a given spectrophotometer.

- (i) Filters **(4marks)**
- (ii) Prism Monochromator **(6marks)**
- (iii) Diffraction grating monochromators **(10marks)**

Question FIVE

- a) Explain the difference between
- (i) Absorption and emission spectroscopy **(4marks)**
 - (ii) Continuum and line sources of electromagnetic radiation **(4marks)**
 - (iii) Classical and instrumental methods of analysis **(4marks)**
- b) A UV/Vis spectrophotometric determination of copper II sulphate concentration in an unknown sample was done at 635nm. The following data was obtained using standard copper II sulphate solutions

| <i>Concentration (PPM)</i> | <i>Absorbance</i> |
|----------------------------|-------------------|
| 1 | 0.03 |
| 2 | 0.07 |
| 5 | 0.15 |
| 7 | 0.22 |
| 9 | 0.25 |
| 10 | 0.31 |

If the unknown copper II sulphate sample gave an absorbance of 0.11, draw a calibration curve and determine its concentration. **(8marks)**