2915/302
INSTRUMENTATION METHODS II
AND BIOCHEMISTRY
Oct./Nov. 2022
Time: 4 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ANALYTICAL CHEMISTRY

MODULE III

INSTRUMENTATION METHODS II AND BIOCHEMISTRY

4 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
        Answer booklet;
        Non-programmable scientific calculator.
This paper consists of TWO sections; A and B.
Answer ALL questions in section A and any THREE questions from section B.
Each question in section A carries 4 marks while each question in section B carries 20 marks.
Maximum marks for each part of the question are indicated.
Candidates should answer the questions in English.

This paper consists of 6 printed pages.

Candidates should check the question paper to ascertain that
all the pages are printed as indicated and that no questions are missing.

Turn over

SECTION A (40 marks)

Answer ALL the questions in this section.

1. Explain two limitations of IR spectroscopy as a method of analysis. (4 marks)

2. (a) State two reasons for purging samples of dissolved air before analysis by HPLC. (2 marks)

   (b) State how the samples in (a) above are purged of dissolved air. (2 marks)

3. Calculate the wave number of the C-C bond in ethane if the force constant = 4.5×10^5 dymes/cm. (C = 12 N = 6.023×10^{23}). (4 marks)

4. State two advantages of:

   (a) HPLC over GLC;

   (b) GLC over HPLC. (4 marks)

5. Define he following terms as used in UV-visible spectrophometry:

   (a) bathochromic shift;

   (b) hypsochromic shift;

   (c) hyperchromism;

   (d) hypsochromism. (4 marks)

6. List four characteristics of the mobile liquid phase used in HPLC. (4 marks)

7. Name any four types of bases in anucleic acid. (4 marks)

8. (a) List the **two** main classifications of vitamins.   (2 marks)

    (b) State the functions of the following vitamins:

         (i)   thiamine
         (ii) vitamin E   (2 marks)

9. State the functions of the following enzymes.

    (a) oxidoreductases;

    (b) transferases;

    (c) ligases;

    (d) hydrolases.   (4 marks)

10. State **four** chemical interferences encountered in UV-visible spectroscopy.   (4 marks)

SECTION B (60 marks)

Answer THREE questions from this section.

11. (a) Explain **five** advantages of UV-visible spectroscopy over atomic spectroscopic
         instrument.   (10 marks)

    (b) List **four** methods of sampling solids in infrared spectroscopy.   (4 marks)

    (c) The RMM of an organic compound is 406 and its absorption coefficient is 260, and its
         absorbance is 1.25. Calculate the molar absorptivity of this compound.   (6 marks)

12. (a) (i)   Define the term green chemistry.   (2 marks)

         (ii) Explain **five** goals of green chemistry.   (10 marks)

    (b) (i)   Describe the preparation of 250 cm^3 of a solution of sodium carbonate whose
               concentration is 100 ppm with respect to sodium.   (4 marks)

         (ii) 50 ppm solution of manganese gives an AAS signal of 20.0 percent
               transmittance. Calculate the sensitivity of the instrument for manganese
               Mn = 55.   (4 marks)

13. (a) State **three** disadvantages of gas liquid chromatography as a separation method.

(4 marks)

(b) The results in table 1 were obtained in an experiment to calibrate an atomic absorption instrument by the standard series method.

Table I

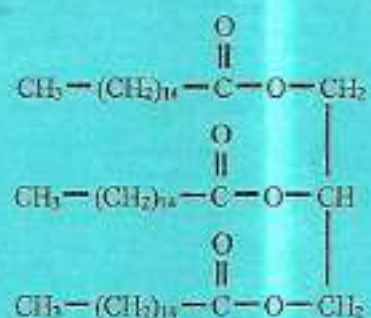| Concentration of standards in ppm	0	100	200	300	400	500
Instrumental response	20	45	69.5	101	120	141

(i) Plot the appropriate calibration graph.

(8 marks)

(ii) Use the graph obtained in (i) above to estimate the analyse concentration of a sample that produced an instrumental response of 85 units after tenfold pre concentration.

(2 marks)

(c) Two solutes A and B were analysed by HPLC and their retention times were 2.80 and 3.95 minutes respectively, while the solvent passed through the column in 1.15 minutes. The base widths for the solutes were 1.90 and 1.30 minutes respectively. The column length was 95 cm. Calculate:

(i)   resolution   (2 marks)
(ii) mobile flow rate   (1 mark)
(iii) column efficiency   (1 mark)
(iv) plate height   (2 marks)

14. (a) Draw the structures of each of the following fatty acids:

(i) $14:1 \triangle^8$
(ii) $5:1 \triangle^2$
(iii) $16:1 \triangle^{9,12}$
(iv) $18:2 \triangle^{7,11}$

(4 marks)

(b) For each of the fatty acids in (a) above, give their systematic names.   (4 marks)

(c) (i) Name the types of fatty acids that are classified as essential and give a reason.

(3 marks)

(ii)   State how our bodies obtain the essential fatty acid.   (1 mark)

(d)   (i)   Draw the structures of the products that are formed when the triglyceride shown below is hydrolyzed using each of the following .

(I)   aqueous H_2SO_4 (2 marks)
(II)   aqueous NaOH   (2 marks)

$$CH_3-(CH_2)_{14}-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-O-CH_2$$

$$CH_3-(CH_2)_{14}-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-O-CH$$

$$CH_3-(CH_2)_{14}-\overset{\displaystyle O}{\overset{\displaystyle \|}{C}}-O-CH_2$$

(ii)   Name the structures in d(i) above.   (2 marks)

(e)   Complete the following reactions.

(i)   Oleic acid + H_2 $\xrightarrow{\text{Nickel}}$

(ii)   Oleic acid + $KMnO_4$ $\xrightarrow[\text{Condition}]{\text{Mild}}$

                                                                                                (2 marks)

15. (a) (i) Outline the steps required to locate the positions of the amino acids on a TLC plate and how to calculate their Rf values. (4 marks)

(ii) Explain why amino acids have different Rf values. (2 marks)

(b) The curve below shows the effect of temperature on the activity of a typical enzyme. Use it to answer questions below.
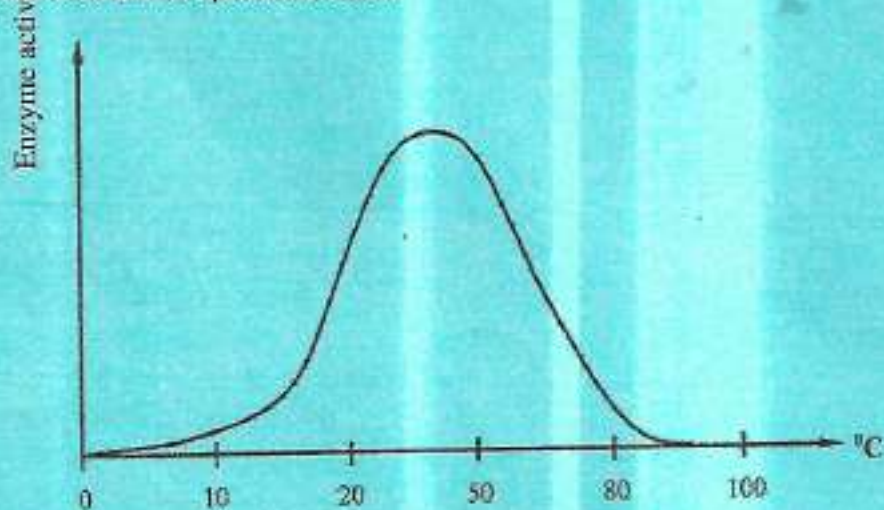
(i) Explain the gradual increase of enzymes activity from 0°C to about 50°C. (2 marks

(ii) Explain the sharp drop of enzymes activity after 50°C. (2 marks)

(c) (i) Define the term electrophoresis technique. (2 marks)

(ii) List **four** factors that the rate of migration of ions in electrophoresis depends on. (4 marks)

(iii) Differentiate the **two** types of electrophoresis techniques. (4 marks)

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