2411/304
CHEMICAL ANALYTICAL METHODS
AND BIOCHEMISTRY
Oct./Nov. 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ANALYTICAL CHEMISTRY

CHEMICAL ANALYTICAL METHODS AND BIOCHEMISTRY

3 hours

INSTRUCTIONS TO CANDIDATES

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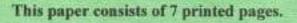*Non-programmable scientific calculator;*
Answer booklet.
This paper consists of TWO sections; A and B.
Answer ALL the questions in section A and any THREE questions from section B in the answer booklet provided.
Each question in section A carries 4 marks while each question in section B carries 20 marks.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

This paper consists of 7 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. (a) State the meaning of the term "sample blank" as used in titrimetry.   (2 marks)

    (b) Explain why a sample blank is used in titrimetry.   (2 marks)

2. List any **four** ways of minimising errors in titrimetry.   (4 marks)

3. (a) Explain why the concentration of any hydrogen peroxide sample as indicated on the label is said to be nominal.   (3 marks)

    (b) Describe a qualitative test that must be carried out before any sample of hydrogen peroxide is used.   (1 mark)

4. (a) Define "gravimetric factor" as used in gravimetry.   (1 mark)

    (b) Calculate the gravimetric factor of aluminium in Aluminium Sulphide.

    ($Al = 27, S = 32$).   (3 marks)

5. Explain any **two** advantages of gravimetry as a method of analysis.   (4 marks)

6. Describe a method of extracting caffeine from tea leaves using water and chloroform as solvents.   (4 marks)

7. (a) Draw a labelled diagram of a sintered glass funnel.   (2 marks)

    (b) Give any **two** types of separations in which sintered glass funnel is used.   (2 marks)

8. Match each of the following structural characteristics to either polysaccharides, amylopectin, amylose, glycogen, cellulose or chitin.

    A. Contains both $\alpha\,(1 \to 4)$ and $\alpha\,(1 \to 6)$ glycosidic linkages.
    B. Polymer chain is unbranched.
    C. Glucose derivatives are present in the polymer chain.
    D. Contains only $\beta\,(1 \to 4)$ glycosidic linkages.   (4 marks)

9. State the difference in meaning, if any, between the members of each of the following pairs of terms:

    A. Triacylglycerol and fat.   (2 marks)

    B. Triacylglycerol and mixed triacylglycerol.   (2 marks)

10. Predict the direction of movement of each of the following amino acids in a solution at the pH value specified under the influence of an electric field:

A. Alanine at pH   12.0
B. Valine at pH   5.97
C. Aspartic acid at pH 1.0
D. Arginine at pH   13.0

(4 marks)

SECTION B (60 marks)

*Answer any **THREE** questions from this section.*

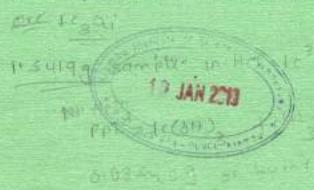11. (a) State the law of conservation of mass as used in gravimetry. (1 mark)

    (b) An ore containing magnetite, Fe_3O_4, was analysed by dissolving a 1.5419 g sample in concentrated HCl, giving a mixture of Fe^{3+} and Fe^{2+}. HNO_3 was then added and the resulting solution was diluted with water and all iron was precipitated as $Fe(OH)_3$ by adding $NH_{3(aq)}$. After filtering and rinsing, the residue was ignited giving 0.8525 g of pure Fe_2O_3.

        (i) Explain why HNO_3 was added. (3 marks)

        (ii) Explain why precipitation of $Fe(OH)_3$ was effected using $NH_{3(aq)}$ and not $NaOH_{(aq)}$. (4 marks)

        (iii) Calculate the percentage w/w of Fe_3O_4 in the sample. (12 marks)

12. The data in table I was obtained in a precipitation titration of Nacl with 0.10 M $AgNO_3$.

Table I

Volume of $AgNO_3$ added in cm^3	P^{Ag^+}
0.00	-
5.00	8.31
10.00	8.14
15.00	7.93
20.00	7.60
25.00	4.89
30.00	2.20
35.00	1.93
40.00	1.78
45.00	1.68
50.00	1.60

(a) Define:

    (i) pH; (1 mark)

    (ii) P^{Ag^+}. (1 mark)

(b) Explain how the end-point for this titration can be visually determined. (5 marks)

(c) Explain **three** advantages of the precipitation method used to determine the end-point in this titration. (3 marks)

(d) Plot a graph of P^{Ag^+} against volume of $AgNO_3$ added and use it to determine the molarity of the halite solution for an aliquot of $50\,cm^3$. (10 marks)

13. (a) Name **two** types of filter papers which are used in:
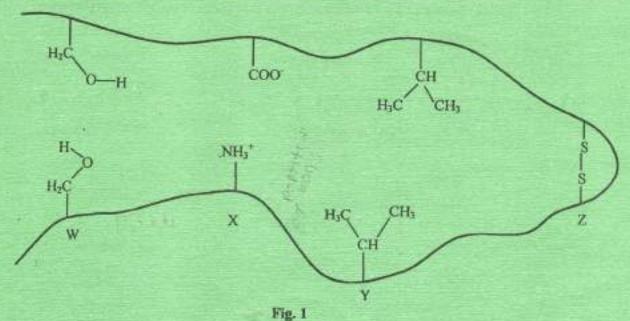
    (i) qualitative analysis; (2 marks)

    (ii) quantitative analysis. (2 marks)

(b) Name **four** grades of filter papers used in filtration processes. (4 marks)

(c) Explain **four** criteria used to select a filter paper for a filtration process. (8 marks)

(d) State **four** advantages of sintered glass crucibles as used in filtration. (4 marks)

14. (a) Figure 1 shows a section of a polypeptide chain with some side chains of amino acids which can be involved in maintaining the tertiary protein structure.

Fig. 1

(i) Identify the type of bonding or attraction involved at each of the sites W, X, Y and Z. (4 marks)

(ii) Indicate the site in the diagram where the bonding is likely to be weakest. (1 mark)

(iii) With reason(s), identify the site which will most likely be affected by a change of pH from 7.0 to 10.0. (3 marks)

(b) Using two molecules of glycine, illustrate how amino acids are linked in a dipeptide. (2 marks)

(c) (i) Draw the structure of tristearin. (1 mark)

(ii) Tristearin can be hydrolysed by heating with aqueous sodium hydroxide. Write a complete balanced equation for this reaction. (2 marks)

(iii) Determine the mass of soap that could be produced from 1000 g of tristearin. (4 marks)

(iv) Explain why compounds such as tristearin are soluble in non-polar solvents such as hexane. (3 marks)

15. (a) Gelatin is a protein which is used for making jelly. The hydrolysis of gelatin is catalysed by the enzyme papain, from pineapple. In an experiment, the rate of hydrolysis of gelatin using papain was measured at different temperatures and the results are shown in the table II below:

Table II

Temperature °C	Relative Rate of Reaction
10	1.0
15	1.2
20	1.6
25	3.2
30	4.9
35	4.8
40	1.6

(i) Plot a graph of relative rate of reaction against temperature. (5 marks)

(ii) Use the graph to predict the optimum temperature for papain. (1 mark)

(iii) Explain what is happening to the enzyme above the optimum temperature. (3 marks)

(iv) Suggest one advantage and one disadvantage of adding papain to washing powder. (2 marks)

(b) (i) Explain why the notation ser - cys and cys - ser represent two different molecules rather than one molecule. (2 marks)

(ii) Identify the amino acids contained in the following peptide:

$$H_3N - \underset{\underset{\underset{OH}{|}}{\underset{CH_2}{|}}}{CH} - \underset{O}{\overset{O}{\underset{||}{C}}} - \underset{H}{\overset{H}{\underset{|}{N}}} - \underset{\underset{CH_3}{|}}{CH} - \underset{O}{\overset{O}{\underset{||}{C}}} - \underset{H}{\overset{H}{\underset{|}{N}}} - \underset{\underset{\underset{SH}{|}}{\underset{CH_2}{|}}}{CH} - COO^-$$

(3 marks)

(c)   Indicate whether each of the following phrases describes a simple or a conjugated enzyme.

(i)   an enzyme that has both protein and a non-protein portion;

(ii)   an enzyme that requires Mg^{2+} ions for activity;

(iii)   an enzyme in which only amino acids are present;

(iv)   an enzyme in which a cofactor is present.   (4 marks)

THIS IS THE LAST PRINTED PAGE.