2915/105
PHYSICAL CHEMISTRY I AND CHEMICAL ANALYTICAL METHODS I
Oct./Nov. 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ANALYTICAL CHEMISTRY

MODULE I

PHYSICAL CHEMISTRY I AND CHEMICAL ANALYTICAL METHODS I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Scientific calculator.
This paper consists of TWO sections; A and B.
Answer ALL questions in section A and 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 a question are indicated.
Candidates should answer the questions in English.

This paper consists of 4 printed pages.

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

SECTION A (40 marks)

Answer ALL the questions in this section.

1. Name **four** methods of storing samples in a chemistry laboratory. (4 marks)

2. 50.00 cm^3 of 0.2 M EDITA solution was mixed with 18.50 cm3 of copper (II) $Cu^{2+}_{(aq)}$, solution. The excess EDTA was back-titrated with 3.20 cm^3 of 0.005 M $CuSO_{4(aq)}$. Calculate the molarity of the copper(II) ions in the sample. (4 marks)

3. State **four** applications of ionic equilibria in industry. (4 marks)

4. The K_{sp} of a salt A, is 1.8×10^{-18} and that of a salt B is 3.9×10^{-21}. The formulae of A and B are M_2n_3 and X_3Y respectively. Determine which of the two salts has a higher solubility in water. (4 marks)

5. (a) Define the term alkalimetry as used in acid base titrations. (1 mark)

   (b) Identify **three** primary standards used in alkalimetry. (3 marks)

6. Calculate the pH of 0.08 M benzoic acid.
   (pKa = 4.2) (4 marks)

7. (a) Define the term buffer as used in both acids and bases. (1 mark)

   (b) State **three** applications of buffers in industry. (3 marks)

8. Describe the preparation of 100.00 cm^3 of concentration 200 ppm with respect to aluminium using AR aluminium sulphate by the method of direct weighing. (4 marks)

9. (a) Define the term colligative property of solutions. (1 mark)

   (b) When 0.6 g of an organic solute was dissolved in 180 g of water, the boiling point of the solution was 100.8°C. $(K_b = 5.2\,Jmol^{-1}K^{-1})$. Calculate the molecular weight of the organic solute. (3 marks)

10. The concentrations in table I are for sodium chloride in mg/100 g obtained during analysis of rock-salt samples from different sites along Kenya's coastline.

Table I

Sample	Concentration of $NaCl$
1	80.2
2	92.1
3	95.8
4	98.2
5	73.8
6	60.9

Calculate the mean concentration of sodium chloride $(NaCl)$ in the rock-salt samples. (4 marks)

SECTION B (60 marks)

Answer any THREE questions from this section.

11. (a) Name **four** types of EDTA titrations. (4 marks)

(b) State **four** methods of increasing selectivity in EDTA titrations. (4 marks)

(c) A 25.00 cm³ sample of a liquid bleaching agent was diluted to 1000.00 cm³ in a volumetric flask. A 25.00 cm³ aliquot of the diluted sample was treated with excess of acidified potassium iodide, $KI_{(aq)}$, oxidizing the ^{-}OCl to Cl^{-} and producing $I_{3(aq)}^{-}$. The liberated tri-iodide ion, $I_{3(aq)}^{-}$ was determined by titration with 0.09892 M $Na_2S_2O_3$ solution, requiring 8.96 cm³ to reach the starch end-point. Report the % w/v of $NaOCl$ in the sample of the liquid bleaching agent.
$(NaOCl = 74.5)$ (12 marks)

12. (a) (i) Draw a labelled diagram of the apparatus used in determining the elevation of boiling point of a solution. (8 marks)

(ii) Describe how the elevation of boiling point is determined. (4 marks)

(b) When 0.535 g of $NaCl$, was dissolved in 100 g of water, the boiling point of the solution 100.38°C.
$(K_b = 5.2\,J\,mol^{-1}k^{-1})$

(i) Calculate the formula mass of $NaCl$. (4 marks)

(ii) Account for the value obtained in (b)(i) above.
$(Na = 23, Cl = 35.5)$ (4 marks)

13. (a) Derive the equation for the solubility product of aluminium sulphide. (7 marks)

(b) The solubility product of aluminium sulphide is 2.0×10^{-71}. Calculate the solubility of aluminium sulphide in:

(i) water; (4 marks)
(ii) 0.1 M Na_2S; (4 marks)
(iii) 0.1 M $Al_2(SO_4)_3$ (4 marks)

(c) Explain why the value in (b)(i) is higher thatn the values obtained in (b)(ii) and (b)(iii). (1 mark)

14. The values in table **II** are the amounts of iron in mg/ 1000 g in iron ores sampled from ten sites in **Kitui County**. Study it and answer the questions that follow.

Table II

Name of mining site	Concentration of iron in mg/ 1000 g
KITUTI	742.5
IKUTHA	694.8
ENDAU	898.2
KYUSO	901.1
KAKUMUTI	243.5
KWA SIKU	346.9
MATINYANI	769.8
NGUNI	902.1
NGOMENI	721.2
KATSE	692.4

Calculate:

(a) mean concentration of iron in the iron ore samples; (4 marks)
(b) standard deviation of the concentration of iron in the iron ore samples. (16 marks)

15. An aqueous solution of sodium acetate turns litmus paper blue.

(a) Write an equation which shows how the base is produced. (1 mark)
(b) Write an expression for the hydrosis constant K_h for the salt. (1 mark)
(c) Derive an expression relating K_h, the ionic product of water Kw and the ionization constant of acetic acid, Ka. (5 marks)
(d) If $pKa = 4.75$ and $pKw = 14$ determine K_h of the salt. (4 marks)
(e) Calculate the pH of 0.002 M CH_3COONa from first principles. (9 marks)

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