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**ENVIRONMENTAL ANALYTICAL TECHNIQUES
AND LABORATORY MANAGEMENT**

June/July 2020

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY

MODULE II

ENVIRONMENTAL ANALYTICAL TECHNIQUES AND LABORATORY MANAGEMENT

3 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 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 as 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 questions in this section.

1. Explain the significance of using a fluted filter paper in performing hot filtrations. (4 marks)
2. Draw a labelled experiential set-up of an oil bath that can be used to extract a substance from a mixture at 180°C using Silicone oil, 50 mL round bottomed flask, heating mantle, aluminium pan and clamp. (4 marks)
3. Outline four steps used in purifying a compound by recrystallization method. (4 marks)
4. (a) Define multi-stage solvent extraction. (2 marks)
(b) Write a mathematical expression for the distribution coefficient, k_D , of a solute A between benzene and water. (2 marks)
5. (a) Differentiate between paper chromatography and thin layer chromatography with respect to their stationary phases. (2 marks)
(b) Explain the importance of retardation factor, R_f , in paper chromatography. (2 marks)
6. Match the acid-base titration with the appropriate indicators shown in table I. (4 marks)

Table I

Acid-base titration	Indicator
- $CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(l)}$	- Bromothymol blue
- $H_2SO_{4(aq)} + KOH_{(aq)} \rightarrow K_2SO_{4(aq)} + H_2O_{(l)}$	- Methyl orange
- $HCl_{(aq)} + NH_4OH_{(aq)} \rightarrow NH_4Cl_{(aq)} + H_2O_{(l)}$	- Phenolphthalein
- $H_2SO_{4(aq)} + NaOH_{(aq)} \rightarrow Na_2SO_{4(aq)} + H_2O_{(l)}$	- Bromothymol blue

7. List four features that makes management a science. (4 marks)
8. State four uses of an organization chart in a learning institution. (4 marks)
9. Compare centralized and decentralized purchase system in an organization with respect to:
 - (a) promptness in sourcing materials; (2 marks)
 - (b) standardization of purchased materials. (2 marks)

10. State **four** benefits of the numerical classification filing system. (4 marks)

SECTION B (60 marks)

Answer any THREE questions from this section.

11. (a) Outline the steps used in preparing a fluted filter paper. (5 marks)
- (b) Draw a labelled experimental set-up used in filtering a precipitate from solution using Buchner flask, cork, buchner funnel, filter paper and suction pump. (8 marks)
- (c) (i) Explain **three** size requirements of a filter paper used in vacuum filtration. (3 marks)
- (ii) Draw a labelled diagram describing a set-up for separating a small quantity of a substance by vacuum filtration. (4 marks)
12. (a) Define distribution ratio as used in solvent extraction. (2 marks)
- (b) A weak acid buffered at pH 3 has a dissociation constant of 1.0×10^{-4} . Given that 50.00 mL of 0.025 M aqueous solution of the acid was extracted, determine the extraction efficiency. The partition coefficient, k_D , between water and dichloromethane is 3.00. (7 marks)
- (c) (i) 10 g of a solute is contained in 100 ml water. Determine the amount of the solute that can be extracted from the solution using two 50 ml portions of ether ($K_e = 4.0$). (5 marks)
- (ii) State the advantage of using two 50 ml portions of the solvent instead of a 100 ml portion in 12 (c)(i). (2 marks)
- (d) Describe **two** conditions that make Soxhlet extraction technique appropriate. (4 marks)
13. (a) Outline the process of packing a column with silica gel using the slurry method. (10 marks)
- (b) Define ion exchange. (2 marks)
- (c) Write the equilibrium constant expression, k_e , for a sodium-form resin (Na - R) with:
- (i) H^+ . (2 marks)
- (ii) Ca^{2+} . (2 marks)

- (d) Match the types of ion exchange resin with the correct functional group shown in Table II. (4 marks)

Table II

Type of resin	Functional group
- strong acid cation exchanger	- sulphonic acid
- weak acid cation exchanger	- carboxylic acid
- strong base anion exchanger	- quaternary amine
- weak base ion exchanger	- Amine

14. (a) (i) State **five** benefits of good planning to an organization (5 marks)
- (ii) Describe planning premises. (2 marks)
- (b) Distinguish between mission and objectives as elements of planning process in an organization. (4 marks)
- (c) State **five** merits of democratic leadership style. (5 marks)
- (d) List **four** important features of control in an organization. (4 marks)
15. (a) Explain **four** factors considered in locating a store in an organization. (8 marks)
- (b) List **four** types of inventories received by the store of a manufacturing firm. (4 marks)
- (c) State **six** objectives of an efficient store keeping system in an organization. (6 marks)
- (d) Define credit note. (2 marks)

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