



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

BACHELOR OF SCIENCE (MATHEMATICS)

BACHELOR OF EDUCATION (SCIENCE)

BACHELOR OF SCIENCE (BIOLOGY)

**SCH 103: INTRODUCTION TO CLASSICAL ANALYSIS AND SEPARATION
TECHNIQUES**

DATE: 8/5/2019

TIME: 2.00-4.00 PM

INSTRUCTIONS TO CANDIDATES

- 1. This paper contains five (5) questions.**
- 2. Answer question one (compulsory) from section A and any other two questions from section B**

QUESTION ONE (30 MARKS) (COMPULSORY)

- a) Differentiate between the following terms as used in environmental analysis of samples
 - i. Qualitative and Quantitative analysis (2 marks)
 - ii. Titrimetric and Gravimetric analysis (2 marks)
 - iii. Chromatogram and retention time as used in chromatographic studies. (2 marks)
 - iv. Precision and accuracy as used in qualitative and quantitative analysis. (2 marks)
- b) With the aid of clearly labelled diagrams, outline the different parts of a Gas Liquid

Chromatography and a High-Performance Liquid Chromatography. Explain the functions of different identified parts and state two major differences between the equipment.

(6 marks)

- c) Explain the four main ways of expressing concentration in chemical analysis. (4 marks)
- d) Dr Jerome is a reknown chemical analyst working with Kenya Bureau of Standards in the Chromatography laboratory. His daily activities involve analysis of pesticide residues. Outline step wise how solvent extraction technique can be used to extract diuron from an aqueous solution using a separatory funnel and dichloromethane as the extraction solvent. (6 marks)
- e) An aqueous solution contains 10 g of solute per litre. When 1 litre of the solution is treated with 100 ml of ether, 6 g of the solute are extracted. How much more of the solute would be extracted from the aqueous solution by a further adding of 100 ml ether. Assume that the molecular state of the solute is the same in ether and water. (6 marks)

SECTION B

QUESTION TWO (20 MARKS)

- a) Using examples differentiate between the Arrhenius concept, Bronsted lowry concept and the Lewis concept as used in the definition of acids and bases. 4 marks
- b) Njoroge collected a random sample of the number of children per household in kiambu county. The data is as shown below.

X	0	1	2	3	4	5	6
F	10	19	7	7	2	1	4

Find the sample mean and the sample standard deviation of the data set. (6 marks)

- c) With an aid of a diagram explain how the pH of an environmental sample can be determined in the laboratory. (4 marks)
- d) Oil refinery companies are good examples of the companies using fractional distillation technique for the purification and separation of crude oil to its individual components. With an aid of a diagram, explain the working of a fractional distillation apparatus as applied in oil refinery companies. (6 marks)

QUESTION THREE (20 MARKS).

- a) Statistics is the science of collecting, organizing, analyzing and interpreting data in order to make decision. Using two examples in each case differentiate between measure of central tendency and measure of variability as used in statistics. (4 marks)
- b) Nernst's distribution law is used to explain the distribution of a solute in two non-miscible solvents at equilibrium. State and explain the limitations of the Nernst's distribution law. (4 marks)
- c) Differentiate between simple extraction and multiple extraction. (4 marks)
- d) Scientific researchers apply a wide range of analytical techniques in undertaking qualitative and quantitative analysis. Some of the techniques applied include GC, HPLC and Thin layer chromatography. With an aid of a diagram, name and explain the functions of the four main components of a TLC. (8 marks)

QUESTION FOUR (20 MARKS)

- a) Capillary Electrophoresis is a chromatographic technique which involve use of external electric field to allow separation of analytes. In this technique, only small quantities of sample are introduced into the capillary if high efficiency is to be maintained. Two main ways of achieving this is through hydrostatic injection and electrokinetics injection. Using diagrams, explain the working of the three main types of hydrostatic injection applied in capillary electrophoresis. (9 marks)
- b) Differentiate between systematic error and random error as used in statistical work. (3 marks)
- c) Ion Exchange Chromatography is a subset of one of the modes of HPLC which uses ion-exchange resins to separate ions based on their interactions with the fixed groups of the resins. Differentiate between suppressed ion chromatography and non-suppressed ion chromatography as separation techniques used in analytical chemistry. (4 marks)
- d) Gas Chromatography is a common technique used in qualitative and quantitative analysis of pesticides like atrazine. The injector is normally set at a higher temperature to vaporize the liquid sample into gaseous form. Name and explain the working of the two injection modes used in Gas Liquid Chromatography. (4 marks)

QUESTION FIVE (20 MARKS)

- a) Using examples, explain what you understand by the term conjugate acid base pair (4 marks)
- b) State the law of mass action. Give the equilibrium constant expression for the reaction
$$\text{N}_2\text{O}_5(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$$
 (4 marks)
- c) Using examples, explain the various classes of bronsted acids and bases (4 marks)
- d) Define a buffer solution. Differentiate between acid buffers and basic buffers giving an example in each case (3 marks)
- e) If a solution has a pH of 5.50 AT 25 0C, calculate its hydroxide ion (-OH) concentration (3 marks).
- f) What is an acid base indicator. Give two examples (2 marks)