MACHAKOS UNIVERSITY COLLEGE

(A Constituent College of Kenyatta University)
University Examinations for 2015/2016 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST SEMESTER EXAMINATION FOR DIPLOMA IN SCIENCE LABORATORY TECHNOLOGY

DSL 215: INSTRUMENTAL METHODS OF ANALYSIS

DATE: SCHOOLBASED **TIME:**

INSTRUCTIONS:

- Answer all questions in section A and any other two questions from questions in section B in the answer booklet provided.
- ALL working MUST be clearly shown where possible.
- Data: 1 nm = 1 x 10^{-9} m, 1 Å = 10^{-8} cm, c = 3.0 x 10^{8} m/s, and h = 6.63 x 10^{-34} Js

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SECTION A

QUESTION ONE (30 MARKS) –COMPULSORY

a) Distinguish between the terms chromophore and auxochrome and give examples (4 marks)

b) Describe the ways in which instrumental methods of analysis are superior over classical methods of analysis and highlight challenges encountered in instrumental analysis (6 marks)

c) A compound has a molar absorptivity of 2.17×10^3 L $cm^{-1}mol^{-1}$. What concentration of the compound would be required to produce a solution that has a transmittance of 8.42 % in a 2.50-cm cell (3 marks)

d) Most instrumental methods require calibration

i. State the meaning of the term calibration? (1 mark)

ii. Describe the applications of a calibration curve and illustrate your answer. (4 marks)

e) Distinguish between the terms signal and noise and write an expression for signal to noise ratio of an analytical measurement (4 marks)

f) Calculate the energy of a photon of visible radiation having a wavelength of 530 nm (3 marks)

g) Mention three energy components associated with the bands of a molecule in molecular absorption of polyatomic molecules (3 marks)

h) By use of a suitable expression, describe the relationship between absorbance and transmittance and define each term in the expression. (2 marks)

SECTION B

QUESTION TWO (20 MARKS)

a) Describe four types of instrumental noise and explain how each can be minimized (8 marks)

b) A radioactive material emits photons each with energy 1.6×10^{-13}J

i. Calculate the frequency of the radiation (2 marks)

ii. What is the wavelength of the electromagnetic radiation (2 marks)

c) Explain the effects of solvent on absorption of radiation by an absorbing species (4 marks)

d) Mention four main conditions for the application of Beer's law. (4 marks)

QUESTION THREE (20 MARKS)

a) Discuss three main limitations of Beer's law. (9 marks)

b) State the quantum theory of electromagnetic radiation and write an expression for the energy of a photon of radiation. (2 marks)

c) Calculate the molar absorptivity of a 1×10^{-4} M solution, which has an absorbance of 0.2 when the path length is 2.5 cm. (3 marks)

d) Describe the theory and applications of ultraviolet and visible spectroscopy (6 marks)

QUESTION FOUR (20 MARKS)

a) Describe the meaning of the following numerical criteria for selecting analytical methods (10 marks)

(i) Precision (ii) Bias (iii) Sensitivity

(iv) Detection limit (v) Selectivity

b) A solution of tryptophan has an absorbance of 0.54 in a 0.5 cm length cuvette at 280 nm. If the absorption coefficient of tryptophan is 6.4×10^3 $LMol^{-1}cm^{-1}$ determine the concentration of the solution. (3 marks)

c) Describe the role of drying agents in liquid-Liquid extraction (4 marks)

d) Distinguish between matrix and analyte and illustrate your answer (3 marks)

QUESTION FIVE (20 MARKS)

a) Describe the various instrumental components of a spectrophotometer (12 marks)

b) State Beer-Lambert's law and write its mathematical expression defining each term. (3 marks)

c) Calculate the magnitude of the energy of a quanta of electromagnetic radiation associated with light of wavelength 6056.2 Å. (3 marks)

d) Distinguish between line spectra and continuous spectra (2 marks)