TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

DIPLOMA IN ANALYTICAL CHEMISTRY & DIPLOMA IN LABORATORY SCIENCE AND TECHNOLOGY

ACH 2303: INSTRUMENTAL METHODS OF ANALYSIS II

SUPPLEMENTARY EXAMS

SERIES: JULY 2025

TIME: 2 HOURS

DATE: Pick Date JULY 2025

Instructions to Candidates

1. You should have the following for this examination

-Answer Booklet, examination pass, scientific non-programmable calculator and student ID

2. This paper consists of **FIVE** questions. Attempt all questions in **QUESTION ONE** and any other **TWO** questions.

3. **Do not write on the question paper.**

Question one

a) Differentiate between emission and absorption spectra **(2 marks)**

b) Define the following terms as employed in spectroscopic methods of analysis;

i. Ground state **(1 mark)**

ii. Excited state **(1 mark)**

iii. Singlet excited state **(1 mark)**

iv. Triplet excited state **(1 mark)**

c) UV-Vis spectrum is a range of wavelengths in the electromagnetic spectrum that are applied in spectroscopic methods of analysis. Describe the wave- particle duality nature of electromagnetic radiation using relevant expressions. **(4marks)**

d) Name two **MAIN** types of detectors used in Infrared spectrophotometer. **(2marks)**

e) Explain why Atomic absorption spectroscopy does not suffer from severe spectral interference.

(4marks)

f) Highlight two advantages of using **pressed pellet technique** over mull technique a method of sample preparation in Infrared spectroscopy. (**2marks)**

g) The characteristic yellow emission of sodium vapors consists of a pair of lines at 589 nm and 589.6 nm at a temperature of 3000K. These arise from the emission of radiation by the gaseous sodium atoms in the 3p excited state to 3s ground state. Compute the ratio of the sodium atoms in the excited state to the ground state. (Boltzmann constant 1.38×10^{-23} J/K, Planks constant 6.63×10^{-34} Js) . **(7 marks)**

h) Stray radiation is a spectral interference in Atomic Absorption spectroscopy. Name other five causes of interference in AAS **(5marks)**

Question two

a. Calculate the ratio of sodium atoms in the 3p excited state to the number in the ground state 3s at 3050K in oxyacetylene flame ($E = 3.371 \times 10^{-19}$ J, Boltzmann constant 1.38×10^{-23} J/K) **(7 marks).**

b. Is atomic emission analysis of sodium sensitive to fluctuations in the flame temperature? **Explain.**

(3marks)

c. Is atomic absorbance analysis of sodium sensitive to fluctuations in the flame temperature? **Explain.**

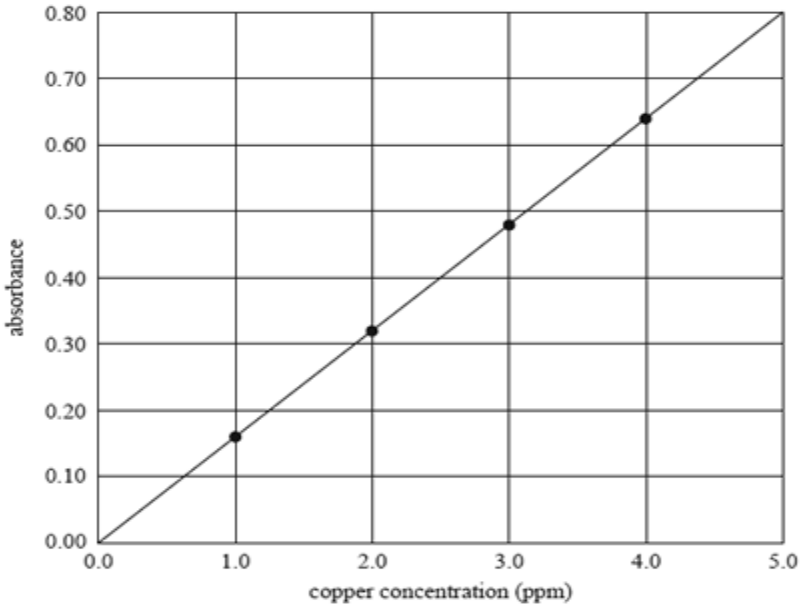
(3 marks)

d. Explain why flame photometry is also called atomic flame emission spectrometry **(AES)? (2marks)**

Question three.

a. An atomic absorption spectrometer can be used to determine the level of copper in soils. The calibration curve below plots the absorbance of four standard copper solutions against the concentration of copper ions in ppm.

The concentrations of copper ions in the standard solutions were 1.0, 2.0, 3.0 and 4.0 mg L–1. (1 mg L^{-1} = 1 ppm).



i. State and explain the concentration range of copper ions which can be accurately determined from the calibration curve. **(2marks)**

ii. If the test solution gave an absorbance reading of 0.4 what would be the concentration of copper ions in the solution in moles/liter? (Cu = 63.5 $gmol^{-1}$) **(3marks)**

b. For the same concentration of nickel, the absorbance at 352.4 nm was found to be about 30% greater for a solution that contained 50% ethanol than for an aqueous solution. Explain. **(4marks)**

c. Define the following terms associated with AAS **(6marks)**

i. Releasing agent

ii. Protective agent

iii. Atomization

Question four

a. Outline the principle of IR spectroscopy **(4marks)**

b. Which of the following gives a stronger band and why? **(2marks)**

i. C=O

ii. C=C

c. Explain how the following factors affect vibrational frequency in IR spectroscopy **(6 marks)**

i. Resonance effect

ii. Conjugation

iii. Hydrogen bonding

d. Calculate the approximate wavenumber and wavelength of the fundamental absorption due to the stretching vibration of a carbonyl group C = O. **(5marks)**

[Force constant (k) = 1 x 10^3 Nm^{-1}, speed of light (c) = 3 x 10^{10} cms^{-1}.]

Question five

a. Account for the need of using the linear region of the calibration plot for quantitative analysis in emission spectroscopy? **(2marks)**

b. The following data were obtained in the flame photometric determination of sodium by internal standard method. 10 ppm of lithium was added to the series of standard solutions of sodium and the sample. The ratios of intensity of emission at the wavelengths of sodium and the lithium are given in table below.

Table 7.4: The ratio of intensity of emission at the wavelength of Na and Li during flame photometric determination by internal standard method

Solution number	Concentration of Li, ppm (fixed)	Concentration of Na, ppm (varying)	Intensity ratio of sodium to lithium
0	10.0	0.0	0.0
1	10.0	2.0	15.8
2	10.0	4.0	31.4
3	10.0	6.0	45.4
4	10.0	8.0	58.1
5	10.0	10.0	70.2
Sample	10.0	Unknown	43.0

i. Plot a graph of intensity ratio against concentration of the standard solution of sodium

(5marks)

ii. Determine the intensity ratio for the solution of unknown concentration **(2marks)**

c. Highlight four sampling techniques that are applied in IR spectroscopy **(4marks)**

d. State two advantages of using AAS as a chemical analytical tool **(2marks)**