



KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BSC (CHEMISTRY)

COURSE CODE: SCH 323

COURSE TITLE: INSTRUMENTAL ANALYTICAL CHEMISTRY AND
QUALITY CONTROL

DATE: 23/11/2022

TIME: 8:00AM-10:00AM

INSTRUCTIONS TO CANDIDATES:

- Answer Question ONE (Compulsory) and any other TWO (2) questions

TIME: 2 Hours

Constants: $h = 6.626 \times 10^{-34} \text{ Js}$; $c = 3.0 \times 10^8 \text{ ms}^{-1}$

This paper consists of 4 printed pages. Please Turn Over



KIBU observes ZERO tolerance to examination cheating

Question 1 [30 Marks]

- Explain the 3 stages in TLC analysis [6 Marks]
- Highlight 4 sources of error in spectrophotometric instruments [4 Marks]
- Differentiate between TGA and DTA [4 Marks]
- Highlight 3 types of liquid chromatography [3 Marks]
- Define chromatography [2 Marks]
- Define R_f value as used in TLC [1 Mark]
- Name the types of columns used in gas chromatography [2 Marks]
- Explain the difference between accuracy and precision of analytical methods [2 Marks]
- Discuss the advantages of instrumental techniques [4 Marks]
- Define chromatography [2 Marks]

Question 2 [20 Marks]

EDTA forms colored complexes with a variety of metal ions that may serve as the basis for a quantitative spectrophotometric method of analysis. The molar absorptivities (ϵ) of the EDTA complexes of Cu, Co, and Ni at three wavelengths are summarized in the following table (all values of ϵ are in $M\text{ cm}$). Path length is 1.00 cm for all measurements.

Metal	$\epsilon_{732.0}$ ($M^{-1}\text{ cm}^{-1}$)	$\epsilon_{462.9}$ ($M^{-1}\text{ cm}^{-1}$)	$\epsilon_{378.7}$ ($M^{-1}\text{ cm}^{-1}$)
Co^{2+}	3.11	2.11	15.8
Cu^{2+}	7.73	95.2	2.32
Ni^{2+}	13.5	3.03	1.79

Using this information determine the following:

- The concentration of Co^{2+} in a solution that has an absorbance of 0.338 at a wavelength of 462.9 nm. [2 Marks]
- The concentrations of Co^{2+} and Cu^{2+} in a solution that has an absorbance of 0.453 at a wavelength of 462.9 nm and 0.107 at a wavelength of 378.7 nm. [6 Marks]
- The concentrations of Co^{2+} , Cu^{2+} , and Ni^{2+} in a sample that has an absorbance of 0.423 at a wavelength of 462.9 nm, 0.184 at a wavelength of 378.7 nm, and 0.291 at a wavelength of 732.0 nm. [12 Marks]

Question 3 [20 Marks]

- Highlight 5 steps in the analytical process [10 Marks]
- A reading of 22.5 is obtained on spectrometer when a sample solution is analyzed for copper. When 10.00 ml of the solution is spiked with 10.00 ml of 2 ppm copper solution the mixture gives a reading of 26.8.
Assuming the readings are directly proportional to the concentration of copper in the solution, determine the concentration of copper in the original sample. [10 Marks]

Question 4 [20 Marks]

- a. Provide the missing information in the following table [10 Marks]

Wavelength (m)	Frequency (s ⁻¹)	Wavenumber (cm ⁻¹)	Energy (J)
	1.09 x 10 ¹⁵		9.17 x 10 ⁻¹⁸
		3.22 x 10 ³	
2.25 x 10 ⁻⁷	1.33 x 10 ¹⁵		

- a. To determine the concentration of NO₂ in air, the sample is passed through a solution of H₂O₂, which oxidizes NO₂ to HNO₃, and titrating the HNO₃ with NaOH. What is the concentration of NO₂, in mg/L, if a 5.0 L sample of air requires 9.14 mL of 0.01012 M NaOH to reach the end point. [10 Marks]

Question 5 [20 Marks]

- a. Discuss method validation as applied in analytical chemistry [2 Marks]
- b. When sodium bicarbonate is heated, it decomposes between 100 °C and 225 °C releasing water and carbon dioxide. The combined loss of water and carbon dioxide was 36.6 % by mass whereas the mass loss due to carbon dioxide alone was 25.4 %.
Describe the reaction equation and compare theoretical mass loss values with the observed result. [10 Marks]
- b. Calculate the percentage mass change for the following reactions [8 Marks]



