



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

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Question 1 [30 Marks]

a.	Explain the 3 stages in TLC analysis	[6 Marks]
b.	Highlight 4 sources of error in spectrophotometric instruments	[4 Marks]
c.	Differentiate between TGA and DTA	[4 Marks]
d.	Highlight 3 types of liquid chromatography	[3 Marks]
e.	Define chromatography	[2 Marks]
f.	Define R _f value as used in TLC	[1 Mark]
g.	Name the types of columns used in gas chromatography	[2 Marks]
h.	Explain the difference between accuracy and precision of analytic	al methods[2 Marks]
i.	Discuss the advantages of instrumental techniques	[4 Marks]
j.	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 cm). Path length is 1.00 cm for all measurements.

Metal	ε _{732.0} (M ⁻¹ cm ⁻¹)	ε _{462.9} (M ⁻¹ cm ⁻¹)	ε _{378.7} (M ⁻¹ 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:

- a. The concentration of Co^{2+} in a solution that has an absorbance of 0.338 at a wavelength of 462.9 nm. [2 Marks]
- b. 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]
- c. The concentrations of Co²⁺, Cu²⁺, and Ni²⁺ 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]

a. Highlight 5 steps in the analytical process

[10 Marks]

b. 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]

Provide the missing information in the following table

[10 Marks]

Wavelength (m)	Frequency (s ⁻¹)	Wavenumber (cm ⁻¹)	Energy (J)
	1.09×10^{15}		9.17 x 10 ⁻¹⁸
		3.22×10^3	
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 N

[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]

i.
$$NH_4 NO_3(s) \xrightarrow{\Delta} N_2O(g) + 2H_2O(g)$$

ii.
$$Ca(OH)_2(s) \xrightarrow{\Delta}_{Heat} CaO(s) + H_2O(g)$$

iii.
$$CuSO_4(s) \xrightarrow{\Delta} CuO(s) + SO_3(g)$$

iv.
$$6PbO(s) + O_2(g) \xrightarrow{\Delta} 2Pb_2O_4(s)$$

							(272)	(271)	(268)	(277)	(264)	(266)	(262)	(261)	227.03	226.02	(223)	
							Rg	Ds	Mt	Hs	Bh	Sg	Db	Rf	†Ac	Ra	H	
							111	110	109	108	107	106	105	104	89	88	87	
(222)	(210)	(209)	208.98	207.2	204.38	200.59	196.97	195.08	192.2	190.2	186.21	183.85	180.95	178.49	138.91	137.33	132.91	
Rn	At	Po	Bi	PЬ	11	Hg	Au	Pt	Ir	08	Re	W	Ta	Hf	*La	Ba	Cs	
86	85	84	83	82	81	80	79	78	77	76	75	74	73	72	57	56	55	
131.29	126.91	127.60	121.75	118.71	114.82	112.41	107.87	106.42	102.91	1.101	(98)	95.94	92.91	91.22	88.91	87.62	85.47	
Xe	I	Te	Sb	Sn	In	2	Ag	Pd	Rh	Ru	Tc	Mo	Zb	Zr	Y	Sr	Rb	
54	-	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	
83.80	_	78.96	74.92	72.59	69.72	65.39	63.55	58.69	58.93	55.85	59.94	52.00	50.94	47.90	44.96	40.08	39.10	
Kr	Br	Se	As	Ge	Ga	Zn	Cu	Z	င္ပ	Fe	Mn	Cr	V	Ti	Sc	Ca	×	
36		34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	
39.95		32.06	30.97	28.09	26.98	IIB	B		- VIIIB -	П	AIIA	AIA	BA	IVB	18	24.30	22.99	
Ar	Ω	S	Ą	Si	Al	12	11	10	. 9	00	7	6	U	Δ	w	Mg	Na	
18		16	15	14	13											12	11	
20.18		16.00	14.1	12.01	10.81	- Account										9.01	6.94	
Ze		0	Z	0	В											Be	Li	
10		8	7	6	5											4	3	
4.00	VIIA	VIA	VA	IVA	IIIA											IIA	1.008	
He		16	15	14	13	100										2	H	
2				TATE	TATATA			7		TILL			1					
VIIIA	1		- 1	FIFMENTS	M	I	HHL	LHC	PERIODIC TARIE OF	TAR		5	PHR				Ā -	