KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BSC (CHEMISTRY)

COURSE CODE: SCH 221

COURSE TITLE: ANALYTICAL CHEMISTRY I

DATE: 14/04/2023 **TIME: 2:00-4:00PM**

INSTRUCTIONS TO CANDIDATES:

Answer **question ONE** and **any TWO** of the remaining

KIBABII observes ZERO tolerance to examination cheating

Question 1 [30 Marks]

i. An organic compound is known to contain only carbon, hydrogen and oxygen. The compound contains, by mass, 39.1% of carbon and 8.7% of hydrogen. Determine its empirical formula [5 Marks]

ii. A sample of an impure iron ore is approximately 55% w/w Fe. The amount of Fe in the sample is to be determined gravimetrically by isolating it as Fe_2O_3. What mass of sample do you need to ensure that you isolate at least 1 g of Fe_2O_3? [4 Marks]

iii. Explain the importance of fundamental analysis [3 Marks]

iv. The reaction between ethanol and an organic takes about 6 hours at boiling point. The reaction achieves a conversion of approximately 70%. Comment of the suitability of this reaction as a titration reaction. [5 Marks]

v. Differentiate between a methods' sensitivity and its detection limit [4 Marks]

vi. Desribe the range when evaluating data and discuss its importance [3 Marks]

vii. Differentiate between a population and a sample and indicate the difference in standard deviation calculations [6 Marks]

Question 2 [20 Marks]

i. The concentration of arsenic in an insecticide is determined gravimetrically by precipitating $MgNH_4AsO_4$ and isolating $Mg_2As_2O_7$. Determine the %w/w As_2O_3 in a 1.627 g sample of insecticide if it yields 106.5 mg of $Mg_2As_2O_7$. [8 Marks]

ii. To determine the amount of iron in a dietary supplement, a random sample of 15 tablets weighing a total of 20.505 g was ground into a fine powder. A 3.116 g sample was dissolved and treated to precipitate the iron as $Fe(OH)_3$. The precipitate was collected, rinsed, and ignited to a constant weight as Fe_2O_3, yielding 0.355 g. Determine the iron content of the dietary supplement as g $FeSO_4 \cdot 7H_2O$ per tablet. [12 Marks]

Question 3 [20 Marks]

i. Your team has been tasked to assess the quality of borehole water used by Kibabii University students in residences around the University. Discuss five factors to consider when choosing a suitable analytical method [15 Marks]

ii. During the analysis of Ca^{2+} in water an analyst notices an interference in the presence of Zn^{2+}. When the concentration of Ca^{2+} is 100 times greater than that of Zn^{2+} the analysis for Ca^{2+} gives a relative error of +0.5%. Determine the selectivity coefficient for the method. [5 Marks]

Question 4 [20 Marks]

i. An analytical method is determined to provide accurate results when the analyte's concentration is approximately 10 ppb.
   a. If the method requires a sample of 0.5 mL, determine the mass of analyte is being measured [4 Marks]
   b. Determine the mass of analyte in a 1ml sample if the analyte is present at 10% w/v and at 10% w/w. [6 Marks]

ii. For a quantitative analysis, the sample's composition must accurately represent the target population. Discuss five issues to consider when developing a sampling plan [10 Marks]

Question 5 [20 Marks]

An analyst obtained the following data (mg) after determining the amount of aspirin in 10 tablets.

247.53 257.18 256.97 244.52 251.05 244.55 245.69 255.73 249.20 247.57

i. Report the mean, median, range, standard deviation and variance for this data. [7 Marks]

ii. Determine the percentage of tablets containing between 240 mg and 245 mg of aspirin [13 Marks]

Table 1: Single-Sided Normal Distribution

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641
0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4365	0.4325	0.4286	0.4247
0.2	0.4207	0.4168	0.4129	0.4090	0.4502	0.4013	0.3974	0.3396	0.3897	0.3859
0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
1.7	0.0466	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
2.3	0.0107	0.0104	0.0102		0.00964		0.00914		0.00866	
2.4	0.00820		0.00776		0.00734		0.00695		0.00657	
2.5	0.00621		0.00587		0.00554		0.00523		0.00494	
2.6	0.00466		0.00440		0.00415		0.00391		0.00368	
2.7	0.00347		0.00326		0.00307		0.00289		0.00272	
2.8	0.00256		0.00240		0.00226		0.00212		0.00199	
2.9	0.00187		0.00175		0.00164		0.00154		0.00144	
3.0	0.00135									
3.1	0.000968									
3.2	0.000687									
3.3	0.000483									
3.4	0.000337									
3.5	0.000233									
3.6	0.000159									
3.7	0.000108									
3.8	0.0000723									
3.9	0.0000481									
4.0	0.0000317									

Table 2: Critical Values for t-Test

Values of *t* for... ...a confidence interval of: ...an α value of: Degrees of Freedom	90% 0.10	95% 0.05	98% 0.02	99% 0.01
1	6.314	12.706	31.821	63.657
2	2.920	4.303	6.965	9.925
3	2.353	3.182	4.541	5.841
4	2.132	2.776	3.747	4.604
5	2.015	2.571	3.365	4.032
6	1.943	2.447	3.143	3.707
7	1.895	2.365	2.998	3.499
8	1.860	2.306	2.896	3.255
9	1.833	2.262	2.821	3.250
10	1.812	2.228	2.764	3.169
12	1.782	2.179	2.681	3.055
14	1.761	2.145	2.624	2.977
16	1.746	2.120	2.583	2.921
18	1.734	2.101	2.552	2.878
20	1.725	2.086	2.528	2.845
30	1.697	2.042	2.457	2.750
50	1.676	2.009	2.311	2.678
∞	1.645	1.960	2.326	2.576

PERIODIC TABLE OF THE ELEMENTS

1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.1	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 59.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.75	52 Te 127.60	53 I 126.91	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 *La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.2	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.02	89 †Ac 227.03	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (272)							