



# THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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**MAIN EXAMINATION**

**SEPTEMBER –DECEMBER 2021**

**FACULTY OF SCIENCE**

**DEPARTMENT OF CHEMISTRY**

**REGULAR PROGRAMME**

**CHEM 308: ANALYTICAL CHEMISTRY I**

**Date: DECEMBER 2021**

**Duration: 2 Hours**

**INSTRUCTIONS: Answer Question ONE and any TWO Questions**

Q1.

(a) Define the following terms:

**(5marks)**

- (i) Standard curve
- (ii) Quantitative analysis
- (iii) Van Deemter equation
- (iv) Spectroscopy
- (v) Test Statistic

(b) Distinguish between random and systematic errors.

**(2marks)**

(c) Calculate the mean and the standard deviation of the following set of analytical results, 15.67, 15.69, and 16.03g.

**(5marks)**

(d) Describe the basic components of a pH-meter.

**(3marks)**

(e) A concentrated solution of aqueous ammonia is 28.0% w/w  $\text{NH}_3$  and has a density of 0.899 g/mL. What is the molar concentration of  $\text{NH}_3$  in this solution? **(3marks)**

(f) Why is the injection port in a gas chromatograph heated to a relatively high temperature?

**(2marks)**

(g) Draw an example of an instrumental chromatography peak and show in your drawing and describe in words the specific method by which peak area is measured by integration. **(5marks)**

(h) What is the purpose of the high-energy electron beam utilized in a mass spectrometer? **(2marks)**

(i) Is x-ray fluorescence molecular?, atomic?, or neither? Explain.

**(3marks)**

Q2.

(a) Define the following terms:

**(4marks)**

- (i) Pearson's correlation coefficient
- (ii) ANOVA
- (iii) F-test
- (iv) T-test

(b) Standard aqueous solutions of fluorescein are examined in a fluorescence spectrometer, and yield the following fluorescence intensities.

<b>Distance:</b>	2.1	5.0	9.0	12.6	17.3	21.0	24.7
<b>Concentration (pg ml<sup>-1</sup>):</b>	0	2	4	6	8	10	12

Determine the correlation coefficient, r.

**(8marks)**

(c) A chemist obtained the following results for the alcohol content of a sample of human blood.

**%C<sub>2</sub>H<sub>5</sub>OH:** 0.084, 0.089, and 0.079

Calculate the 95% confidence interval for the mean.

**(8marks)**

Q3. Compare and contrast single- beam and double-beam spectrophotometer in terms of instrumentation, working principle, advantages and disadvantages over one another.

**(20marks)**

Q4.

(a) What are three attributes of a successful titrimetric analysis?

**(3marks)**

(b) Look at Figures 5.5 and 5.7 and tell what indicator you would recommend for the titration of phosphoric acid at the second inflection point. Explain.

**(3marks)**

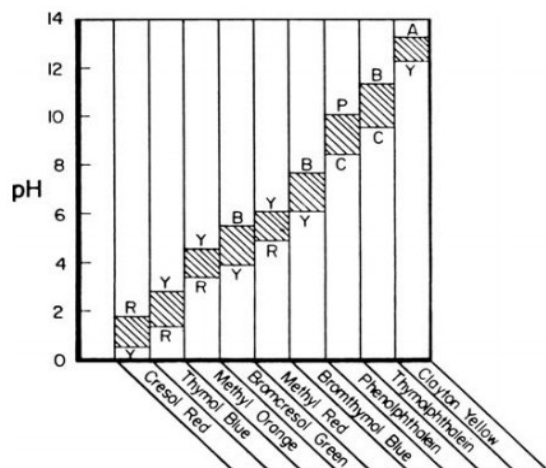


Figure 5.5

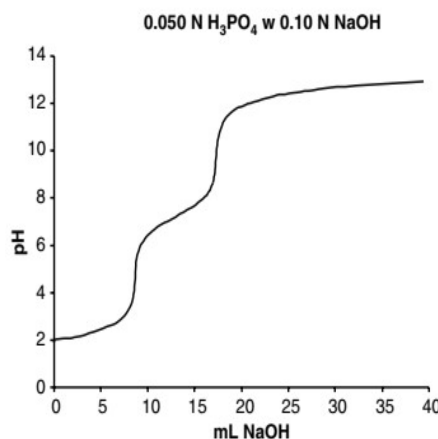


Figure 5.7

**Figure 5.5** Some acid–base indicators and their color change ranges. R = red, Y = yellow, B = blue, P = pink, C = colorless, and A = amber.

**Figure 5.7** Titration curve of 0.050 N  $H_3PO_4$  titrated with 0.10 N NaOH

(c) One of the following unbalanced equations represents a redox reaction and one represents a reaction that is not a redox reaction. Select the equation that is a redox reaction and answer the questions that follow.



(i) Which one is redox, (1) or (2)? **(2marks)**

(ii) What is the oxidizing agent? **(2marks)**

(iii) What has been oxidized? **(2marks)**

(iv) Did the reducing agent lose or gain electrons? **(2marks)**

(d) Explain the difference between an indirect titration and a back titration.

**(4marks)**

(e) Briefly explain the use of the following substances in iodometry:

**(2marks)**

(i) KI

(ii)  $Cr_2O_7$

Q5. (a) Explain the principles by which qualitative analysis can be performed in GC with the use of retention times. **(6marks)**

(b) What is the capacity factor if the retention time for the component of interest is 3.2 min and the retention time of the sample solvent is 0.70 min?

**(3marks)**

(c) Define internal standard. Tell why an internal standard is important in a quantitative analysis by GC. Also tell what is plotted on the x- and y-axes when plotting the standard curve in internal standard procedures. **(6marks)**

(d) What might be the cause of a drifting chromatogram baseline? **(2marks)**

(e) What can a GC analyst do to solve the problem of unexpected peaks on the chromatogram? **(3marks)**

**Useful Information:**

Table 1.1 Values of 't' for confidence intervals

Degrees of freedom	Values of t for confidence interval of				
	80%	90%	95%	99%	99.9%
1	3.08	6.31	12.7	63.7	637
2	1.89	2.92	4.30	9.92	31.6
3	1.64	2.35	3.18	5.84	12.9
4	1.53	2.13	2.78	4.60	8.60
5	1.48	2.02	2.57	4.03	6.86
6	1.44	1.94	2.45	3.71	5.96
7	1.42	1.90	2.36	3.50	5.40
8	1.40	1.86	2.31	3.36	5.04
9	1.38	1.83	2.26	3.25	4.78
10	1.37	1.81	2.23	3.17	4.59

$$r = \frac{\sum \{(x_1 - \bar{x})(y_1 - \bar{y})\}}{\left\{ \sum (x_1 - \bar{x})^2 \right\} \left\{ \sum (y_1 - \bar{y})^2 \right\}}^{1/2}$$

**PERIODIC TABLE**

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period 1	1 H																	2 He
Period 2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
Period 3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
Period 4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
Period 5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
Period 6	55 Cs	56 Ba	57 La *	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
Period 7	87 Fr	88 Ra	89 Ac *	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
			* 58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu		
			* 90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr		

DTE DEC 2021

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