



RAJARATA UNIVERSITY OF SRI LANKA  
FACULTY OF APPLIED SCIENCES

B.Sc. Second year Semester II Examination – October/November 2017

CHE 2103 – Analytical Chemistry

Answer both questions.

Time: 1 hour

The use of non-programmable calculator is permitted.

- 1). (a) Perform the following calculations with the correct number of significant digits.
- $3.2215 + 1.67 + 2.3$
  - $815.991 \times 324.6$
- (b) Find the total error in each of the following calculations.
- $(2.0 \pm 0.2) - (1.0 \pm 0.1) + (3.0 \pm 0.3)$
  - $\frac{(2.0 \pm 0.2) \times (1.0 \pm 0.1)}{(3.0 \pm 0.3)}$
- (c) A soda ash sample is analyzed with standard hydrochloric acid. The analysis is performed in triplicate. The mean and the standard deviation established for the determination are 92.50% and 0.072% respectively. Within what range are you 95% confident that the true value lies?

(Hint: the values of  $t$  for 95% confidence level are given in the table below).

Degree of freedom	confidence limit, 95%
1	12.706
2	4.303
3	3.182
4	2.776

- (d) The analysis of sample of iron ore gave the percentage values for the iron content: 7.08, 7.21, 7.12, 7.09 and 7.07. Calculate the standard deviation for the values.
- (e) Find the coefficient of variation (CV) for the values in (d) above. Check whether the last value 7.21 to be rejected or not from the values given in (d) above at the 95% confidence level.



No. of observation	Confidence level	
	$Q_{90}$	$Q_{95}$
3	0.941	0.970
4	0.765	0.829
5	0.642	0.710
6	0.560	0.625

- (f) Draw the titration curves for the following titrations? What would be the suitable indicator in each case.
- 100 mL of  $0.1 \text{ mol dm}^{-3}$  ammonia with  $0.1 \text{ mol dm}^{-3}$  hydrochloric acid.
  - 100 mL of  $0.1 \text{ mol dm}^{-3}$  acetic acid with  $0.1 \text{ mol dm}^{-3}$  sodium hydroxide.
- (g) In a titration experiment, a student finds that 0.5468 g of  $\text{KHC}_8\text{H}_4\text{O}_4$  (KHP) is needed to completely neutralize 23.48 mL of a NaOH solution. What is the concentration (in  $\text{mol dm}^{-3}$ ) of the solution?  
(The formula weight of KHP is  $204.2 \text{ g mol}^{-1}$ ).
- (h) The purity of  $\text{NH}_4\text{NO}_3$  can be analyzed by titrating a solution of  $\text{NH}_4\text{NO}_3$  with NaOH solution. In an experiment a 0.2041 g sample of industrially prepared  $\text{NH}_4\text{NO}_3$  required 24.42 mL of  $0.1023 \text{ mol dm}^{-3}$  NaOH for neutralization. What is the percent purity of the sample?  
(The formula weight of  $\text{NH}_4\text{NO}_3$  is  $80.05 \text{ g mol}^{-1}$ ).
- (i) Calculate the pH of a buffer solution prepared by adding 20.5 g of  $\text{CH}_3\text{COOH}$  and 17.8 g of  $\text{CH}_3\text{COONa}$  in  $5.00 \times 10^2 \text{ mL}$  of solution.  $K_a = 1.76 \times 10^{-5}$ .
- (j) A sample of 0.5662 g of an ionic compound containing chloride ions is dissolved in water and treated with an excess of  $\text{AgNO}_3$ . If the mass of the  $\text{AgCl}$  precipitate that forms is 1.0882 g. What is the percent by mass of Cl in the original compound?  
(The relative atomic weights of Ag and Cl are 108.0 and <sup>35.5</sup>~~108.0~~ respectively).

(10 x 12 marks = 120 marks)



- 2). Answer either part A or part B.

Part A

- (a) Briefly explain the types of systematic errors which affect an experimental result. (24 marks)
- (b) Calculate the percent of alcohol (ethanol) content in a 60.00 g sample of blood from a driver required 28.64 mL of  $0.07654 \text{ mol dm}^{-3} \text{ K}_2\text{Cr}_2\text{O}_7$  for titration in acidic medium. (24 marks)
- (c) Calculate the concentration of  $\text{H}_2\text{C}_2\text{O}_4$ ,  $\text{HC}_2\text{O}_4^-$ ,  $\text{C}_2\text{O}_4^{2-}$  and  $\text{H}^+$  in a  $0.20 \text{ mol dm}^{-3}$  oxalic acid solution. ( $K_{a1}$  and  $K_{a2}$  of oxalic acid are  $6.5 \times 10^{-2} \text{ mol dm}^{-3}$  and  $6.1 \times 10^{-5} \text{ mol dm}^{-3}$  respectively). (32 marks)

Part B

- (a) (i) Describe an experimental technique that would increase of forming crystals.  
(ii) Give a process where an impurity can be incorporated into a crystal. (16 marks)
- (b) Calculate the solubility of  $\text{CaC}_2\text{O}_4$  using the systematic approach, the pH of a solution is 4.0.  
(Solubility product of  $\text{CaC}_2\text{O}_4$  is  $2.6 \times 10^{-9} \text{ mol}^2 \text{ dm}^{-6}$  and ionic product of water is  $1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ ). (36 marks)
- (c) A mixture containing only  $\text{FeCl}_3$  and  $\text{AlCl}_3$  weighs 5.65 g. The chlorides are converted to the hydrous oxides and ignited to  $\text{Fe}_2\text{O}_3$  and  $\text{Al}_2\text{O}_3$ . The oxides mixture weighs 2.35 g. Calculate the percent Fe and Al in the original mixture.  
(The relative atomic weights of Al and Fe are 26.98 and 55.85 respectively, and the formula weights of  $\text{Al}_2\text{O}_3$ ,  $\text{AlCl}_3$ ,  $\text{Fe}_2\text{O}_3$  and  $\text{FeCl}_3$  are 101.96, 133.34, 159.69 and 162.21  $\text{g mol}^{-1}$  respectively). (28 marks)

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Periodic table of the elements

1 H 1.0																	2 He 4.0
3 Li 6.9	4 Be 9.0															9 F 19.0	10 Ne 20.1
11 Na 23.0	12 Mg 24.3															17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1	21 Sc 44.9	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.9	27 Co 58.9	28 Ni 58.7	29 Cu 63.6	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc 98.1	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (272)	112 Uub		114 Uuq		116 Uuh		118 Uuo

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.3	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
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90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.1	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)
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