RAJARATA UNIVERSITY OF SRI LANKA

FCULTY OF APPLIED SCIENCES

B.Sc. Second year Semester II Examination – April /May 2016

CHE 2103 –Analytical Chemistry I

Answer both questions.

Time: 1 hour

The use of non-programmable calculator is permitted.

1).   (a)   Give the correct answer to the correct number of significant figures of the following:

           (i) $\dfrac{12.34}{6.29}$

           (ii) $0.00402 \times 13.00 \times 4306$

           (iii) $\log (4.000 \times 10^{-5})$

    (b)   Calculate the standard deviation and coefficient of variation for the following set of data: 0.812, 0.792, 0.794 and 0.900.

    (c)   What is the absolute uncertainty in the following calculation?

        $(6.0 \pm 0.2) \div (47.3 \pm 1.0)$

    (d)   The following results were obtained for the determination of P (ppm) in blood serum: 4.40, 4.42, 4.60, 4.48, and 4.50. Determine whether the 4.60 ppm result is an outlier or should be retained at the 95% confidence level.

Hint:- rejection quotient, Q values are given in the following table:

Number of Observation	90% confidence	95% confidence
3	0.941	0.970
4	0.765	0.829
5	0.642	0.710
6	0.560	0.625

(e)   A sample of pure Na_2CO_3, weighing 0.3542 g is dissolved in 50.0 mL of water and titrated with a solution of HCl using methyl orange as an indicator. A volume of 30.23 mL of HCl solution is required to reach the end point. Calculate the concentration of HCl.
(The molar mass of Na_2CO_3 is 106.0 g mol^{-1}).

(f)   (a)   Define the following terms:
       (i)   Gravimetric factor
       (ii)   Nucleation.
       (b)   A sample of iron ore is dissolved in acid and precipitated as $Fe_2O_3.xH_2O$. Then the precipitate is filtered, washed and ignited to Fe_2O_3, find the gravimetric factor to calculate the percentage of iron in the sample.

(g)   A mixture containing only Al_2O_3 and Fe_2O_3 weighs 2.019 g. When heated under a stream of H_2, Al_2O_3 is unchanged, but Fe_2O_3 is converted into metallic Fe plus H_2O (g). If the residue weighs 1.774 g, what is the weight percent of Fe_2O_3 in the original mixture?
(The molar masses of Al_2O_3, Fe_2O_3, and Fe are 101.96, 159.69 and 55.85 g mol^{-1} respectively)

(h)   Write down a charge balance expression and a mass balance expression for an aqueous solution of $MgCO_3$.

(i)   Calculate the pH of a solution made by mixing 50 mL of 0.1 mol L^{-1} NH3 and 50 mL of 0.040 mol L^{-1} HCl. The K_b of NH_3 is 1.8 x 10^{-5} and K_w is 1.0 x 10^{-14} .

(j)   Draw the titration curves to show the changes in sharpness of the endpoint for 100 mL of 0.1 mol L^{-1} solutions of weak acids of different K_a values (1×10^{-3}, 1×10^{-5} , 1×10^{-7} , and 1×10^{-9}) versus 0.1 mol L^{-1} NaOH.

(10 x 12 marks = 120 marks)

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

<u>Part (A)</u>

Answer <u>all</u> parts.

(a)   (i)   What is meant by the term determinate error and briefly explain the
              different types of determinate errors and give at least two reasons to occur
              in each type of determinate error.

                                                                              (15 marks)

(b)   Define the following terms:
       (i)   Coefficient of variation
       (ii)   Range.

                                                                              (10 marks)

(c)   The percentage of diver's blood alcohol level was measured 4 times and the
       following results were obtained: 0.078, 0.081,0.082 and 0.080. Calculate the
       (i)   Mean blood alcohol level and the standard deviation,
       (ii)   Confidence interval at 90% and ~~99%~~ .95%,

       Hint:- the t values are given in the table below:

Degree of freedom	90% confidence	95% confidence
3	2.353	5.841
4	2.132	4.604
5	2.015	4.032

                                                                              (30 marks)

(d)   A mixture weighing 7.290 mg contained only cyclohexane, C_6H_{12}, and oxiräne,
       C_2H_4O. When the mixture was analyzed by combustion analysis, 21.999 mg of
       CO_2 was produced. Find the weight percent of oxirane in the mixture.
       (The molar masses of C_6H_{12}, C_2H_4O, and CO_2 are 84.159, 44.053 and 44.010 g
       mol^{-1} respectively).

                                                                              (20 marks)

Part (B)

Answer all parts.

(a) Calculate the pH at 0.0, 10.0, 20.0, 25.0, 49.50, 49.0, 50.0, 50.1, 51.0 and 60.0 mL of titrant in the titration of 50.0 mL of 0.100 M acetic acid with 0.100 M NaOH. Construct the titration curve for this titration and predict the suitable indicator. Explain your answer.

(K_a value for acetic acid is 1.76×10^{-5})

(40 marks)

(b) (i) Give the steps in systematic approach in equilibrium calculations.

(ii) Calculate the pH of 0.1 mol L^{-1} Na_3PO_4 solution, using systematic equilibrium method. Express your answer with correct significant figures, [The ionization constant values of phosphoric acid (K_{a1}, K_{a2}, and K_{a3}) and water (K_w) are given below:$K_{a1} = 7.1 \times 10^{-3}$, $K_{a2} = 6.3 \times 10^{-8}$, $K_{a3} = 4.2 \times 10^{-13}$, $K_w = 1.0 \times 10^{-14}$]

(40 marks)

Periodic table of the elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.0																	2 He 4.0
3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.1
11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	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
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)