RAJARATA UNIVERSITY OF SRI LANKA
FCULTY OF APPLIED SCIENCES
B.Sc. Second year Semester II Examination – April /May 2015
CHE 2103 –Analytical Chemistry I

Answer both questions. Time: 1 hour

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The use of non-programmable calculator is permitted.

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

(i) What is the pH of an aqueous solution when the concentration of hydrogen ion is $5.0 \times 10^{-4}$ M?

(ii) $\dfrac{3.2\times10^{3}}{5.7\times10^{-2}}$

(b) Calculate the mean, standard deviation (SD), and coefficient of variation (CV) for the following data: 44, 47, 48, 43, and 48. Give the relevant equation in each calculation.

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

$$\left(\frac{4.3(\pm2.5)}{4.6(\pm0.5)\times1.6(\pm0.8)}\right)$$

(d) Use the $Q$ test to determine the value 3.483 can be dropped from the following data set in 90 % and 95 % confidence level;

3.274, 3.258, 3.265, 3.258, 3.350, 3.483

Hint:-

| Number of Observations, *n* | 90% C.L. | 95% C.L. | 99% C.L. |
|---|---|---|---|
| 3 | 0.941 | 0.970 | 0.994 |
| 4 | 0.765 | 0.829 | 0.926 |
| 5 | 0.642 | 0.710 | 0.821 |
| 6 | 0.560 | 0.625 | 0.740 |

(e) What is the pH of a $7.900 \times 10^{-8}$ M solution of the strong acid HI?

(f) How much lead (II) nitrate do you need to weigh out to produce 500 mL of an aqueous solution in which the concentration of $Pb^{2+}$ is 10 mg $L^{-1}$ ?
[Hint: The relative atomic weights of N, O and Pb are 14, 16 and 207 Respectively].

(g) Write a charge balance expression for a calcium oxalate solution ($CaC_2O_4$) that has been buffered so that its pH is constant and equal to 4.00.

(h) (i) Why do you use a pencil and not a pen to mark TLC plates?

(ii) Define $R_f$. Can the $R_f$ value ever be more than 1?

(i) Name three common mobile phases used in gas chromatography (GC).

(j) Draw a block diagram of Gas Chromatograph (GC).

10 x 12 marks = 120 marks)

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

Part (A)

Answer all parts.

(a) Explain the following terms:

(i) accuracy
( ii) determinate error
(iii) precision
(iv) indeterminate error,

(20 marks)

(b) The following data were obtained in an atomic emission spectroscopy experiment for the standard solutions of calcium ion concentrations and the sample of house hold tap water.

| Concentration of Ca / ppm | Emission |
|---|---|
| 493 | 1.035 |
| 370 | 0.905 |
| 247 | 0.735 |
| 123 | 0.512 |
| 0 | 0.0 |
| Tap water | 0.790 |

Calculate the calcium ion concentration in house hold tap water using the linear least squares for the above data.

[Hint: slope of the least square line , $m = \dfrac{\sum x_i y_i - \left[\left(\sum x_i \sum y_i\right)/n\right]}{\sum x_i^2 - \left[\left(\sum x_i\right)^2/n\right]}$

(30 marks)

(c) Ammonical nitrogen can be determined by treatment of the sample with chloroplatinic acid.

$$H_3PtCl_6 + 2NH_4^+ \rightarrow (NH_4)_2PtCl_6 + 3H^+$$

The precipitate decomposes on heating, yielding metallic platinum and gaseous products.

$$(NH_4)_2PtCl_6 \rightarrow Pt + 2Cl_2 + 2NH_3 + 2HCl$$

Calculate the percentage of ammonia in a 0.2213g sample that gave rise to 0.5881g of platinum.

[Hint: The relative atomic weight of H and Pt are 1 and 195.1 respectively].

(30 marks)

Part (B)

Answer all parts.

(a) The calcium in a 200.0 mL sample of a natural water was determined by precipitating the cation as $CaC_2O_4$. The precipitate was filtered, washed, and ignited in a crucible with an empty mass of 26.6002 g. The mass of the crucible plus CaO (fwt = 56.077 g/mol) was 26.7134 g. Calculate the concentration of Ca (fwt = 40.078 g/mol) in the water in units of grams per 100 mL.

(20 marks)

(b) Calculate the molar solubility of CuS in a solution in which the $H_3O^+$ concentration is held constant at 0.1 mol $dm^{-3}$.

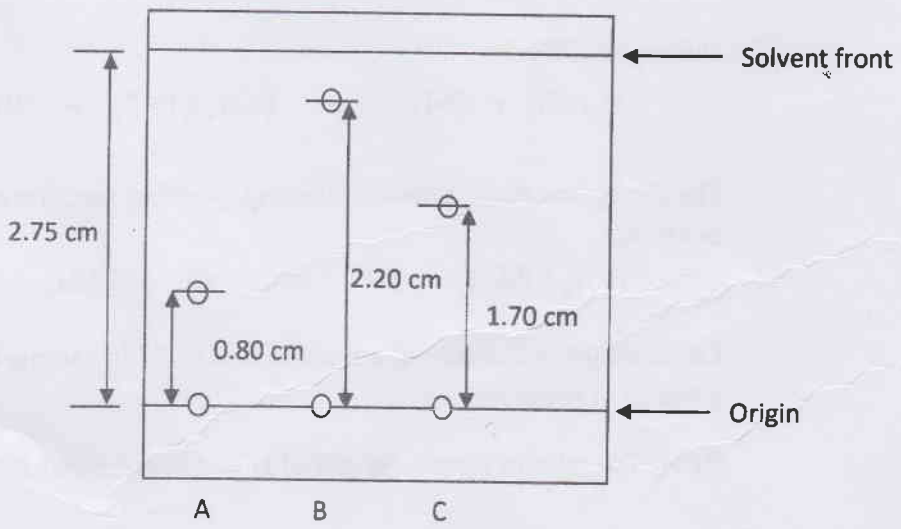
(30 marks)

Hint: The solubility constant, Ksp of CuS, ionic product of water, Kw, $Ka_1$ and $Ka_2$ values of $H_2S$ are as follows:

$K_{sp} = 8 \times 10^{-37}$ mol$^2$ dm$^{-6}$ $\quad$ $Ka_1 = 9.12 \times 10^{-8}$ mol$^2$ dm$^{-6}$

$K_w = 1.0 \times 10^{-14}$ mol$^2$ dm$^{-6}$ $\quad$ $Ka_2 = 1.10 \times 10^{-12}$ mol$^2$ dm$^{-6}$

(c) Consider the following silica gel TLC plate of compounds A, B, and C developed in hexanes:



(i) Determine the $R_f$ values of compounds A, B, and C run on a silica gel TLC plate using hexanes as the solvent.

(ii) Which compound, A, B, or C, is the most polar?

(iii) What would you expect to happen to the $R_f$ values if you used acetone instead of hexanes as the eluting solvent?

(iv) How would the $R_f$ values change if eluted with hexanes using an alumina TLC plate?

**(30 marks)**