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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. in Applied Sciences
Second Year – Semester II Examination – September/October 2020

CHE 2103 – ANALYTICAL CHEMISTRY

Time: One (01) hour.

Answer both questions.
Use of a non-programmable calculator is permitted.

1. a) Calculate the answer and determine the standard deviation of the result and round off the answer only significant digits are retained.

$$\frac{[14.3(\pm 0.2) - 11.6(\pm 0.2)] \times 0.050(\pm 0.001)}{[8.20(\pm 10) + 1030(\pm 5)] \times 42.3(\pm 0.4)}$$

   b) The solubility product of Ksp, for the silver salt, AgI is $[4.0\ (\pm 0.4)] \times 10^{-8}$, calculate the solubility of AgI and uncertainty in it.

   c) The CaO percentages obtained from the replicate analysis of a calcite sample were 56.00, 55.95, 56.08, 56.04, and 56.35. The last value appears anomalous. Should this result be retained or rejected at 90% confidence level.

   Hint:- Q test decision level at 90 % confidence level

N	3	4	5	6
Q	0.94	0.76	0.64	0.56

   d) The following results were obtained by replicate determination of calcium on a blood sample using an atomic absorption spectrophotometer (AAS) and a calorimeter. Is there a significant difference in the precision of the two methods at the 95% confidence level?

AAS, mg/dL	Colorimetric, mg/dL
10.9	9.2
10.1	10.5
10.6	9.7
11.2	11.5
9.7	11.6
10.0	9.3
	10.1
	11.2

Hint: - values of F at the 95% Confidence Level.

	$v_1 = 2$	3	4	5	6	7	8
$v_2 = 2$	19.0	19.2	19.2	19.3	19.3	19.4	19.4
3	9.55	9.28	9.12	9.01	8.94	8.89	8.85
4	6.94	6.59	6.39	6.26	6.16	6.09	6.04
5	5.79	5.41	5.19	5.05	4.95	4.88	4.82
6	5.14	4.76	4.53	4.39	4.28	4.21	4.15
7	4.74	4.35	4.12	3.97	3.87	3.79	3.73
8	4.46	4.07	3.84	3.69	3.58	3.50	3.44

e) A 9.709 g crude sodium carbonate sample is dissolved in water and diluted to 1.00 L with distilled water. A 10.00 mL sample is taken from the flask and titrated to equivalence point with 16.90 mL of a 0.1022 M HCl solution. Determine the percentage of Na_2CO_3 in the sample. (Molar mass of Na_2CO_3 is = 106 g mol^{-1})

f) Calculate the molar solubility of $Cr(OH)_3$ in a solution buffered at pH = 11. ($Ksp = 6.7 \times 10^{-31}$)

g) How many grams of sodium formate do you need to add to 400.0 mL of 1.00 M formic acid to prepare a pH 3.5 buffer?
($Ka = 1.77 \times 10^{-4}$, molar mass of sodium formate = 68.0069 g mol^{-1})

h) What is the pH when 25.0 mL of 0.200 M of CH_3COOH has been titrated with 35.0 mL of 0.100 NaOH?

$(15 \times 08 = 120$ marks)

2. Answer either <u>Part A</u> or <u>Part B</u>.

<div align="center">Part A</div>

a) The following measurements of absorbance for six known concentrations of protein solutions were obtained using a spectrophotometer. Use the method of least squares to obtain the best straight line for the calibration curve and calculate the ;

    i.   protein level of the urine sample, if the absorbance of the sample was 0.380,

    ii.   standard deviation of the absorbance values.

| Amount of Protein	Absorbance
0.0	0.099
5.0	0.185
10.0	0.282
15.0	0.345
20.0	0.425
25.0	0.483
For blank	0.099

Hint:- $s_y = \sqrt{\dfrac{\sum (d_i)^2}{n-2}}$ where $d_i = y_i - mx_i - b$

$$m = \frac{\sum x_i y_i - \left[\left(\dfrac{\sum x_i \sum y_i}{n} \right) \right]}{\sum x_i^2 - \left[\dfrac{\left(\sum x_i \right)^2}{n} \right]}$$
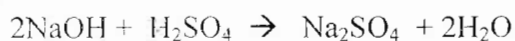
<div align="right">(40 marks)</div>

b) Tablets of ascorbic acid are commonly taken as a source of vitamin C. The following procedure was used to determine the percentage, by mass of ascorbic acid in vitamin C tablets.

    <u>Step 1</u>   Five vitamin C tablets, each of mass 500 mg, were crushed and added to 50.0 mL of 1.0 mol L^{-1} NaOH solution.

                      $C_6H_8O_6 + NaOH \rightarrow NaC_6H_7O_6 + H_2O$
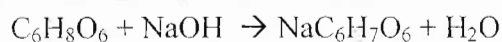
    <u>Step 2</u>   The excess NaOH was titrated with 0.50 mol L^{-1} H_2SO_4 solution from a burette.

                      $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

In the titration 38.79 mL of H_2SO_4 was required to react completely with the excess NaOH. Calculate the total mass of ascorbic acid in the tablets and hence the percentage, by mass, of ascorbic acid in the tablets.
(H = 1 , C =12, O = 16)

(40 marks)

Part B

a)   i.   Give the steps involving in the gravimetric analysis by precipitation in determining the percentage of Ca present in limestone.

      ii.   A 2.00 g sample of limestone was dissolved in HCl and all the calcium present in the sample was converted to calcium oxalate, CaC_2O_4 (s) by adding excess ammonium oxalate solution, $(NH_4)_2C_2O_4$.
The precipitate was filtered, dried and weighed to a constant mass of 2.43 g. Determine the percentage by mass of calcium in the limestone sample.
(relative atomic masses of C =12.01, O = 16.00, Ca = 40.08)

(40 marks)

b)   0.7209 g of a mixture contains only $MgCl_2$ and $NaNO_3$. An excess of $AgNO_3$ solution was added to the mixture and the solid precipitate was obtained. Then the precipitate was filtered and dried. The mass of the solid was 1.032 g.
Determine the percentage of $MgCl_2$ and $NaNO_3$ in the mixture. Discuss three possible sources of error in this experiment.
(Formula weights of $MgCl_2$ and AgCl are 95.20 g mol^{-1} and 143.32 g mol^{-1} respectively).

(40 marks)

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