

Index Number:



UNIVERSITY OF RUHUNA
FACULTY OF FISHERIES AND MARINE SCIENCES &
TECHNOLOGY

Academic Year 2023/2024

Bachelor of Science Honours in Fisheries and Marine Sciences Degree/ Bachelor of
Science Honours in Marine and Freshwater Sciences Degree

Level II Semester I Examination – Oct / Nov- 2024

CHM 1122: Analytical Chemistry- I

Time: 1 hour and 30 minutes

Answer any three (03) questions.

01. Answer **all** parts

a. Define the following terms pertaining to volumetric analysis.

- Primary standard
- End point
- Equivalence point

(15 marks)

b. Consider the titration of 25.00 mL of $0.1 \text{ mol dm}^{-3} \text{ NH}_4\text{OH}$ solution with $0.1 \text{ mol dm}^{-3} \text{ HCl}$ solution. Calculate the pH at the following points (i-iii).

$$K_b (\text{NH}_4\text{OH}) = 1.8 \times 10^{-5} \text{ mol dm}^{-3}, K_w \text{ at } 25^\circ\text{C} = 1 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$$

- Before titrant is added (initial pH).
- After adding 10.00 mL of titrant
- At the equivalence point
- Sketch the titration curve and propose a suitable indicator for this titration.

(55 marks)

c. A solution labeled "S" was prepared by using a solid containing Na_2CO_3 and NaHCO_3 . A 25.00 mL aliquot of "S" was titrated with $0.010 \text{ mol dm}^{-3} \text{ HCl}$ solution to the phenolphthalein endpoint. The endpoint was observed at 10.00 mL. The same titration was performed separately to the methyl orange endpoint and the endpoint was 25.00 mL. Calculate the concentrations of Na_2CO_3 and NaHCO_3 in ppm.

(30 marks)

02. Answer **all** parts.

- a. Considering complexometric titrations.
 - i. Explain why the maintaining pH is important during the titration.
 - ii. List five different uses in analysis.
 - iii. Explain the reason for performing back titration in certain occasions.

(30 marks)

- b. A recent study has discovered the upstream of raw water source of a water treatment plant has been contaminated with Ni^{2+} . To take necessary actions it was necessary to check whether the treatment process was working properly or not for removing Ni^{2+} . In order to do that the following analysis was carried out.

After diluting a 10.00 mL of contaminated water sample 10-fold, a 25.00 mL aliquot was mixed with 30.00 mL of $0.0100 \text{ mol dm}^{-3}$ EDTA solution. Then the solution was adjusted to a pH of 10 and titrated with $0.0080 \text{ mol dm}^{-3}$ Zn^{2+} solution to the EBT endpoint. The endpoint was observed at 20.15 mL.

- i. Write down all the possible reactions that may occur during the titration.
- ii. Calculate the molarity of Ni^{2+} of the upstream raw water sample.

(30 marks)

- c. Formation of precipitate is a crucial step in gravimetric analysis and precipitation titration.
 - i. What are the main phases in precipitate formation?
 - ii. Briefly explain the methods that can be used to maximize the crystal growth.
 - iii. Suppose that a water sample is given to you to analyze its Cl^- ion concentration using a precipitation titration method. If the pH of the medium is found to be slightly acidic. Propose a suitable argentometric titration method for this analysis.

(40 marks)

03. Answer **all** parts.

- a. Describe the following terms.
 - i. Population
 - ii. Accuracy
 - iii. Absolute error
 - iv. Systematic errors

(25 marks)

- b. The following values were obtained for the Fe^{3+} ion concentration in a sediment samples collected from different locations. 0.52, 0.53, 0.49, 0.82, 0.52, 0.59, 0.56 and 0.60 ppm. Perform the Q test on the above data set and reject the data points which are not acceptable within the 90% confidence level. (30 marks)

- c. Calculate the following parameters for the data set accepted after the Q test.

- Mean
- Standard deviation
- Variance
- Relative standard deviation.

(45 marks)

04. Answer **all** parts

- a. Redox titrations are well-known titrimetric analyses based on oxidation-reduction reactions. Give short answers to the following questions regarding redox titrations.

- Define the terms “**oxidation**” and “**reduction**”.
- Mention three types of redox indicators.
- State five uses of redox titration in analysis.

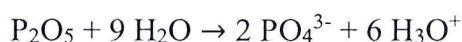
(30 marks)

- b. Suppose that a solid sample from iron ore is analyzed for its iron composition as follows. A 0.8040-g sample of iron ore is dissolved in acid. The iron is then reduced to Fe^{2+} and titrated with 47.22 mL of $0.02242 \text{ mol dm}^{-3}$ KMnO_4 solution. Calculate the results of this analysis in terms of

- % Fe (55.847 g/mol) and
- % Fe_3O_4 (231.54 g/mol)

(45 marks)

- c. Phosphorus which is considered to be present as P_2O_5 , in a 4.258-g sample of a plant food, was converted to PO_4^{3-} according to following reaction and precipitated as Ag_3PO_4 by adding 50.00 mL of $0.0820 \text{ mol dm}^{-3}$ AgNO_3 . The excess AgNO_3 was back-titrated with 4.06 mL of $0.0625 \text{ mol dm}^{-3}$ KSCN .



Express the results of this analysis in terms of % P_2O_5 . $M_{\text{P}_2\text{O}_5} = 313 \text{ g/mol}$

(25 marks)

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N	Q_{crit} (CL:90%)	Q_{crit} (CL:95%)	Q_{crit} (CL:99%)
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
7	0.507	0.568	0.680
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568

Part II

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CHM 2111: Analy

Instructions

- Answer Part I
- In each of the q
is correct or m
- Use the answer