



UNIVERSITY OF RUHUNA

FACULTY OF FISHERIES AND MARINE SCIENCES TECHNOLOGY

Bachelor of Science Honors in Fisheries and Marine Sciences Degree/

Bachelor of Science Honors in Marine and Freshwater Sciences Degree

Level II, Semester-II Examination -2024/2025

CHM 2212: Physical Chemistry

Time: 1 hour and 30 minutes

Part -II

Answer **only Two (02)** questions

1)

A) i) What is meant by the “half-life ($t_{1/2}$)” of a chemical reaction? (05 marks)

ii) Ammonium nitrate, a popular ingredient in plant fertilizer, decomposes at 300 °C to form nitrous oxide and water.



The rate constant for this first-order reaction is $7.3 \times 10^{-4} \text{ s}^{-1}$. What is the half-life of ammonium nitrate in this reaction? (10 marks)

B) i) Write **four (04)** factors that affect the rate of a chemical reaction. (10 marks)

ii) The rate constant for the following **second-order reaction** is $0.80 \text{ M}^{-1} \text{ s}^{-1}$



a) Write the rate law for this reaction. (10 marks)

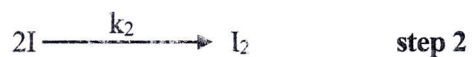
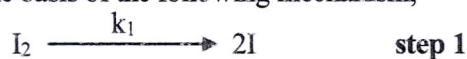
b) Calculate the concentration of NOBr after 22 seconds if the starting concentration is 0.086M. (10 marks)

C) i) State the difference between an elementary reaction and a consecutive elementary reaction. (10 marks)

ii) a) Use the steady state approximation (SSA) to derive the rate law for the formation of HI.



On the basis of the following mechanism,



b) If step 3 is the slowest step, simplify the rate law you derived in ii(a).
Note: if step 3 is slow, k_3 and $k_2 \gg k_1$ and consider $k_1 k_2 / k_3 = K$ (05 marks)

c) If large quantity of H_2 is used compared to I_2 simplify the rate law you derived in ii(a).
Note: Now, $k_2 [H_2] \gg k_3$ (05 marks)

2)

A) i) What is meant by the "Critical Micelle Concentration" (05 marks)

ii) Write **two (02)** differences between lyophilic sols and lyophobic sols. (10 marks)

iii) "Surfactants are responsible for the cleaning action in detergents". Briefly explain how they help remove dirt from surfaces. (10 marks)

B) i) State any **two (02)** assumptions of the Langmuir Isotherm. (05 marks)

ii) The mathematical equation for the Langmuir isotherm is $\frac{V}{V_m} = \frac{KP}{1+KP}$

a) What do each of the symbols V , V_m , K , and P represent? (10 marks)

b) Rearrange this to get a linear form of the Langmuir isotherm equation. (10 marks)

iii) The following data were obtained for adsorbing of nitrogen on a chromium-alumina catalyst at low temperature. The volume adsorbed was measured in all cases

P_{N_2} /mmHg	0.19	0.97	1.90	4.05	7.50	11.95
V / cm^3	0.042	0.163	0.221	0.321	0.411	0.471

a) Plot the data and confirm that they fit the Langmuir isotherm. (15 marks)

b) Estimate the values of V_m and K . (10 marks)

C) i) The normal boiling point of a solution contacting 105.5 g of a nonionic solute and 625 g water is 102.70 °C. Calculate the molar mass of the solute. The boiling point elevation constant, K_b of water, is 0.512 °C kg/mol. (15 marks)

ii) Suppose the same mass of NaCl is dissolved in water instead of the nonionic solute. Compare and explain how the boiling point elevation would change in this case. (10 marks)

3)

A) Give brief answers to the following questions.

i) Define the term ideal gas

ii) Using the universal gas equation, derive Charles's law (20 marks)

B) A Container filled with nitrogen gas, at a known temperature, has a 2.0 dm^3 volume under 150 kPa pressure. At the same temperature container filled with oxygen gas has a 3.0 dm^3 volume under 180 kPa . Without changing the temperature, these two gases were added to a container with a 5.0 dm^3 volume. Calculate the partial pressures of two gases and the total pressure of the system.

(05 marks)

(05 marks)

(30 marks)

C) Laws of thermodynamics can be used to explain many biological and physical processes in the universe.

(50 marks)

- i) Mention the first two laws of thermodynamics.
- ii) Define the term "Enthalpy" using the first law of thermodynamics.
- iii) One mole of a perfect gas expands from 5 to 1 atm at 298 K . Calculate (I) q , (II) w , (III) ΔU , and ΔH if the expansion is carried out reversibly.

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