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 II Examination – April/May 2024
CHM 2212: Physical Chemistry I-Theory

Part II -(70 marks)

I) Answer all parts

a)

I) Derive the integrated rate law for the following first-order reaction assuming that the rate constant of the reaction is k, the initial concentration of A is $[A]_0$, and the concentration of A at time t is [A].

$$A \rightarrow B$$

(05 marks)

II) Prove that the half-life of a first-order reaction is independent of the initial concentration of the reactant.

(03 marks)

III) The ^{14}C is a radioactive isotope used to date archeological samples. Its radioactive decay is a first-order process with a rate constant of 1.22×10^{-4} yr^{-1}. Calculate the half-life of this radioactive isotope.

(02 marks)

b)

I) Distinguish between adiabatic and diathermic boundaries.

(04 marks)

II) State the relationship between enthalpy change (ΔH) and change in internal energy (ΔU).

(02 marks)

III) The internal energy change in the conversion of 1.0 mol calcite form of $CaCO_3$ to the aragonite is +0.21 kJ. Calculate the difference between the enthalpy change and the change in internal energy when the pressure is 1.0 bar and the densities of the solids are 2.71 and 2.93 g cm^{-3}, respectively.

(04 marks)

c)

I) State what is meant by the "rate law" of a reaction.

(02 mark

II) Using steady-state approximation, derive the rate law for the decomposition of ozone in th reaction, **$2\ O_3(g) \rightarrow 3\ O_2(g)$,** on the basis of following mechanism:

$$O_3(g) \rightarrow O_2(g) + O(g) \qquad k_a$$
$$O_2(g) + O(g) \rightarrow O_3(g) \qquad k'_a$$
$$O(g) + O_3(g) \rightarrow O_2(g) + O_2(g) \qquad k_b$$

(10 marks)

III) The decomposition of dimethyl ether at 504 °C is first order with a half-life of 1570 s. What fraction of the initial amount of dimethyl ether remains after 4710 s?

(03 marks)

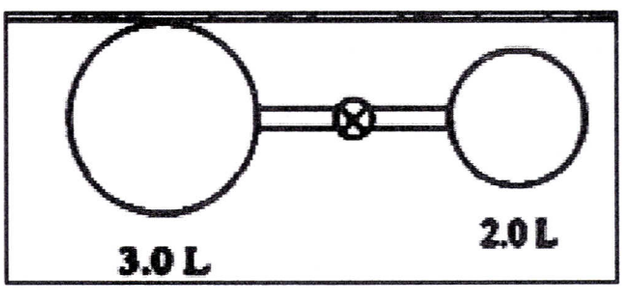
2) Answer all parts

a)

I) State 03 (three) properties of an ideal gas.

(03 marks)

II) Consider the two bulbs joined by a tube of negligible volume as illustrated in the following diagram. If the valve between the 2.00-L bulb, in which the gas pressure is 1.00 atm, and the 3.00-L bulb, in which the gas pressure is 1.5 atm, is opened, what is the final pressure in the two bulbs? Asume that the temperature is kept constant in both bulbs.



(04 marks)

III) State what is meant by colligative properties and provide one example.

(03 marks)

b)

(02 marks)

ɔn of ozone in the

(10 marks)

ˈ1570 s. What

(03 marks)

(03 marks)

he following
atm, and the
essure in the

04 marks)

03 marks)

I) Briefly describe free expansion in thermodynamics.

(02 marks)

II) Starting from dw = -pdV, show that the work done in an isothermal reversible expansion of an ideal gas is equal to -nRT$ln\left(\frac{V_f}{V_i}\right)$. Note that all symbols have their usual meanings.

(04 marks)

III) Calculate the work done when 50 g of iron (molar mass 55.85 g/mol) reacts with hydrochloric acid in,

A. A closed vessel of fixed volume,

B. An open beaker at 25 °C.

(04 marks)

c)

I) State 02 (two) properties of a colloidal system.

(02 marks)

II) Distinguish between cohesive and adhesive forces.

(02 marks)

III) Distinguish between lyophilic and lyophobic colloids.

(06 marks)

IV) In water, the fluorescence quantum yield and observed fluorescence lifetime of tryptophan are φ_f = 0.20 and τ_0 = 2.6 ns, respectively. Calculate the fluorescence rate constant of tryptophan in s^{-1}.

(05 marks)

@@@@@@@@@@