Assignment 8

## Indian Institute of Science Education and Research

CHM202: Energetics and dynamics of chemical reactions

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Ques. 1 A reactant R undergoes three first-order parallel reactions to give three products P_1, P_2 and P_3.write the expression for the rate equation of each species. Show that the products are formed in the ratio of the rate constants for respective reactions i.e. $[P_1]: [P_2]: [P_3] = k_1: k_2: k_3$

**Ques. 2** Consider the following two parallel irreversible first order reactions at temperature T,

$$P \xrightarrow{k_1} Q$$
$$P \xrightarrow{k_2} R$$
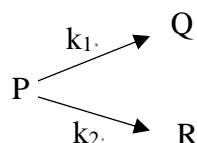
Where k_1 and k_2 are rate constants and their values are 5×10^{-2} min^{-1} and 15×10^{-2} min^{-1} respectively, at temperature T. If the initial concentration of the reactant 'P' is 4 mol L^{-1} then calculate the concentration of product 'R' after 10 minutes of reaction.

Ques. 3 The decomposition mechanism of ozone is:

$$O_3 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} O_2 + O$$
$$O_3 + O \xrightarrow{k_2} 2O_2$$
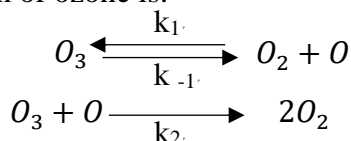
If $k_{-1}[O_2] << k_2[O_3]$, What will be order of the reaction with respect to ozone.

Ques. 4 For a consecutive reaction in which first step is reversible and second step is irreversible.

$$L \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} M \xrightarrow{k_2} N$$
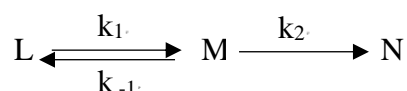
Calculate the rate constant for formation of N. If k_1 is 10^5 L mol^{-1} sec^{-1}, k_{-1} is 10^4 sec^{-1} and k_2 is 10 sec^{-1}.

Ques. 5 Consider two consecutive first order reactions: $A \xrightarrow{k_1} B \xrightarrow{k_2} C$

Assuming $k_1 \neq k_2$ and at time t = 0, only A is present and [B] = [C] = 0.

a) Derive an expression for the t_{max} (i.e. the time when [B] is maximum) in terms of rate constants k_1 and k_2.

b) Derive an expression for [B$_{max}$]. (i.e. maximum concentration of B)

c) Given $k_1 = \left(\frac{\ln 2}{4}\right)$ and $k_1 = \left(\frac{\ln 2}{4}\right)$, calculate time taken by B to reach the maximum concentration.