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Department of Chemical Engineering & Bio Technology

Assignment No.1

Subject: Chemical Reaction Engineering-I

Q1. Experiment shows that the homogeneous decomposition of ozone proceeds with a rate

$-r_{O3} = k [O_3]^2 [O_2]^{-1}$

(a) What is the overall order of reaction?

(b) Suggest a two-step mechanism to explain this rate and state how you would further test this mechanism.

Q2.On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order. For the stoichiometry A + B →R (products) find the reaction orders with respect to A and B.

Q3. Data on the tenebrionid beetle whose body mass is 3.3 g show that it can push a 35-g ball of dung at 6.5 cm/s at 27 C, 13 cm/s at 37 C, and 18 cm/s at 40 C. How fast can it push dung at 41.5 C? [B. Heinrich. The Hot-Blooded Insects Cambridge, Mass.: 1993).]

Q4. Mechanism for enzyme catalyzed reactions. To explain the kinetics of enzyme-substrate reactions, Michaelis and Menten (1913) came up with the following mechanism, which uses an equilibrium assumption

$$\left.\begin{array}{l} A + E \underset{k_2}{\overset{k_1}{\rightleftharpoons}} X \\ X \xrightarrow{k_3} R + E \end{array}\right\} \text{ with } K = \frac{[X]}{[A][E]}, \quad \text{and with} \quad [E_0] = [E] + [X]$$

and where $[E_0]$ represents the total enzyme and [E] represents the free unattached enzyme. G. E. Briggs and J. B. S. Haldane, Biochem J., 19, 338 (1925), on the other hand, employed a steady-state assumption in place of the equilibrium assumption

$$\left.\begin{array}{l} A + E \underset{k_2}{\overset{k_1}{\rightleftharpoons}} X \\ X \xrightarrow{k_3} R + E \end{array}\right\} \text{ with } \frac{d[X]}{dt} = 0, \quad \text{and} \quad [E_0] = [E] + [X]$$

What final rate form $-r_A$ in terms of [A], $[E_0]$, k_1, $k_2$and k_3 does

(a) The Michaelis-Menten mechanism gives?

(b) The Briggs-Haldane mechanism gives?