



- Notes :
1. All question carry marks as indicated.
 2. Answer **three** question from Section A and **three** question from Section B.
 3. Due credit will be given to neatness and adequate dimensions.
 4. Assume suitable data wherever necessary.
 5. Diagrams and chemical equations should be given wherever necessary.
 6. Illustrate your answer necessary with the help of neat sketches.
 7. Discuss the reaction, mechanism wherever necessary.
 8. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION - A

1. a) What is rate of reaction? What are the factors affecting the rate of reaction? 7
 b) A human beings consumes about 6000kJ of food per day. Assume that the food is all glucose and that the overall reaction is $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O - OH_R = 2816kJ$ Find man's metabolic rate in terms of moles of oxygen used per m^3 of person per second. Assume that density of man is $1000 kg/m^3$. 7

OR

2. a) What is rate constant? 3
 b) What are homogeneous reactions and non homogeneous reactions? Explain with suitable example. 6
 c) On doubling the concentration of reactant, the rate of reaction triples. Find the reaction order. 5
3. a) The pyrolysis of ethane proceeds with an activation energy of about 75000 Cal. How much faster is the decomposition at $650^\circ C$ than at $500^\circ C$. 7
 b) Differentiate between single reaction and multiple reaction. 6

OR

4. a) Phosphine decomposes when heated according to following reaction. 6
 $4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$
 At the given instant, the rate of which phosphine decomposes is $2.4 \times 10^{-3} \text{ mol/(l.s)}$.
 i) Express the rate in three different ways using differential notation and show the relationship between them.
 ii) What is the rate of formation of P_4 and H_2 ?
 b) Explain the order of reaction and rate constant. 7
5. a) Derive the integrated rate equation for unimolecular type Irreversible first order reaction. 5
 b) Derive the integrated rate equation for the autocatalytic reaction $A + R \rightarrow R + R$ for constant volume batch reactor data. 8

6. Determine the reaction order of the given reaction: $A \rightarrow B + 2C$ 13
 This reaction was carried out in the laboratory in an isothermal batch system in which the total pressure was recorded at various time during the reaction. Assume the reactant was initially present in the reaction vessel.

Time (min)	00	2.5	5.0	10.0	15.0	20.0
Total Pressure (mm Hg)	7.5	10.5	12.5	15.8	17.9	19.4

SECTION - B

7. a) Derive the performance equation for ideal batch reactor for variable volume and constant volume reaction system. Also represent it graphically. 7
 b) Assuming a stoichiometry $A \rightarrow R$ for a first order gas reaction. The size of plug flow reactor needed for a given duty ($x_A = 0.9$, pure feed) is 32 lit. If the reaction stoichiometry is $A \rightarrow 3R$ with this corrected stoichiometry what is the required volume. 7

OR

8. a) Define space time and space velocity with suitable example. 6
 b) Derive the performance equation for CSTR for variable volume and constant volume. System. Also represent it Graphically. 8
9. a) A liquid reactant stream (1 mol/l) passes through two mixed flow reactors in series. The concentration of A in the exit of the first reactor is 0.5 mol/L. Find the concentration of A in the exit stream of a second reactor. The reaction follows second order kinetic with respect to A and $\frac{V_2}{V_1} = 2$. 7
 b) Explain the size comparison of single MFR with PFR. 6

OR

10. a) An aqueous reactant stream (4 mol A/lit) passes through a mixed flow reactor followed by a plug flow reactor. Find the concentration at the exit of the plug flow reactor if in the mixed flow reactor $C_A = 1$ mol/lit. The reaction is second order with respect to A and the vol^m of the plug flow unit is three times that of the mixed flow unit. 7
 b) Explain the rate concentration curve for autocatalytic reaction. 6
11. At present conversion is 66.67% for elementary second order liquid phase reaction $2A \rightarrow 2R$ when operating in an isothermal plug flow reactor with a recycle ratio of unity. What will be the conversion if the recycle stream is shut off? 13

OR

12. a) Liquid reactant A decomposes as follows 8
 $A \rightarrow R \quad r_R = K_1 C_A^2, K_1 = 0.4 \text{ m}^3/(\text{mol} \cdot \text{min})$
 $A \rightarrow S \quad r_S = K_2 C_A^2, K_2 = 2 (\text{min})^{-1}$
 A feed of aqueous A ($C_{A0} = 40 \text{ mol/m}^3$) enters a reactor decomposes and a mixture of A, R and S leaves. Find C_R , C_S and Z for $X_A = 0.9$ in a MFR
- b) What is optimum temperature progression? Explain in detail. 5
