17562

14115

3 Hours/100 Marks

Seat No. | | | | | | | | |

***Instructions**: (1) **All** questions are **compulsory**.*
*(2) Answer **each** next main question on a **new** page.*
*(3) Illustrate your answers with neat sketches **wherever** necessary.*
*(4) Figures to the **right** indicate **full** marks.*
*(5) **Assume** suitable data, if **necessary**.*

MARKS

1. A) Attempt **any three** of the following : **(3×4=12)**

a) Give comparison of transition state and collision theories. (two points)

b) Define the terms internal energy, gibbs free energy, entropy and fugacity. (1 mark each)

c) Draw plots of concentration terms v/s time for zero order and first order reactions for a constant volume system.

d) State the meaning of space time and space velocity with their units and mathematical expressions in the case of a flow reactor.

B) Attempt **any one** : **6**

a) For the reaction A $\rightarrow$ products the following data were obtained at 25°C in which the concentration of A is given at different intervals of time :

t, min	0	10	20	30	40
C_A, mol/l	0.860	0.740	0.635	0.546	0.405

Find the order of reaction and the half life period.

b) Draw plots of lnk v/s 1/T, energy of the reacting molecules v/s distance along reaction path for endothermic and exothermic reactions. [2 marks for each plot]

MARKS

2. Solve **any two** of the following : **(2×8=16)**

   a) Derive temperature dependency of the rate constant from transition state theory.

   b) Derive the performance/design equation for a steady state plug flow reactor in terms of conversion.

   c) Draw neat and labelled sketches of fluidized bed reactor and multitubular fixed bed reactor and list two industrial applications of each.

3. Attempt **any four** of the following : **(4×4=16)**

   a) Calculate the increase in entropy of 3 mol. of an ideal gas as it changes from 27°C at 0.20 atm to 727°C at 2 atm. Data : R = 1.987 Cal/(mol.K) and C_p = 7.0 Cal/(mol.K)

   b) Give the steps involved in analysing the kinetic data by the intergral method.

   c) For a reversible gas phase reaction $aA + bB \rightleftharpoons rR + sS$. Derive the relation $K_p = K_c (RT)^{\Delta n}$.

   d) State factors affecting the rate of chemical reaction and units of the rate constant for the first order and zero order reactions if time is in second(s) and concentration is in mol/l. **(2+1+1)**

   e) What do you mean by catalyst deactivation ? What are its different types ? Explain any one of them.

4. A) Attempt **any three** : **12**

   a) Derive an integrated rate expression for a bimolecular second order reaction [$2A \rightarrow R$] in terms of (i) concentration and (ii) conversion.

   b) List merits of (i) fixed bed reactor and (ii) fluidised bed reactor.

MARKS

c) Define ε_A (fractional change in the volume of the reaction system). For $A \rightarrow 3R$ with 40 mole% A and 60 mole% inerts find ε_A.

d) Calculate K_P and K_C for the reaction $CO + \frac{1}{2}O_2 \rightarrow CO_2$.
Data : The partial pressures of the components in a vessel at 3000 K and at equilibrium are $P_{CO_2} = 0.6$ atm, $P_{O_2} = 0.2$ atm and $P_{CO} = 0.4$ atm.

B) Attempt **any one** of the following : **6**

a) At 1100K n-nonane thermally cracks 20 times as rapidly as at 1000 K. Estimate the activation energy for this decomposition.

b) For a reversible reaction $aA + bB \rightleftharpoons rR + sS$, derive the relationship : $\Delta G^\circ = -RT \ln K_p$.

5. Solve **any two** of the following : **(2×8=16)**

a) After 8 minutes in a batch reactor, reactant is 80% converted and after 80 minutes the conversion is 90%. Find the rate expression for this reaction if $C_{A_0} = 1$ mol/l.

b) Derive the performance/design equation for a steady state mixed flow reactor in terms of conversion.

c) In an isothermal batch reactor, the conversion of a liquid reactant A achieved in 13 minutes is 70%. Find the space time and space velocity necessary to effect this conversion (i) in a plug flow reactor and (ii) in a mixed flow reactor. Assume first order kinetics.

6. Attempt **any four** of the following : **(4×4=16)**

a) Show by a graphical procedure how to obtain τ (space time) for a mixed flow reactor and t (batch time) for a batch reactor.

b) Derive the relationship between K_P and X_A. (extent of reaction for a reversible reaction of the type $A \rightleftharpoons R$).

MARKS

c) State the differences between order and molecularity of chemical reaction.

d) For the first order reaction $A \rightarrow R$ occurring in a variable volume batch reactor, obtain the relation $-\ln\left(1-\frac{\Delta V}{\varepsilon_A V_0}\right) = kt$.

e) State any four differences between fixed bed reactor and fluidized bed reactor.

f) List advantages and disadvantages of a batch reactor.
