21718

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.

(6)   Use of Non-programmable Electronic Pocket Calculator is permissible.

Marks

1.   **(A)   Attempt any THREE :**   **12**

(a)   Explain the term rate constant. If concentration is measured in (mol/l) and time in seconds, find the unit of rate constant for 2nd order reaction.

(b)   Define entropy and Gibbs free energy. State their units.

(c)   What is fractional change in volume (E_A) ? For the gas phase reaction A $\rightarrow$ 3R with 50 mole % inerts and 50 mole % A at the start, find E_A.

(d)   Define space time and space velocity for flow reactors with their units and mathematical expression.

(B)   Attempt any ONE :   **6**

(a)   Derive an integrated rate expression for zero order reaction in terms of concentration and conversion. Also give the graphical representation.

(b)   The pyrolysis of ethane proceeds with an activation energy of about 300 kJ/mol. How much faster is the decomposition of 650 °C than at 500 °C ?

2.   **Attempt any TWO :**   16

   (a)   Explain temperature dependency of rate constant from transition state theory.

   (b)   Derive the performance equation for ideal batch reactor for a constant volume. Also show the graphical representation.

   (c)   Explain the methods of catalyst preparation with suitable example.

3.   **Attempt any FOUR :**   16

   (a)   10 gm helium is compressed isothermally and reversibly at 100 °C from a pressure of 3 atm to 15 atm. Calculate the entropy change for this process assuming that helium is an ideal gas.

   $R = 1.987$ cal/(mol.k) and atomic wt. of Helium $= 4$

   (b)   Derive an empirical rate equation for n^{th} order reaction $A \rightarrow$ products using integral method.

   (c)   Based on Van't Hoff equation, explain increase in temperature is not desirable for exothermic reaction.

   (d)   Differentiate between order and molecularity of a reaction. (any 4 points)

   (e)   List the types of catalyst deactivation. Explain any one in detail.

4.   **(A)   Attempt any THREE :**   12

   (a)   Decomposition of a gas is second order when the initial concentration of a gas is 5×10^{-4} mol/l, it is 40% decomposed in 50 min. Calculate the value of rate constant.

    (b)   Give merits and demerits of fluidised bed reactor.

    (c)   Show graphical representation of integrated rate equation in terms of concentration and conversion for constant volume 1st order reaction.

    (d)   Derive the relation between $\Delta G°$ and K_p.

(B) Attempt any ONE :   **6**

    (a)   A certain reaction has a rate given by, $-r_A = 0.005\, C_A^2$, mol/(cm^3.min).

           If concentration is expressed in mol/l and time in hours, what would be the value and units of rate constant ?

    (b)   Derive Von't Hoff's equation.

5.   Attempt any TWO :   **16**

    (a)   Derive an integrated rate expression for constant volume irreversible 2nd order reaction $2A \rightarrow$ products, in terms of concentration. Also give graphical representation.

    (b)   In an isothermal batch reactor, the conversion of a liquid reactant A achieved in 13 min is 70%. Find the space time and space velocity necessary to effect this conversion in a PFR and in a MFR consider 1st order kinetics.

    (c)   Derive performance equation for steady state plug flow reactor. Show graphical representation also.

6.   Attempt any FOUR :   **16**

    (a)   Explain plug flow reactors are not put in series.

(b) Derive the relation between K_p an K_c.

(c) State the factors affecting rate of reaction. (any four points)

(d) Write the stepwise procedure for analysis of kinetic data using integral method.

(e) List the advantages and disadvantages of batch reactor.

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