**Scheme – G**

# Sample Test Paper-I

**Course Name : Diploma in Chemical Engineering**

**Course Code : CH** **17562**

**Semester : Fifth**

**Subject Title : Chemical Reaction Engineering.**

**Marks : 25** **Time: 1 hour**

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**Instructions:**

1. All questions are compulsory.
2. Illustrate your answers with neat sketches wherever necessary.
3. Figures to the right indicate full marks.
4. Assume suitable data if necessary.
5. Preferably, write the answers in sequential order.

**Q1. Attempt any three** **9 Marks**

a) Define the following terms:
   i) Gibbs free energy
   ii) Fugacity
   iii) Internal energy

b) Calculate the increase in entropy of 3 mole of an ideal gas as it changes from 27 $^{o}$C at 0.2 atm to 72 $^{o}$C at 2 atm (R= 1.987cal/mol$^{o}$K, Cp = 7 cal/mol$^{o}$K

c) Distinguish between order of reaction and molecularity of reaction (any three points).

d) Define rate of reaction and rate constant.



**Q2. Attempt any two** **8 Marks**

a) Derive $Kp = Kc (RT)^{\Delta n}$

b) State any four factors affecting the rate of chemical reaction.

c) Decomposition of acetone dicorboxilic acid is the first order reaction
$CO(CH_2COOH)_2 \rightarrow CO(CH_3)_2 + 2CO_2$

| T $^{o}$K | 273 | 293 | 313 | 333 |
|---|---|---|---|---|
| K1 $(S)^{-1}$ | 2.46 x$10^5$ | 47.5 x$10^5$ | 576 x$10^5$ | 5480 x$10^5$ |

Find out energy of activation for this reaction graphically.

**Q3. Attempt any one** **8 Marks**

a) Derive the expression for entropy change of an ideal gas for
   i) Constant pressure process
   ii) Constant temperature process

b) Derive temperature dependency of rate constant from Arrhenius law.

**Scheme – G**

# Sample Test Paper-II

**Course Name : Diploma in Chemical Engineering**

**Course Code : CH** **17562**

**Semester : Fifth**

**Subject Title : Chemical Reaction Engineering.**

**Marks : 25** **Time: 1 hour**

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**Instructions:**

1. All questions are compulsory.
2. Illustrate your answers with neat sketches wherever necessary.
3. Figures to the right indicate full marks.
4. Assume suitable data if necessary.
5. Preferably, write the answers in sequential order.

**Q1. Attempt any three only** **9 Marks**

a) Differentiate between fixed bed and fluidized bed reactor (any three points).
b) Draw a sketch of graphical representation of the performance equation for batch reactor.
c) Define half life period. The half life period for a certain fist order reaction is 2500 sec. how long will it take for (1/4) of reactants to be left behind.
d) Define the terms:
i) Promoters ii) Inhibitors iii) Catalyst Poisons



**Q2. Attempt any two** **8 Marks**

a) Derive an integrated rate expression for first order reaction (A→R) in terms of (a) concentration (b) conversion
b) 400 lit/min of an aqueous feed of A and B with $CA_0$ = 100 mmole/lit and CBo=200 mmole/lit is to be converted into product in a mixed flow reactor. The kinetics and stoictiometry of the reaction are given by
$A+B \rightarrow C \quad -r_A = 200\ C_A C_B$ mol/(litmin)
c) Draw a nature of graph $1/-r_A$ V/s (X ) for the following arrangements :
i) Two PFR of different size are connected in series.
ii) Two MFR of different size are connected in series.

**Q3. Attempt any one** **8 Marks**

a) Derive performance / design equation for first order reaction in a plug flow reactor for constant volume and variable volume batch reactor with graphical representation.
b) Derive an integrated rate expression for zero order reaction (A→R) in terms of (a) concentration (b) conversion. Also write characteristics of zero order reaction.

**Scheme – G**

# Sample Question Paper

**Course Name : Diploma in Chemical Engineering Group**

**Course Code : CH**

**Semester : Fifth** **17562**

**Subject Title : Chemical Reaction Engineering**

**Marks : 100** **Time: 3 hours**

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**Instructions:**

1. All questions are compulsory
2. Illustrate your answers with neat sketches wherever necessary
3. Figures to the right indicate full marks
4. Assume suitable data if necessary
5. Preferably, write the answers in sequential order

**Q1. (A) Attempt any THREE** **12 Marks**

a) Write any four differences between elementary and non-elementary reactions.

b) Derive the van't Hoff equation: $[d \ln K/dT] = \Delta H/RT^2$

c) Decomposition of gas is second order. When the initial concentration of gas is $5x10^{-4}$ mol/lit, it is 40% decomposed in 50 min. calculate the value of rate constant.

d) Define the term space time and space velocity with their units and mathematical expression.

**Q1. (B) Attempt any ONE** **06 Marks**

a) Write stepwise procedure of analyzing the kinetic data by the integral method.

b) List theories of reaction rate constant and compare between them on the basis of :

i) Experiment

ii) Mathematical equation

iii) Activated complex

**Q2. Attempt any TWO** **16 Marks**

a) Derive temperature dependency of rate constant from Arrhenius law.

b) It is proposed to operate a batch reactor for converting A into R. This is a liquid phase reaction with the stoichiometry A→R. Find the time required to drop the concentration of A from $C_{Ao}$=1.3 mol/lit to $C_{Af}$=0.3 mol/ Lit. The rate Vs concentration data are as given below:

| $C_A$ mol/lit | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 | 1.0 | 1.3 | 2.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $-r_A$ mole/lit.min | o.1 | 0.3 | 0.5 | 0.6 | 0.5 | 0.25 | 0.1 | 0.06 | 0.05 | 0.045 | 0.042 |

c) Draw the neat labeled sketch of fixed bed and fluidized bed reactor and explain in brief.

**Q3. Attempt any FOUR** **16 Marks**

a) Calculate $K_y$ and $K_c$ for the reaction:

$CO + ½ O_2 \rightarrow CO_2$

Data: the partial pressures of the components in a vessel at 3000 $^oK$ and at equilibrium are $p_{CO2}$ = 0.6 atm $p_{O2}$=0.2 atm and $p_{CO}$=0.4 atm

b) Define half life period and write the relation between half life and rate constant for first order reaction. State its one characteristics.

c) Define the following terms:

i) Entropy ii)Enthalpy iii) Fugacity iv) Gibbs free energy

d) State any four factors which affect the rate of chemical reaction.

e) Name the three catalyst deactivation categories. Describe any one

**Q4.(A) Attempt any THREE** **12 Marks**

a) Derive an integrated rate expression for zero order reaction (A→R) in terms of (i) concentration (ii) conversion.

b) Define the following terms:

i) Catalyst ii) Promoters iii) Inhibitors iv) Catalyst poisoning

c) Show that the decomposition of $N_2O_5$ at 67$^o$C is a first order reaction. Calculate the value of rate constant.

Data:

| Time, Min | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| $C_{N2O5}$ mol/lit | 0.16 | 0.113 | 0.08 | 0.056 | 0.040 |

d) Derive $Kp = Kc (RT)^{\Delta n}$

**Q4.(B) Attempt any ONE** **06 Marks**

a) Concentration Vs time data for the reaction is give below:

A→R

B→S

| Time(hr) | Concentration of A Mol/lit | Concentration of R Mol/lit |
|---|---|---|
| 0 | 0.100 | 0.00 |
| 2 | 0.050 | 0.050 |

| Time(hr) | Concentration of B Mol/lit | Concentration of S Mol/lit |
|---|---|---|
| 0 | 0.100 | 0.00 |
| 2 | 0.075 | 0.025 |

Calculate

i) Which reaction proceeds at the greatest rate?
ii) What are the rates of formation of R and S?

b) Derive the expression for entropy change of an ideal gas for
i) Constant pressure process
ii) Constant temperature process

**Q5. Attempt any TWO** **16 Marks**

a) Derive the relation for constant volume irreversible second order reaction
A + B → Product using integral method of analysis.
b) Derive the performance equation for constant volume batch reactor where first order reaction takes place. Give the graphical representation also.
c) 1) Draw a nature of graph $(1/-r_A)$ V/s (X ) for the following arrangements :
i) Two different size PFR connected in series.
ii) Two different size MFR connected in series.
2) List type of reactors used in industry and write one application for each type.



**Q6. Attempt any FOUR** **16 Marks**

a) Draw graphical representation of performance equations for batch reactors and Mixed flow reactor.
b) Derive the relationship between $\Delta G^o$ and $K_p$.
c) Differentiate order and molecularity of chemical reaction (any four points).
d) Derive relation $C_A = C_{A0}(1- X_A)$
e) 400 lit/min of an aqueous feed of A and B with $C_{A0}$ = 100 mmole/lit and $C_{Bo}$=200 mmole/lit is to be converted into product in a mixed flow reactor. The kinetics and stoictiometry of the reaction are given by
a. A+B → C $-r_A = 200\ C_A C_B$ mol/(litmin)