314308

24225

3 Hours / 70 Marks Seat No. | | | | | | | | |

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

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following : **10**

a) State Zeroth law of thermodynamics.

b) Define Internal Energy.

c) Give Mathematical Expression of entropy with its SI unit.

d) State Gibbs phase rule.

e) State the characteristics of chemical equilibrium.

f) State any two applications of Zeroth Law.

g) State relation between C_p and C_v.

Marks

2. Attempt any THREE of the following : **12**

a) List different types of equilibrium for thermodynamic system. Give example of each.

b) Discuss temperature dependency of heat capacity.

c) State any eight applications of second law of thermodynamics.

d) Describe H – S diagram for pure substance.

3. Attempt any THREE of the following : **12**

a) Determine ΔU, Q and W for reversible isothermal process.

b) 5 kg of a certain gas is compressed reversibly according to law PV = 0.75 where P is in bar and V is in m^3/kg. The final volume is $1/4^{th}$ of the initial volume. Find the work done on the gas.

c) Explain phase diagram of water system.

d) State Le-chatelier's principle and discuss the effect of following changes on chemical equilibria –

i) Concentration change

ii) pressure change

iii) Temperature change

4. Attempt any THREE of the following : **12**

a) Differentiate between Reversible process and Irreversible process. (any for points)

b) Calculate the entropy change associated with freezing of 1 mol of water at 298 K to ice at 263 K using following data :

i) Heat of fusion of ice at its fusion point (273 K) is 6.00 KJ/mol

ii) C_p of ice = 36.82 J/(mol.k)

iii) C_p of water = 75.31 J/(mol.k)

Marks

c) State and Explain Equations of state for real gases.

d) Calculate the equilibrium constant at 500 K for the reaction $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$. The standard heat of formation of NH_3 at 298 K is -41600 J/mol and the standard free energy of formation of NH_3 is -16500 J/mol. Assume that the standard heat of reaction does not vary over the range 298 K to 500 K.

e) Discuss limitations of first law of thermodynamics and significance of second law of thermodynamics.

5. Attempt any TWO of the following : **12**

a) Derive an expression for work done for Isobaric and Isochoric process.

b) An ideal gas at 300 K and 1000 KPa enters a rigid and insulated apparatus. This gas leaves the apparatus in two streams in equal quantities, one is at 360 K and 100 KPa and the other is at 240 K and 100 KPa. Calculate the total entropy change. Is the process thermodynamically possible ? Take $C_p = 30 \frac{KJ}{Kmol.K}$.

c) Write 'Van't Hoff' equation. State the effect of rise in temperature for –

i) Endothermic reaction,

ii) Exothermic reaction

6. Attempt any TWO of the following : **12**

a) One mole of an ideal gas contained in a piston-cylinder assembly is compressed from 100 KPa and 27°C till its volume is reduced to $\frac{1}{15}^{th}$ of the original volume. The process of compression is polytropic with n = 1.2. Determine –

i) the final temperature and pressure of the gas,

ii) the work done on the gas, and

iii) the heat interaction.

Marks

b) Derive an equation for entropy change during Adiabatic mixing of Two fluids.

c) Calculate the pressure developed by 1 Kmol of ammonia gas contained in a vessel of 0.6 m^3 volume at constant temperature of 200°C by using –

i) the ideal gas equation,

ii) Van der Waals equation ;

1) $a = 0.4233\ N.m^4/mol^2$

2) $b = 3.73 \times 10^{-5}\ m^3.mol$
