22406

21819

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

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(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) Define system and surroundings with respect to thermodynamic process.

b) Define open system and closed system.

c) State Zeroth law of thermodynamics.

d) Give the sign convention used for work done (W).

e) Give the relation between C_P and C_V for ideal gas.

f) Give the formula to calculate Vander Waals constant in Vander Waals equation.

g) Give the equation to calculate entropy change during isothermal mixing of ideal gases.

Marks

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

a) Define extensive and intensive property with example.

b) Show that internal energy is a state function.

c) A system consisting of some fluid is stirred in a tank. The rate of work done on the system by the stirrer is 1678 J/S. The heat generated due to stirring is dissipated to the surroundings. If the heat transferred to the surroundings is 3400 kJ/hour, determine the changes in internal energy.

d) Ten Kilograms of water at 375 k is mixed adiabatically with 30 kg of water at 275 k. Evaluate the change in entropy. Assume that specific heat of water is 4.2 kJ/kg k and is independent of temperature.

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

a) Give the criteria for thermal, mechanical chemical and thermodynamic equilibrium.

b) One mole of an ideal gas is compressed from an initial state of 0.1 MPa and 300 k till its volume is reduced to 1/15 of the original volume. The process of compression can be approximated as poly tropic process with n = 1.2. Determine the final temperature and pressures of the gas.

c) Derive an equation for entropy change of an ideal gas in terms of temperature and volume.

d) Calculate the entropy change when 2 moles of water at 273 k is heated to steam at 473 k.

Cp for water = 4.2 kJ/kg k.

Cp for steam = 1.9 kJ/kg k.

Latent heat of vaporization at 373 k = 2257 kJ/kg.

Marks

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

a) State Gibbs phase rule. A binary mixture of benzene and toluene is in equilibrium with its own vapour. Determine the number of degrees of freedom.

b) Calculate the entropy change for the following gas phase reaction occurring at 1 bar and 298 k.

$CO + \frac{1}{2} O_2 \longrightarrow CO_2$. The absolute entropies of CO, oxygen and CO_2 are respectively 198 J/mol k, 205.2 J/mol k and 213.8 J/mol k.

c) Show that for an equimolar mixture consisting of 2 distinct ideal gases, the entropy change during isothermal mixing is R *l*n 2

d) Derive the relation between Δ G and K.

e) State Lechateliers principle. Based on Lechateliers principle, explain the effect of change in pressure on the dissociation reaction $N_2O_4 \rightleftharpoons 2NO_2$.

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

a) Explain Joule Thomson Porous plug experiment.

b) Draw the phase diagram for carbondioxide system and explain.

c) Calculate Kp for NH_3 synthesis at a total pressure of 30 atm and 400°C. Reaction is $N_2 + 3H_2 \rightleftharpoons 2NH_3$. Percentage of NH_3 at equilibrium is 10%.

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

a) Explain P-V diagram of water.

b) Explain Mollier diagram.

c) Derive the relation between conversion and thermodynamic equilibrium constant for 2^{nd} order reversible reaction of the form $A + B \rightleftharpoons R + S \longrightarrow$ Products.