

# 22406

**22223**

**3 Hours / 70 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.
  - (7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.
  - (8) Use of Steam tables, logarithmic, Mollier's chart is permitted.

**Marks**

- 1. Attempt any FIVE of the following:** **10**
- a) Define adiabatic process.
  - b) Define Isobaric process.
  - c) State the Law of conservation of energy.
  - d) State Joule-Thomson coefficient.
  - e) State the relation between  $C_p$  and  $C_v$ .
  - f) Define degree of freedom.
  - g) State second law of Thermodynamics.

P.T.O.

- 2. Attempt any THREE of the following:** **12**
- a) Define Thermal and Chemical equilibrium.
  - b) Give the equation for calculating  $\Delta U$ ,  $Q$  and  $w$  for constant volume and constant pressure process.
  - c) Calculate  $\Delta U$  and  $\Delta H$  in KJ for 1 Kmol water as it is vapourised at the constant temperature of 373K and constant pressure of 101.3 KPa. The specific volumes of liquid and vapour at these conditions are  $1.04 \times 10^{-3}$  and  $1.675 \text{ m}^3/\text{kmol}$  respectively. 1030 KJ of heat is added to water for this change.
  - d) 10 kg of water at 375 k is mixed adiabatically with 30 kg water at 275 k. What is the change in entropy?  
Assume Sp. heat of water is 4.2 KJ/kgK and is independent of temperature.
- 3. Attempt any THREE of the following:** **12**
- a) Define extensive and intensive property with example.
  - b) Show that  $C_p - C_v = R$  for an ideal gas.
  - c) State Clausius inequality. Give the expression for reversible and irreversible process.
  - d) Determine the changes in entropy when 2 kg of gas at 277 k is heated at constant volume to a temperature of 368 k.  
Assume sp. heat at constant volume = 1.42 KJ/kg.K.

- 4. Attempt any THREE of the following:** **12**
- a) What is the change in entropy when 1 kmol of an ideal gas at 335 k and 10 bar is expanded irreversibly to 300 k and 1 bar? [p = 29.3 KJ/kmol.K.]
  - b) Give the Van der Waal's equation for real gases and give the volumes of constants.
  - c) Two perfectly insulated tanks each of capacity  $1\text{m}^3$  are connected by means of a small pipelines fitted with a valve. Initially the first tank contain's an ideal gas at 300 k and 200 KPa and the second tank is completely evacuated. The valve is opened and the pressure and the temperature are equalised. Determine the change in total entropy.
  - d) Derive the relation between  $K_p$ ,  $K_c$  and  $K_y$
  - e) Calculate the equilibrium constant at 298 k of the reaction.  
$$\text{N}_2\text{O}_{4(\text{g})} \rightarrow 2\text{NO}_{2(\text{H})}$$
given that the standard free energies of formation at 298 k are 97.54D J/mol for  $\text{N}_2\text{D}_4$  and 51310 J/mol for  $\text{NO}_2$ .
- 5. Attempt any TWO of the following:** **12**
- a) Explain Joule Thomson Porous plug experiment.
  - b) Describe T-S diagram.
  - c) Describe temperature dependance of equilibrium constant for exothermic and endothermic reaction based on Vant Hoff equation.
- 6. Attempt any TWO of the following:** **12**
- a) Describe P-V diagram for a pure substance.
  - b) Describe phase diagram for water system with neat sketch.
  - c) Describe relation between conversion and thermodynamic equilibrium constant for second order reversible reaction.
-