Thermodynamics & Biochemical Engg
T.E- BT/V/CBGS/TBE

QP Code : 3425

(3 Hours) [Total marks: 80]

N.B:

1. Question No. 1 is **compulsory.**
2. Attempt any **three** questions out of remaining five questions
3. Make necessary, suitable assumptions and justify the same.
4. Figures to the right indicate full marks.

Q.1 Attempt **any four** questions (20)

a. Explain P-V-T behavior of pure fluids with the aid of pressure-volume diagram.

b. Show that C_p-C_v = R for an ideal gas.

c. Explain the limitations of the first law of Thermodynamics

d. Assuming air to behave as ideal gas, calculate the molar volume of air at 350 K and 1 bar.

e. Explain Le Chatelier's principle and effect of temperature on equilibrium constant

Q. 2. Derive Maxwell relations in detail using first principle. (20)

Q. 3.

a. Find the second and third virial coefficients of the van der Waals equation. (10)

b. Estimate the molar volume of CO_2 at 500 K and 100 bar using Van der Waals equation. The van der Waals constants are 0.364 m^4N/mol^2 and 4.267 x 10-5 m^3/mol. (10)

Q.4.

a) Prove That— (10)

$$C_p - C_v = -T\left(\frac{\partial V}{\partial T}\right)_p^2 \left(\frac{\partial P}{\partial V}\right)_T$$

b) Air initially at 389 K and 8 bar is expanded reversibly and isothermaily to such a pressure that when it is cooled to 278 K at constant volume, its pressure is 2 bar. Assume air to be an ideal gas with C_p = 29.3 J/mol K. Calculate the work, heat transferred, changes in internal energy and changes in enthalpies. (10)

(P.T.O.)

Q. 5.

a) Derive Gibbs-Duhem equation (8)

b) A constant volume bomb is used to burn liquid $C_{10}H_{20}$ to CO_2 and H_2O (l) in oxygen atmosphere at 25 °C which causes 51832 Joules (per gram of C10H20) of heat to evolve. Calculate the standard heat of combustion of fuel at 25 °C assuming that water formed is present in vapor phase. (12)

ΔH^0_{f298}, H_2O (l) = -68,317 Cal/gmole

ΔH^0_{f298}, H_2O (g) = -57,798 Cal/gmole

Q.6. Write short notes on **any four** (20)

a. Carnot cycle

b. Kelvin-Plank Statement

c. Intensive & Extensive properties

d. Cyclic processes and reversible processes

e. First law of Thermodynamics for cyclic and non-flow processes

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