SE/IV/CBSGS/Chemical/ CET-I 8/12/16

Chemical Engg. Thermodynamics - I

Q. P. Code : 573102

(30)

(3 Hours) [Total Marks: 80]

N.B. (1) Question No. 1 is **compulsory.**

(2) Attempt any **three**questions out of remaining **five** questions.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

**1.** Solve any **Five** **(20)**

1.Explain H-T diagram in detail.

2. State and explain in brief Zeroth law of thermodynamics.

3. Distinguish between extensive and intensive properties

4. Explain Fugacity and fugacity coefficient in brief.

5.A car riding downhill at a speed of 20 m/s was applied brake when it was at a height of 30 m vertically above the bottom of a hill. When the car comes to a halt at the bottom of the hill, how much energy as heat must be dissipated by the brakes, if wind and other frictional effects are neglected? The car weighed 1400 kg

6. Prove $C_{P}-C_{V} = T\left(\frac{\partial p}{\partial T}\right)_{V}\left(\frac{\partial V}{\partial T}\right)_{p}$

**2.** 1. An ideal gas is undergoing a series of three operations: The gas is heated at constant volume from 300 K and 1 bar to a pressure of 2 bar. It is expanded in a reversible adiabatic process to a pressure of 1 bar. It is cooled at constant pressure of 1 bar to 300 k. Determine the heat and work effects for each step. Assume Cp = 29.3 KJ/KmolK. **(10)**

2. State Carnot Principal and derive efficiency of Carnot engine. **(10)**

**3.** 1.Find the volume of n.pentane at 500 K and 20 bar for the following cases **(10)**

1. Van der Waals equation 2. Peng Robinson

$T_c$ = 469.6 K, $p_c$ = 33.7 bar, $\omega$ = 0.251

2. A block of 10 kg ice at 00C is dumped in an insulated tank containing 100 kg water at 300C.Calculate the change in entropy of the mixture and entropy generated. The heat capacity of water is 4.24 kJ/kg K and the latent heat of melting of ice is 333.44 kJ/kg. **(10)**

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4. 1. Prove- (10)

1. $\left(\frac{\partial U}{\partial P}\right)_T = -T\left(\frac{\partial V}{\partial T}\right)_P - P\left(\frac{\partial V}{\partial P}\right)_T$

2. $\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P$

2. One kmol of an ideal gas is heated at constant volume from 298 k and 150 kpa to 300 kpa. It is then expanded adiabatically and reversibly to its original pressure 150 kpa. The gas is cooled at constant pressure to its original temperature 298 K. Find the changes in the heat produced, work done, and the ratio of work done to the heat supplied. (10)

$C_p = 7/2$ R KJ/KmolK

5. *1. Show that:* (10)

1. $\mu_{JT} = \frac{1}{C_P}\left[T\left(\frac{\partial V}{\partial T}\right)_P - V\right]$

2. $\left(\frac{\partial C_P}{\partial P}\right)_T = -\mu_{JT}\left(\frac{\partial C_P}{\partial T}\right)_P - C_P\left(\frac{\partial \mu_{JT}}{\partial T}\right)_P$

2.A vessel is divided into two parts by a partition, on one side 4 kmol of nitrogen gas at 80°C and 40 bar and on the other side 2 kmol of argon at 120°C and 20 bar are kept. If the partition is removed and the gases are mixed adiabatically and completely, what is the change in the entropy? Assume nitrogen as an ideal gas with $C_v = 5/2$ R and argon as an ideal gas with $C_v = 3/2$ R. (10)

6. 1.Hydrocarbon oil is to be cooled from 425 K to 340 K at a rate of 5000 Kg/h in a parallel flow heat exchanger. Cooling water at a rate of 10,000 Kg/h at 295 K is a available. The mean specific heats of the oil and water are 2.5 KJ/KgK and 4.2 KJ/KgK respectively. (10)

1. Determine the total change in entropy. Is the process reversible?

2. If a reversible carnot engine is to be operated receiving the heat from the oil and rejecting the heat to the surrounding at 295 K, how much work would be available?

2.Explain Thermodynamic Charts with its applications in detail. (10)