

GUJARAT TECHNOLOGICAL UNIVERSITY
BE - SEMESTER-IV(NEW) – EXAMINATION – SUMMER 2019
Subject Code:2140502
Date:17/05/2019
Subject Name: Chemical Engineering Thermodynamics - I
Time:02:30 PM TO 05:00 PM
Total Marks: 70
Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Derive the expressions for First law of Thermodynamics for non-flow process. **03**
- (b) Starting from the definition of primary thermodynamics properties, derive Maxwell's equations. **04**
- (c) Describe PVT behavior of pure substances using PV and PT diagrams. **07**
- Q.2** (a) Differentiate between: **03**
- (i) State function Vs Path function (ii) Reversible process Vs Irreversible process (3) Closed and Open systems
- (b) Discuss four different correlations to estimate latent heat of vaporization of pure substances. **04**
- (c) An ideal gas initially at 1 bar and 298.15 K is compressed to 5 bar and 298.15 K by a two-step process: first isobaric cooling and then isochoric heating. Calculate ΔU , ΔH , Q , W for each step considering heat capacities independent of temperature, $C_V = 20.78 \text{ J/(mol K)}$ and $C_P = 29.10 \text{ J/(mol K)}$. At 298.15 K and 1 bar the molar volume of the gas is $0.02479 \text{ m}^3/\text{mol}$. **07**
- OR**
- (c) Derive equation of constants of Vander Waal's equation of state in terms of critical constants of a substance using condition at critical point in PV diagram. **07**
- Q.3** (a) Discuss Virial equations and their applications. **03**
- (b) Define i) standard heat of formation ii) standard heat of combustion iii) standard heat of reaction iv) latent heat **04**
- (c) Write a Short note on Claude process for gas liquefaction with neat diagram. **07**
- OR**
- Q.3** (a) Give significance of Compressibility factor and volume expansivity. **03**
- (b) Discuss the Linde process for gas liquefaction. **04**
- (c) State and explain "Two Parameter" theorem of generalized correlations for gases. **07**
- Q.4** (a) Explain the concept of entropy. **03**
- (b) Explain working principle of a heat pump **04**
- (c) State and explain various statements of the second law of thermodynamics. **07**

OR

- Q.4** (a) Discuss about thermodynamic diagrams. **03**
 (b) A block of copper at a temperature of 825 K and weighting 5 kg is dropped into 50 kg water at 300 K. If there are no heat losses what is the change in entropy of (a) copper, (b) water, and (c) copper and water both considered together? C_p of copper is 0.4 kJ/kg K and that of water is 4.2 kJ/kg K. **04**
 (c) Calculate the standard heat of reaction of the methanol synthesis at 800 °C. **07**

$\text{CO}_{(g)} + 2\text{H}_{2(g)} \rightarrow \text{CH}_3\text{OH}_{(g)}$. Consider standard heat of reaction at 298.15 K is -90135 J. $C_p/R = A + BT + CT^2 + DT^{-2}$ J and T is in K.

Gas	A	$B \times 10^3$	$C \times 10^6$	$D \times 10^{-5}$
CH_3OH	2.211	12.216	-3.450	0.0
CO	3.376	0.557	0.0	-0.031
H_2	3.249	0.422	0.0	0.083

- Q.5** (a) Write short note on Choice of Refrigerant for Refrigeration **03**
 (b) Discuss thermodynamics fundamentals of compressors and ejectors in brief. **04**
 (c) Using Maxwell's equation prove that : **07**
 $dH = C_p dT + V(1 - \beta T) dP$
 $dS = C_p dT/T - \beta V dP$.
 Where β = Volume expansivity.

OR

- Q.5** (a) Define: sonic velocity, nozzle and Mach no. **03**
 (b) Describe absorption refrigeration cycle **04**
 (c) Write short note on vapor compression refrigeration cycle **07**

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