Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV(New) • EXAMINATION – WINTER 2016

Subject Code:2140502 **Date:22/11/2016**

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		**Short Questions**	**14**
	1	Define internal energy.	
	2	What is a steady flow process?	
	3	Explain system and surroundings.	
	4	Define the phase rule.	
	5	Define specific heat.	
	6	Define state function.	
	7	What do you mean by equation of state?	
	8	Define sensible heat.	
	9	Define latent heat of sublimation.	
	10	Define standard heat of formation.	
	11	Define standard heat of combustion.	
	12	What is a fundamental property ?	
	13	Write Kelvin-Planck statement for the second law of thermodynamics.	
	14	What is Refrigeration?	
Q.2	**(a)**	State whether the following properties are extensive or intensive: i) temperature, ii) volume, iii) specific volume, iv) heat capacity, v) potential energy, vi) pressure	**03**
	(b)	A special manometer fluid has a specific gravity of 3.65 and is used to measure a pressure of 1.25 bar at a location where the barometric pressure is 760 mm Hg. What height will the manometer fluid register?	**04**
	(c)	For an ideal gas prove that $\frac{\Delta S}{R} = \int_{To}^{T} \frac{C_v^{ig}}{R}\frac{dT}{T} + \ln\frac{V}{Vo}$	**07**
		OR	
	(c)	Derive a mathematical expression of the first law of thermodynamics for a flow process.	**07**
Q.3	**(a)**	Explain the principle of corresponding states.	**03**
	(b)	Discuss any major four desirable properties of a good refrigerant.	**04**
	(c)	Explain PVT behaviour of pure substances with the help of PT and PV diagrams.	**07**
		OR	
Q.3	**(a)**	Explain in brief multistage compression process.	**03**
	(b)	Starting from basic principles, obtain different forms of virial equations. Also, explain the physical significance of virial coefficient.	**04**
	(c)	Explain cubic equations of state and derive expressions of constants a and b of Vander Waal's equations of state in terms of critical properties of a substance.	**07**

Q.4 **(a)** Write a note on third law of thermodynamics. **03**

(b) For steady flow in a heat exchanger at approximately atmospheric pressure, what is the amount of heat required when 10 moles of SO_2 is heated from 200°C to1100°C? Heat capacity of SO_2 is given by: **04**

$Cp^{ig}/R = 5.699 + 0.801 \times 10^{-3}T - 1.015 \times 10^{5}T^{-2}$ J/(mol. K), T is in K

(c) Handbook values for the latent heat of vaporization in J/g are given in the table for benzene at T_n, the normal boiling point. **07**

Calculate: i) the value of the latent heat at T_n by Watson method, given the value at 25°C, ii) the value of the latent heat at T_n by Riedel equation.

Component	$\Delta H^{\ell v}$ at 25°C (J/g)	$\Delta H^{\ell v}$ at T_n (J/g)	T_n (K)	P_c (bar)	T_c (K)
Benzene	433.3	393.9	353.2	48.98	562.2

OR

Q.4 **(a)** Define Hess law and using Hess's law, calculate the heat of formation of methane gas from the following heat of combustion data: **03**

i) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_2(g) + 2H_2O_{(l)}$; $\Delta H_{298} = -890.94$ kJ

ii) $C_{(S)} + O_2(g) \rightarrow CO_2(g)$; $\Delta H_{298} = -393.78$ kJ

iii) $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O\ (l)$; $\Delta H_{298} = -286.03$ kJ

(b) For an ideal gas with constant heat capacities, show that for a temperature increase from T_1 to T_2, ΔS of the gas is greater when the changes occurs at constant pressure than when it occurs at constant volume. **04**

(c) Write a short note on thermodynamics diagrams. **07**

Q.5 **(a)** Define Refrigerator capacity and coefficient of performance. **03**

(b) Drive the equation for enthalpy and Entropy as functions of temperature and pressure. **04**

(c) Show that the maximum fluid velocity attainable for flow through a pipe of uniform cross-section is equal to the sonic velocity. **07**

OR

Q.5 **(a)** Write a short note on ejectors. **03**

(b) Explain the term 'temperature'. Mention different units of temperature and relations among various temperature scales with diagrams. **04**

(c) With neat sketch explain the vapor compression cycle. **07**

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