Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III (New) EXAMINATION – WINTER 2015

Subject Code:2130405 Date:18/12/2015

Subject Name: Thermodynamics

Time: 2:30pm to 5:00pm 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 State Zeroth law of thermodynamics.
2 Write three different units of pressure.
3 Explain system and surroundings.
4 What is steady flow process?
5 Define: internal energy.
6 What do you mean by equation of state?
7 Define: Sensible heat.
8 Define: Latent heat of sublimation.
9 Define: Standard heats of formation.
10 Define: Standard heats of combustion.
11 Define: Standard heats of reaction.
12 Define: Entropy.
13 Define: Heat Pump.
14 What is Refrigeration?

Q.2 **(a)** 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? **03**

(b) Starting from basic principles, obtain different forms of virial equations. **04**

(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**

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

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.

OR

(c) Derive a mathematical expression of the first law of thermodynamic for a flow process. **07**

Q.3 **(a)** Give various statements of the second law of thermodynamics. **03**

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

(c) Explain the factors affecting the choice of a refrigerant with examples. **07**

OR

Q.3 **(a)** Prove that C_p-C_v = R **03**

(b) A refrigeration process operating at a condenser temperature at 290K needs 1 kW of power per ton of refrigeration. **04**
i) What is the coefficient of performance?
ii) How much heat is rejected in the condenser?
iii) what is the lowest temperature the system can possibly maintain?

(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**

Q.4 **(a)** Define the first law of thermodynamics in its various forms. What are its limitations? **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**
$Cpig/R = 5.699 + 0.801 \times 10^{-3}T - 1.015 \times 10^{5}T^{-2}$ J/(mol. K) , T is in K

(c) Explain cubic equations of state and derive expressions of constants 'a' and 'b' of Vanderwaal's equations of state in terms of critical properties of a substance. **07**

OR

Q.4 **(a)** Derive the following Maxwell's equation from the first principle. **03**

$$\left(\frac{\partial T}{\partial V}\right)_S = -\left(\frac{\partial P}{\partial S}\right)_V$$

(b) A system consisting of some fluid is stirred in a tank. The rate of work done on the system by the stirrer is 2.25 hp. The heat generated due to stirring is dissipated to the surroundings. If the heat transferred to the surroundings is 3400 kJ/h, determine the change in internal energy. **04**

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

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

(b) An electric current of 0.5 A from a 12 V supply is passed for 5 minutes through a resistance in thermal contact with saturated water at 1 atm. As a result, 0.798 g of water is vaporized. Assuming that the water vapour behaves ideally, calculate the molar internal energy change and enthalpy change during the process. **04**

(c) A gas is confined in a 0.47 m diameter cylinder by a piston, on which rests a weight. The mass of the piston and weight together is 150 kg. The local acceleration of gravity is 9.813 m/s^2 and the atmospheric pressure is 101.57 kPa. Determine: **07**
i) What is the force in newtons exerted on the gas by the atmosphere, the piston and the weight, assuming no friction between the piston and cylinder? ii) What is the pressure of the gas in kPa? iii) If the gas in the cylinder is heated, it expands, pushing the piston and weight upward. If the piston and weight are raised 0.83 m, what is the work done by the gas in kJ? What is the change in potential energy of the piston and weight?

OR

Q.5 **(a)** Calculate the heat of formation of methane gas from the following heat of combustion data **03**
a) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_2(g) + 2H_2O_{(l)}$; $\Delta H_{298} = -890.94$ KJ
b) $C_{(S)} + O_2(g) \rightarrow CO_2(g)$; $\Delta H_{298} = -393.78$ KJ
c) $H_2(g) + ½\ O_2(g) \rightarrow H_2O$ (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) Explain PVT behavior of pure substances with the help of PT and PVdiagrams. **07**

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