Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2018

Subject Code:2143507 **Date:12/12/2018**

Subject Name:Fundamentals of Stoichiometry

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)** Explain: Fundamental quantities and Derived quantities? **03**

(b) The thermal conductivity of an insulating brick is 0.15 Btu/(ft.h.°F). Express the thermal conductivity in SI units **04**

(c) The average molar mass of a flue gas sample is calculated by two different engineers. One engineer uses the correct molar mass of 28 for N_2 and determines the average molar mass to be 30.08, the other engineer, using an incorrect value of 14, calculates the average molar mass to be 18.74. (i) Calculate the volume % of nitrogen in the flue gases, (ii) If the remaining components of the flue gases are CO_2 and O_2, calculate the volume % each of them **07**

Q.2 **(a)** Explain : Dalton's law and Raoult's law **03**

(b) City gas has composition by volume expressed as : CH_4= 78 % , C_2H_6 = 12% and C_3H_8= 10%, calculate the gas density in kg/m^3 under 585 psig and 37 °C **04**

(c) Bottled liquid gas of the following composition is sold for house hold use: **07**

Components	Mole%	Vapour presure. at 30°C (bar)
n- butane	50	3.4
Propane	45	10.8
Ethane	5	46.6

Determine (1) The pressure of the system and the equilibrium vapour composition at 30°C, and (2) if all ethane is removed from the liquid, the pressure of the system and the vapour composition at 30°C. Assume Raoult's law is applicable

OR

(c) A solution contains 50% Benzene, 30% Toluene and 20% Xylene by weight at a temperature of 100 °C. The vapours are in contact with solution. Calculate the total pressure and molar % compositions of liquid and the vapour. The vapour pressures and the molecular weights are as follows: **07**

Components	Vapour pressure at 100 °C	Mol. weight
Benzene	1340 mm Hg	78
Toluene	560 mm Hg	92
Xylene	210 mm Hg	106

Assume Raoult's law is applicable

Q.3 **(a)** Define : Mass % , Mole % and ppm **03**

(b) The average molecular weight of the mixture of oxygen and sulphur dioxide is found to be 44.8. For 5 kg of this mixture at 298K and 200kPa. Calculate **04**

(a) The partial pressure of oxygen

(b) The volume of mixture

(c) The density at the STP condition

(c) A solution of sodium chloride in water contains 20% NaCl (by mass) at 333 K. The density of the solution is 1.127 kg/L. Find the molarity, normality and molality of the solution. Atomic mass: Na: 23, Cl:35.5 **07**

OR

Q.3 **(a)** Explain: Limiting Reactant, Excess reactant and percent conversion. **03**

(b) 1 kg nitrogen is mixed with 3.5 m^3 of hydrogen at 300 K and 101.3 kPa and sent to the ammonia converter. The product leaving the converter analysed 13.7 % ammonia, 70.32 % hydrogen and 15.98 % nitrogen. **04**

(a) Identity the limiting reactant.

(b) What is the present excess of excess reactant?

(c) What is the present conversion of the limiting reactant?

(c) Calculate the following for the reaction: **07**

$$C_2H_4 + 2Cl_2 \rightarrow C_2HCl_3 + H_2 + HCl$$

(1) The stoichiometric ratio of Cl_2 to C_2H_4

(2) If 4 kmol Cl_2 is used per kmol of C_2H_4, find the % excess Cl_2

(3) The amount of HCl produced from 50 kg C_2H_4 assuming reaction goes to completion.

Q.4 **(a)** Discuss methods of solving material balance problems without chemical reaction. **03**

(b) 2000 kg of wet solids containing 70% solids by weight are fed to tray dyer where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight, calculate: (1) kg of water removed from wet solids (2) kg of the product obtained. **04**

	(c)	A solution of ethyl alcohol containing 8.6% alcohol is fed at the rate of 1000 kg/hr to a continuous distillation column. The product (distillate) is a solution containing 95.5% alcohol. The waste solution from the column carries 0.1% of alcohol. All percentages are by mass. Calculate (a) the mass flow rates of top and bottom products in kg/h and (b) the percentage loss of alcohol	**07**

OR

Q.4	**(a)**	Define: Solubility, Vapour pressure and Boiling point	**03**
	(b)	A single effect evaporator is fed with 10000 kg/hr of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight caustic (NaOH). Calculate (a). Kg/hr of water evaporated (b) kg/hr of thick liquor obtained	**04**
	(c)	The feed to a continuous fractionating column analyzed by weight 28% benzene and 72% toluene. The analysis of the distillate shows 52 % (by weight) benzene and 5 % (by weight) benzene was found in the bottom product. Calculate the amount of distillate and bottom product per 1000 kg of feed per hour. Also calculate the percent recovery of benzene	**07**
Q.5	**(a)**	Define: heat capacity, sensible heat and latent heat	**03**
	(b)	Pure methane is heated from 303 K to 523 K at atmospheric pressure. Calculate the heat added per kmol methane using the following data: $Cp= 26.586 + 7.5820 \times 10^{-3} T - 1.1200 \times 10^{-6} T^2$, kJ/(kmol-K)	**04**
	(c)	The heat of combustion of methane, carbon and hydrogen are -890.4 kJ/mol, -393.51kJ/mol and -285.84 kJ/mol respectively. Calculate the heat of formation of methane.	**07**

OR

Q.5	**(a)**	Define : Adiabatic reaction and adiabatic flame temperature	**03**
	(b)	Calculate the theoretical flame temperature for CO when it is burnt with 100 % excess air. Both the reactants are at 373K. The heat capacities (J/mol.K) (may be assumed constant) are 29.23 for CO, 34.83 for O_2 ,33.03 for N_2 and 53.59 for CO_2. The standard heat of combustion at 298K is -282.99 kJ/mol CO.	**04**
	(c)	Define the following terms with respect to humidification operation: (1) Absolute humidity (2) Relative humidity (3) Percent humidity (4) Dry bulb temperature (5) Wet bulb temperature (6) Dew point temperature (7) Humid Heat	**07**

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