Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2143507 **Date: 12/06/2017**

Subject Name: Fundamentals of Stoichiometry

Time: 10:30 AM to 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Atomic weight : H-1,C-12, O-16, Na-23, Cl-35.5, K-39**

			MARKS
Q.1		**Short Questions**	**14**
	1	Explain Boyle's law	1
	2	Explain Dalton's law	1
	3	Define :degree of freedom	1
	4	What is cox chart?	1
	5	Define: limiting reactant	1
	6	Define: excess reactant	1
	7	What is steady state process?	1
	8	State Roult' law	1
	9	Write Watson equation.	1
	10	What is mass flow rate?	1
	11	Define: mole.	1
	12	10 gal/hr = _____ m^3/s	1
	13	100 J = _____ L.atm	1
	14	10 kW = _____ hp	1
Q.2	**(a)**	Etching operation follows the relation d = 16.2 -16.2 $e^{-0.021t}$., where t is in s and d is in microns. Convert this equation to evaluate d in mm with t in min.	**03**
	(b)	(i) A solution has 100 ^{0}Tw gravity. What is its specific gravity and ^{0}Be? (ii) An oil has a specific gravity of 0.79. Find ^{0}API and ^{0}Be'.	**04**
	(c)	A certain gaseous hydrocarbon is known to contain less than 5 carbon atoms. This compound is burnt with exactly the volume of oxygen required for complete combustion. The volume of reactants (all gases) is 600 ml and the volume of products (all gases) under the same condition is 700 ml. what is the compound?	**07**
		OR	
	(c)	A solution of NaCl in water contains 230 g of NaCl per liter at 20 ^{0}C. The density of the solution at this temperature is 1.148 gm/cc. find the composition in (a) weight % (b) volume % of water (c) mole % (d) atomic % (e) molality (f) molarity (g) g NaCl/ g water.	**07**
Q.3	**(a)**	Explain Recycle , Purge and bypass with suitable diagram	**03**
	(b)	A saturated solution containing 1500 kg of potassium chloride at 360 K is cooled in an open tank to 290 K. If the specific gravity 1.2, the solubility of KCl per 100 parts of water is 53.55 at 360 K and 34.5 at 290 K, calculated the capacity of the tank required	**04**
	(c)	Selective dehydration of alkanes to alkenes is well-	**07**

establish process. In this process, dehydration of i-butane is carried out on a platinum impregnated catalyst at 50 kPa g and 500 ^{0}C. The feed to the reactor is pure i-butane along with 0.75 kmol H_2 per kmol i-butane. Hydrogen stream contains 90 % H_2 and methane (by mole).
Following reactions are known to take place.

$i - C_4H_{10} = i - C_4H_8 + H_2$ ... (1)

$i - C_4H_{10} = i - C_3H_6 + CH_4$ ... (2)

Literature reports 50 % per pass conversion in a battery of three reactors with 88 % yield of i-butylene. Calculate the composition of the product stream leaving the final reactor.

OR

Q.3 **(a)** Define : (1) yield (2) selectivity (3) single fraction conversion **03**

(b) If the dew point of air at 1.013 bar is 278 K, what will be the dew point at 10 bar? The vapour pressure of water in kPa is given by the Antoine equations (T is temp. in ^{0}K) **04**

$$\ln P^S = 16.26205 - \frac{3799.887}{T - 46.854}$$

(c) In a silver electroplating plant, silver nitrate is used. When 1130 amperes were passed through $AgNO_3$ solution for 32000 s , it was found that 2 m^3 oxygen (at NTP) was liberated at the anode. Calculate (a) the amount of silver liberated in kg (b) the current efficiency of the cell. **07**

Q.4 **(a)** Define: (1) Dry bulb temperature (2) wet bulb temperature (3) Absolute humidity **03**

(b) The vapour pressure of water at 363 K and 373 K are respectively 70.11 kPa and 101.3 kPa. Estimate the mean heat of vaporization of water in this temperature range **04**

(c) Calculate the mean heat capacity of a 20 mole percent solution of alcohol in water at 298 K given the following : Heat capacity of water : 4.18 x 10^3 J/kg K; Heat capacity of ethanol : 2.18 x 10^3 J/kg K; and heat of mixing for 20 mol % ethanol-water at 298 K: -758 J/mol; heat of mixing for 20 mol % ethanol-water at 323 K: -415 J/mol. Assume that the heat capacities of pure liquids are constant between 298 K and 523 K. **07**

OR

Q.4 **(a)** Define: (1) Relative humidity (2) Dew point (3) humid heat **03**

(b) Enthalpy of steam at 75 kPa and 573 K is 3075 kJ/kg referred to liquid water at 273 K. if the mean heat capacity of liquid water and water vapour are 4.2 kJ/kg K and 1.97 kJ/kg K respectively, calculate the heat of vapourization of water at 75 kPa. The saturation temperature of water at 75 kPa is 365 K. **04**

(c) Argon gas in an insulated plasma deposition chamber with volume of 2 L is to be heated by an electric resistance heater. Initially the gas, which can be treated as an ideal gas, is at 1.5 Pa and 300 K. The work done by the heater on the gas is 480 J. what is the final gas temperature and pressure at equilibrium? The mass of the chamber is 12 g and its heat capacity is 0.35 J /(g K) . **07**

Assume that the heat transfer to the chamber from the gas at this low pressure and in the short time period is negligible.

Q.5 **(a)** Differentiate between Sensible heat and latent heat **03**

(b) Calculate the standard heat of formation of liquid methanol, given the standard heat of combustion of liquid methanol is -726.55 kJ/mol and the standard heat of formation of gaseous CO_2 and liquid water are, respectively , -393.51 and 285.84 kJ/mol. **04**

(c) A flue gas at 1298 K consisting of CO_2, O_2 and N_2 is passed through a bed of carbon. The following reactions occurs and both go the completion: **07**

$CO_{2(g)} + C_{(s)} \rightarrow 2CO_{(g)}$, $\Delta H^0_r = 170$ kJ/mol

$O_{2(g)} + 2C_{(s)} \rightarrow 2CO_{(g)}$, $\Delta H^0_r = -221.2$ kJ/mol

The combustor is adiabatic and the product gases exit at 1298 K. Calculate the required moles of CO_2 , per moles of O_2 in the feed stream so that the net heat generated is zero and the bed temperature remains constants at 1298 K. the mean molar heat capacities are 0.02, 0.03 , 0.03 and 0.05 kJ/mol K for carbon, oxygen , CO and CO_2 respectively.

OR

Q.5 **(a)** Differentiate between endothermic reaction and exothermic reaction **03**

(b) Calculate the standard heat of the following reaction at 298 K : $C_2H_{12(g)} + 8O_{2(g)} \rightarrow 5CO_{2(g)} + 6H_2O_{(l)}$ The standard heats of formation are as follows: $CO_{2(g)}$ = -393.51 kJ, $H_2O_{(g)}$ = -241.826 kJ, $C_5H_{12(g)}$ = -146.4 kJ. The Latent heat of vapourization of water at 298 K is 43.967 kJ/mol. **04**

(c) Ammonia is produced by the following reaction **07**

$N_2 + 3H_2 \rightarrow 2NH_3$, In a commercial process for ammonia production, the feed to an adiabatic reactor contains 1 kmol/s of nitrogen and stoichiometric amounts of hydrogen at 700 K. what is the maximum allowable conversion in the reactor, if the adiabatic temperature rise across the reactor should not exceed 100 K. Assume that the feed and product streams to be ideal gas mixture. The heat of reaction at 700 K for the above reaction is calculated to be -94.2 kJ/mol. The mean molal heat capacities in the range of 700-800 K are 0.03, 0.0289 and 0.0492 kJ/mol K for nitrogen, hydrogen and ammonia respectively.

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