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

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 2140406 **Date: 03/06/2017**

Subject Name: 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. **Mol. Wt:** Na = 23, K=39, O= 16, H=1, N=14, C=12, M g=24, Ca=40, S=32, Cl=35.5

Q.1		Short Questions	14
	1	Define Yield.	01
	2	Explain the terms Limiting component and Excess	01
	3	Define: Standard Heat of formation	01
	4	Differentiate between Endothermic and exothermic reactions	01
	5	Differentiate between: Sensible heat and latent heat	01
	6	Define: Heat of combustion	01
	7	Define : Dry-bulb temperature	01
	8	Define :Absolute humidity	01
	9	Define :Humid Heat	01
	10	Define: Selectivity	01
	11	Define :Relative humidity	01
	12	Define :Humid heat	01
	13	Define: Selectivity	01
	14	Find out the value of the universal gas constant R in following units: i) atm.lit/gmol.K ii) J/gmol.K	01
Q.2	(a)	Make following conversions: a) 2.1gm/cm^3 to lb/ft^3 (b) 550 kPa to Torr	03
	(b)	A sample of milliolite limestone, obtained from Porbandar, Gujrat, is found to contain 54.5% CaO (by weight). If this CaO is present as $CaCO_3$ in the limestone, find the content $CaCO_3$ in the lime stone.	04
	(c)	An aqueous solution of K_2CO_3 is prepared by dissolving 86 kg K_2CO_3 in 200 kg water at 293 K. Find molarity, normality and molality of the solution. Take specific gravity of solution as 1.3.	07

OR

	(c)	The average molecular mass of a flue gas sample is calculated by two different engineers. One engineer uses the correct molecular mass of 28 for N_2 and determines the average molecular mass to be 30.08, the other engineers, using an incorrect value of 14, calculates the average molecular mass to be 18.74. (a) Calculate the volume% of N_2 in the flue gases. If the remaining components of the flue gases are CO_2 and O_2, b) calculate the volume % of each of them.	07
Q.3	(a)	Write short note on recycling operation.	03
	(b)	The analysis of the gas entering the secondary converter in a contact sulphuric acid plant is 4% SO_2, 13% O_2 and 83% N_2 (on volume basis). The gas leaving the converter contains 0.45% SO_2 on SO_3-free basis (by volume). Calculate the percentage of SO_2 entering the converter getting converted to SO_3.	04
	(c)	It is required to make 1000 kg mixed acid containing 60% H_2SO_4, 32% HNO_3 and 8%water by blending (i) spent acid containing 11.3% HNO_3, 44.4% H_2SO_2 and 44.3% H_2O, (ii) aqueous 90% HNO_3 and (iii) aqueous 98% H_2SO_4. All percentage are by weight. Calculate the quantities of each of the three acids required for blending.	07

OR

Q.3	(a)	Explain Raoult's law, vander Vaals's equation and Dalton's law.	03
	(b)	A gas mixture has the following composition by volume: Ethylene: 31%, Benzene: 24%, Oxygen: 1%, Methane: 15%, Ethane: 25%, Nitrogen: Find the average molecular mass of the gas mixture	04
	(c)	An evaporator system concentrating weak liquor from 5% to 50% solids handles 100 kg of solids per hour. If the same system is to concentrate a weak liquor from 4% to 35%, find the capacity of the system in terms of solids that can be handled per hour assuming water evaporation capacity to be same in both cases.	07
Q.4	(a)	Write short note on bypass operation	03
	(b)	A force equal to 17.635 kgf is applied on a piston with a diameter of 6 cm. Find the pressure exerted on the piston in kPa, bar and psi.	04

(c) Calculate the following for the reaction: $C_2H_4 + 2Cl_2 \rightarrow C_2HCl_3 + H_2 + HCl$ a) the stoichiometric ratio of Cl_2 to C_2H_4. b) if 4 kmol Cl_2 is used per kmol C_2H_4, find the % excess Cl_2. c) the amount of HCl produced from 50 kg of C_2H_4 assuming reaction goes to completion. 07

OR

Q.4 (a) With a neat sketch show the material balance for the following unit operation: Distillation and evaporation 03

(b) Vapour pressure of benzene in the temp. range of 280.65 K (7.5°C) to 377.15 K (104°C) can be calculated using the following Antoine equation: 04

$$\text{Log}_{10}p = 6.9057 - 1211.0 / (t + 220.8)$$

Where p = Vapour pressure in torr (mm Hg), and t = Temperature in °C

Convert the above equation in SI units.

(c) In the Deacon process for manufacture of Chlorine, hydrochloric gas is oxidized with air. The reaction taking place is: $4\ HCl + O_2 \rightarrow 2\ Cl_2 + 2\ H_2O$. The air used is in excess of 30% of that theoretically required and the oxidation is 80% complete. Calculate the composition by volume of dry gases leaving the reaction chamber. 07

Q.5 (a) Using Antoine equation calculate the vapour pressure of acetic acid at 316 K. Data: A=6.5127 B= 1533.30 C= -50.8500 03

(b) The available nitrogen in an urea sample is found to be 45% by mass. Find theactual urea content in the sample. 04

(c) A spent solution of Chloro-acetic acid (Mol. Wt.: 94.5) in ether (Mol. Wt.:74.0) contains 20 mole % Chloro-acetic acid. It is desired to make 1 ton of a saturated solution at 298 K. Find the quantities of spent solution and Chloro-acetic acid required to make the above solution. Data: Solubility of Chloro-acetic acid in ether is 190g/100g ether at 298 K. 07

OR

Q.5 (a) Explain the material balance of crystallizer. 03

(b) Gaseous benzene reacts with hydrogen in presence of Ni catalyst as: $C_6H_{6(g)} + 3H_{2(g)} \rightarrow C_6H_{12\ (g)}$. 30%excess hydrogen is used above that required by above reaction. Conversion is 50% and yield is 90%. Calculate the requirement of benzene for 100 moles of cyclohexane. 04

(c) Pure methane is heated from 303 K to 523 K at atmospheric pressure. Calculate the heat added per kmol methane using the following data: 07

$Cp = 19.2494 + 52.1135 \times 10^{-3}T + 11.973 \times 10^{-6}\ T^2 - 11.3173 \times 10^{-9}\ T^3$ KJ/(Kmol-K)

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