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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

September / October 2023 Supplementary Examinations

Programme: B.E. **Semester: III**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 19BT3DCPPC **Max Marks: 100**
Course: Process Principles and Calculations **Date: 14.09.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	**Marks**
1	a)		A mixture of gases contains 5 moles of water vapour and 10 moles of CO_2. What is the mass fraction of water vapour in the mixture?	**04**
	b)		In the pharmaceutical industry, a lab technician wants to prepare 500 mL of the following concentration of sodium chloride solutions. i. 0.01 Normal ii. 0.10 Molar iii. 1.00 Molal solutions Assuming the solution density is equal to 1000 kg/m^3, calculate the quantity of NaCl to be added to prepare the above solutions.	**08**
	c)		The solubility of sodium hydroxide in water at 298 K is 1000 g/1 kg of water. Express the solubility as the following: i. Mass fraction and mass per cent of NaOH ii. Mole fraction and mole per cent of NaOH iii. kmol of NaOH per 1000 kg of water	**08**
			UNIT - II	
2	a)		State and explain Amagat's and Dalton's laws.	**05**
	b)		Natural gas is piped from the well at 400 K and 500 kPa. The gas contains 90.0% methane, 5.0% propane and the rest nitrogen. Calculate the following: i. The partial pressure of nitrogen ii. The pure-component volume of ethane in 10 m^3 of the gas iii. The density at standard conditions in kg/m^3	**10**
	c)		Pure water and alcohol are mixed to get a 60% (weight) alcohol solution. The densities (kg/m^3) of water, alcohol and the solution may be 998, 798, and 895, respectively, at 293 K. Calculate the volume per cent of alcohol in the solution at 293 K.	**05**

			OR	
	3	a)	State and explain Henry's law and Raoult's law.	**05**
		b)	Elucidate the relative humidity, absolute humidity, and humid volume with respect to humidity chart.	**05**
		c)	An air (B) – water vapour (A) sample has a dry bulb temperature of 45°C and absolute humidity of 0.025 $\frac{\text{kg of water vapour}}{\text{kg dry air}}$ at 1 standard atmospheric pressure. Tabulate its characteristics: a) Partial pressure of water vapour b) Percentage humidity c) Vapour pressure d) Enthalpy e) Humid volume	**10**
			UNIT - III	
	4	a)	The waste acid from a nitrating process contains 30 % H_2SO_4, 35 % HNO_3 and 35 % H_2O by weight. The acid is to be concentrated to contain 39 % H_2SO_4 and 42 % HNO_3 by addition of concentrated sulphuric acid containing 98 % H_2SO_4 and concentrated nitric acid containing 72 % HNO_3 (by weight). Calculate the quantities of three acids to be mixed to get 1000 kg of the desired mixed acid.	**10**
		b)	An aqueous solution of pyridine containing 27% (by weight) pyridine and 73% (by weight) water is to be extracted with chlorobenzene. The feed and solvent are mixed well in batch extractor and the mixture is then allowed to stand for phase separation. The extract phase contains 11% pyridine, 88% chlorobenzene and 1% water by weight. The raffinate phase contains 6% pyridine and 94% water by weight. Calculate the following. (a) The quantities of two phases (layers). (b) The weight ratio of solvent to feed based on 100 kg of feed.	**10**
			UNIT - IV	
	5	a)	Explain the following terms with the equations: i. Limiting and excess reactant, ii. Fractional and percentage conversion, iii. Fractional yield and percentage yield.	**12**
		b)	Acetic acid is manufactured by the oxidation of acetaldehyde. 120 kmol/h of acetaldehyde is fed to the reactor. The product leaving the reactor contains 12.5% acetaldehyde, 58.5% acetic acid and rest oxygen (mole basis). Calculate the percentage conversion of acetaldehyde.	**08**
			OR	

	6	a)	In the electrolytic manufacture of Cl_2 gas from a NaCl solution, the following reaction is carried out. $2NaCl + 2H_2O \rightarrow 2NaOH + H_2 + Cl_2$ How many kg of Cl_2 can be produced from 100 m^3 of a brine solution containing 7% by weight of NaCl? The specific gravity of the solution relative to the water at 4°C is 1.07.	**08**
		b)	A limestone analysis is reported as $CaCO_3$ = 92.89%, $MgCO_3$ = 5.41%, and Insoluble = 1.70%, all percentage by weight. (a) How many kilograms of CaO can be made from 6 tonnes of this limestone? (b) How many kilograms of CO_2 be recovered per kg of limestone? (c) How many kilograms of limestone are needed to make 2 tonnes of lime?	**12**
			UNIT - V	
	7	a)	Explain the following terms with equations. i. Heat of reaction ii. Heat of formation iii. Heat of combustion iv. Heat of mixing	**10**
		b)	A stream flowing at a rate of 30 kmol/h containing 30% (mole) N_2 and 70% (mole) H_2. This is to be heated from 300 K to 470 K. Calculate the amount of heat transferred using the following data. $C^{\circ}_{PN_2} = 29.57 - 5.43\times10^{-3}T + 13.17\times10^{-6}T^2$, kJ/kmol·K $C^{\circ}_{PH_2} = 28.65 + 1.02\times10^{-3}T - 0.15\times10^{-6}T^2$, kJ/kmol·K	**10**

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