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

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 22BT3PCPPC **Max Marks: 100**
Course: Process of Principles and Calaculations **Date: 08.05.2023**

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

UNIT - I

1 a) Define normality, molality and molarity. A Biotechnologist is interested in preparing 500ml of following H_2SO_4 concentration solutions. **10**

i. 1 normal
ii. 1 molar and
iii. 1 molal solution

Assuming the density of H_2SO_4 solution to be 1.075 g/cm^3, calculate the amount of H_2SO_4 to be used to prepare the above solutions.

b) Prove that volume fraction is equal to mole fraction of the ideal gas mixture. **05**

c) A sample of gas having volume of 0.5 m^3 is compressed in such a manner so that pressure is increased by 60%. The operation is done for a fixed mass of a gas at constant temperature. Calculate the final volume of the gas. **05**

UNIT - II

2 a) By electrolysing a mixed brine, a gaseous mixture is obtained at the cathode having the following composition by weight: **10**

Cl_2 = 67%, Br_2 = 28%, and O_2 = 5%

Calculate (a) composition of gas by volume, (b) average molecular weight and (c) density of gas mixture at 298K and 101.325 kPa.

(Atomic weights: Cl = 35.5, Br = 80, O = 16)

b) The dry bulb and wet bulb temperatures on a particular day in Bangalore are observed to be 303K and 295K respectively. Using the psychometric chart, determine: (a) absolute humidity (b) % RH and (c) dew point. **06**

c) Explain Raoults law and Henry's law and list two differences. **04**

OR

3 a) How to calculate the average molecular weight of mixture of gases? A mixture of A and B has the average molecular weight of 22.4. Find the mole percent of A and B in the mixture. Molecular weight of A and B are 16 and 30 respectively **08**

b) Mixture of n-heptane and n-octane are expected to behave ideally. The total pressure over the system is 101.3 kPa. Using the vapour pressure data given below: **12**

T (K)	371.4	378	383	388	393	398.6
P_A^s (kPa)	101.3	125.3	140.0	160.0	179.9	205.3
P_B^s (kPa)	44.4	55.6	64.5	74.8	86.6	101.3

Construct a boiling point diagram (T-x-y).

UNIT - III

4 a) A single effect evaporator is fed with 10000 kg/h of weak liquor containing 15% caustic soda by weight and is concentrated to get thick liquor containing 40% by weight caustic soda (NaOH). Calculate: (a) kg/h of water evaporated and (b) kg/h of thick liquor obtained. **10**

b) The recycle stream and purge stream needed in process industries. Substantiate with suitable example. **05**

c) Draw the neat flow chart for extraction and drying operations used in biochemical processes. **05**

UNIT - IV

5 a) Define the limiting reactant, excess reactant, conversion and yield. Give suitable examples. **08**

b) The carbon monoxide is reacted with hydrogen to produce methanol. Calculate the following from the reaction stoichiometry: **12**

(i) The stoichiometric ratio of H_2 to CO

(ii) kmol of CH_3OH produced per kmol CO reacted

(iii) The weight ratio of CO to H_2, if both are fed to the reactor in stoichiometric properties

(iv) The quantity of CO required to produce 1000 kg of CH_3OH

OR

6 a) Explain proximate and ultimate analysis of coal in the process of combustion. **06**

b) In production of sulphur trioxide, 100 kmol of SO_2 and 100 kmol of O_2 are fed to the reactor. If the % conversion of SO_2 is 80, calculate the composition of the product stream on mole basis. **06**

c) A feed containing 60 mole % A, 30 mole % B and 10 mole % inerts enters the reactor. 80 % of original A reacts according to the following reaction: **08**

$$2A + B \rightarrow C$$

Determine the composition of product stream.

UNIT - V

7 a) How do we determine heat of reaction, when the reaction is taking place in several step? Explain with a suitable example. **04**

b) Derive the equation for effect of temperature on the heat of reaction where heat capacity is given by $Cp = a + bT + cT^2$ **08**

c) A natural gas has the composition on mole basis: **08**
CH_4 = 84%, C_2H_6 = 13%, and N_2 = 3%
Calculate the heat to be added to heat 10 kmol of natural gas from 298 K to 523 K using heat capacity data given below:
$Cp^o = aT+bT+cT^2 + dT^3$

Gas	a	b x 10^3	c x 10^6	d x 10^9
CH_4	19.2494	52.1135	11.973	-11.3173
C_2H_6	5.4129	178.0872	-67.3749	8.7147
N_2	29.5909	-5.141	13.1829	-4.968

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