CBCS SCHEME

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18BT41

Fourth Semester B.E. Degree Examination, June/July 2023
Stoichiometry

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define the following:
(i) Normality (ii) Molarity (iii) Molality
(iv) Volume percent (v) Dalton's law **(10 Marks)**

b. A chemist is interested in preparing 500 ml of 1 normal, 1 molar and 1 molal solution of H_2SO_4. Assuming the density of H_2SO_4 solution to be 1.075 g/cm^3, calculate the quantities of H_2SO_4 to be taken to prepare the solutions. **(10 Marks)**

OR

2 a. A natural gas has the following composition by volume: CH_4 = 82%, C_2H_6 = 12% and N_2 = 6%. Calculate:
(i) Composition by weight
(ii) Average molecular weight
(iii) Density of the gas at 288 K and 101.325 kPa
(iv) Specific gravity (Average molecular weight of air is 28.84) **(10 Marks)**

b. A compound whose molecular weight us 103 by analysis has C - 81.5%, H_2 - 4.9% and N_2 - 13.6%. Determine the molecular formula. **(06 Marks)**

c. Ethanol and water forms a azeotrope containing 96% ethanol by weight. Find the composition of azeotrope by mole percentage. **(04 Marks)**

Module-2

3 a. A feed to a continuous fractioning column analyses by weight 28 percent benzene and 72 percent toluene. The analysis of the distillate shows 52 weight percent benzene and 5 weight percent benzene was found in the bottom product. Calculate:
(i) Amount of distillate and bottom product per 1000 kg of feed per hour.
(ii) Percent recovery of benzene **(10 Marks)**

b. 2000 kg of wet solids containing 70% solids by weight are fed to a tray dryer, where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight. Calculate:
(i) Amount (in kg) of water removed from wet solids
(ii) Amount (in kg) of product obtained **(10 Marks)**

OR

4 a. Define fuel. Classify fuels and write a note on characteristics of fuels. **(10 Marks)**

b. The gross heating value of gaseous propane (C_3H_8) at 298 K is 2219.5 kJ/mol. Calculate its net heating value considering latent heat of water vapour at 298 K is 2442.5 kJ/mol. **(06 Marks)**

c. Write a note on ultimate and proximate analyses of fuels. **(04 Marks)**

Module-3

5 a. With block diagrams, define:
(i) Recycle operation (ii) Bypass operation (iii) Purge operation **(06 Marks)**

b. Fresh juice contains 15% solids and rest 85% water. It is concentrated to contain 40% solids by weight. It is found in an evaporator system that juice escapes water, leaving concentrated juice 55% with flat taste. To overcome this problem, part of the fresh juice bypasses the evaporator. Calculate:
(i) Fraction of juice that bypasses evaporator
(ii) Concentrated juice produced (containing 40% solids) per 100 kg of fresh juice fed to the process. **(14 Marks)**

OR

6 a. Define the following:
(i) Yield (ii) Selectivity (iii) Limiting reactant
(iv) Excess reactant (v) Percent excess **(10 Marks)**

b. A combustion chamber is fed with butane and excess air. Combustion of butane is complete. The composition of gases on volume basis is given by CO_2 - 9.39%, H_2O - 11.73%, O_2 - 4.70% and N_2 - 74.18%. Find percentage excess air used and mole ratio of air to butane used. **(10 Marks)**

Module-4

7 a. Define the following:
(i) Heat of reaction (ii) Heat of formation
(iii) Heat of combustion (iv) Hess's law of constant heat summation **(08 Marks)**

b. Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the reaction : $CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$.

Data: $\Delta H_R^\circ = -90.41$ kJ/mol; $C_P^\circ = a + bT + cT^2 + dT^3$, kJ/(kmol.K) or J/(mol.K)

Component	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CO(g)	29.0277	–2.8165	11.6437	–4.7063
H_2(g)	28.6105	1.0194	–0.1476	0.769
CH_3OH(g)	21.137	70.0843	25.86	–28.497

(12 Marks)

OR

8 a. Calculate the standard heat of formation of n-propanol liquid using the following data:
Standard heat of formation of $CO_2(g) = -393.51$ kJ/mol
Standard heat of formation of $H_2O = -285.83$ kJ/mol
Standard heat of combustion of n-propanol $(C_3H_7OH)(\ell) = -2028.19$ kJ/mol **(10 Marks)**

b. Pure ethylene is heated from 303 K to 523 K at atmospheric pressure. Calculate the heat added/kmol ethylene using heat capacity data given below:
$C_p^\circ = 4.1261 + 155.0213 \times 10^{-3}T - 81.5455 \times 10^{-6}T^2 + 16.9755 \times 10^{-9}T^3$ **(10 Marks)**

Module-5

9 a. Explain the different downstream process involved in production of ethanol. **(10 Marks)**
b. Explain briefly about the historical development of bioprocess technology. **(10 Marks)**

OR

10 a. Elaborate on the various unit operations involved in a bioprocess industry with a neat process flow sheet and example. **(10 Marks)**
b. Discuss the different downstream process involved in the production of pencillin. **(10 Marks)**

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