CBCS SCHEME

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18BT41

Fourth Semester B.E. Degree Examination, Jan./Feb. 2021
Stoichiometry

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. An aqueous solution of K_2CO_3 is prepared by dissolving 43 kg of K_2CO_3 in 100kg of water at 293 K (20°C). Calculate the molarity, normality and molality in solution. **(10 Marks)**

b. Nitric acid and water forms maximum boiling azeotrope containing 62.2% water by mole. Find the composition of azeotrope in weight%. **(10 Marks)**

OR

2 a. A mixture of CH_4 and C_2H_6 has density of 1.0 kg/m^3 at 273 K and 101.325 kPa. Calculate the mole% and weight% of CH_4 and C_2H_6 in the mixture. **(10 Marks)**

b. Define the following :
i) Dalton law ii) Amagat's law iii) Ideal gas law
iv) Normality v) Molality. **(10 Marks)**

Module-2

3 a. A feed to a continuous fractionating column analysis by weight has 28% benzene and 72% toluene. The analysis of the distillate shows 52 weight% of benzene and 5 weight% of benzene in the bottom product. Calculate the amount of distillate and product per 1000 kg of feed per hour. Also calculate the percent recovery of benzene. **(10 Marks)**

b. Crude oil is analyzed to contain 87% Carbon, 12.5% hydrogen and 0.5% Sulphur by weight. Calculate the net calorific value of crude oil at 298 K.
Data: Gross calorific value of crude oil at 298 K is 45071 kJ/kg oil. Latent heat of water vapour at 298 K is 2442.5 kJ/kg. **(10 Marks)**

OR

4 a. Dryer system handles 1000 kg/day of wet solids. Wet solids containing 50% solids and 50% water are fed to the first dryer. From the first dryer the product that comes out has 20% moisture. This is admitted to the second dryer from which the product coming out has 2% moisture. Calculate the % of original coats that is removed in each dryer and final weight of the product. **(10 Marks)**

b. Soyabean seeds are extracted with hexane in batch extractor. The flaked seeds are found to contain 18.6% oil, 69% solid and 12.4% moisture by weight. At the end of the extraction process cake (meal) is separated from hexane-oil mixture. The cake is analyzed to contain 0.8% oil, 87.7% solids and 11.5% moisture by weight. Find the percentage recovery of oil. **(10 Marks)**

Module-3

5 a. In the production of Sulphurtrioxide 100 kmol of SO_2 and 100 kmol of O_2 are fed to a reactor. If the percent conversion of SO_2 is 80, calculate the composition of the product stream on mole basis. **(10 Marks)**

b. A coke is known to contain 90% carbon and 10% non combustible ash (by weight).
i) How many moles of Oxygen are theoretically required to burn 100kg of coke completely?
ii) If 50% excess air is supplied, calculate the analysis. **(10 Marks)**

OR

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

b. Define the following:
(i) Limiting reactant
(ii) Yield
(iii) Selectivity
(iv) Percent excess
(v) Stochiometric ratio. **(10 Marks)**

Module-4

7 a. A stream flowing at a rate of 1500 mol/h containing 25 mole% N_2 and 75 mole% H_2 is to be heated from 298 K (25°C) to 473 K (200°C). Calculate the heat that must be transferred using C_{P° data given below.

$C_{P^\circ} = a + bT + cT^2 + dT^3$ kJ/KmolK **(10 Marks)**

Gas	a	$b\times10^3$	$c\times10^6$	$d\times10^9$
N_2	29.5909	−5.41	13.1829	−4.968
H_2	28.6105	1.0194	−0.1476	0.769

b. A stream containing 10% CH_4 and 90% air by volume is to be heated from 373 K to 573 K at a rate of 0.05 m^3 NTP per second. Calculate the heat required to be added using mean molal heat capacity in KJ/KmolK.

Gas	C_{P° m (373 – 298 K)	C_{P° m (573 – 298 K)
CH_4	37.5974	43.0821
Air	29.2908	29.6132

(10 Marks)

OR

8 a. Calculate the 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 $H_2O(\ell) = -285.83$ KJ/mol
Standard heat of combustion of n-propanol = −2028.19 KJ/mol **(10 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 / KmolK) or (J/molK)

Component	a	$b\times10^3$	$c\times10^6$	$d\times10^9$
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	70.843	25.86	−28.49

(10 Marks)

Module-5

9 a. Explain in detail the unit operations involved in bioprocess technology with a neat flow chart. **(10 Marks)**

b. With a process flow sheet explain the process of manufacturing of ethanol with specific to the various unit operations involved in it. **(10 Marks)**

OR

10 a. Define the following:
(i) Maintenance coefficient
(ii) Yield coefficient
(iii) Specific growth rate
(iv) Proton oxygen ratio. **(08 Marks)**

b. Write short notes on the following :
(i) Historical developments in bioprocess technology.
(ii) Traditional and modern applications of biotechnology. **(12 Marks)**

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