15-06-2026 SE CHEMICAL SEM-III C SCHEME PC QP CODE: 20015194

Time: 3 Hours **Total Marks: 80**

N.B.: 1) Question No.1 is compulsory.
2) Answer any three questions from remaining questions.
3) Each Question carries equal marks.
4) Assume data if necessary and specify assumptions clearly.

Q.1 (a) How many kilogram of carbon are present in 64 kg of methane? **[05]**

(b) Describe (i) Dalton's law (ii) Amagat's law (iii) Raoult's law (iv) Partial pressure (v) Vapour pressure. **[05]**

(c) Draw the block diagram of Evaporation and Extraction operation and write the overall and component material balance. **[05]**

(d) Explain the term conversion, percent excess and yield. **[05]**

Q.2 (a) Sodium chloride weighing 200 kg is mixed with 600 kg potassium chloride. Calculate the composition of the mixture in weight % and mole%. **[10]**

(b) A mixture of CH_4 and C_2H_6 has density 1.0 kg/m^3 at 273 K and 101.325 KPa pressure. Calculate the mole % and weight % of CH_4 and C_2H_6 in the mixture. **[10]**

Q.3 (a) A spent solution of chloroacetic acid [$ClCH_2COOH$] in ether [$C_2H_5OC_2H_5$] contains 20 mole % chloroacetic acid. It is desired to prepare 500 kg of saturated solution at 298 K. Calculate the quantities of spent solution and chloroacetic acid that are required to make the above solution. The solubility of chloroacetic acid in ether at 298 K is 190 g per 100 g. **[10]**

(b) In production of sulphur trioxide, 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]**

Q.4 (a) Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the following reaction: **[15]**

$CO\ (g) + H_2O\ (g) \rightarrow CO_2\ (g) + H_2\ (g)$

Data: $\Delta H^o_R = \Delta H_{T=298\ K} = -41.16$ kJ/mol

$C_p^o = a + bT + cT^2 + dT^3$, kJ/(kmol.K)

Component	a	b × 10^3	c × 10^6	d × 10^9
CO (g)	29.0277	-2.8165	11.6437	-4.7063
H_2O (g)	32.4921	0.0796	13.2107	-4.5474
CO_2 (g)	21.3655	64.2841	-41.0506	9.7999
H_2 (g)	28.6105	1.0194	-0.1476	0.769

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(b) A sample of dry flue gas has the following composition by volume: CO_2 = 13.4%, N_2 = 80.5%, O_2 = 6.1%. Find the percent excess air supplied assuming that the fuel contained no nitrogen, the nitrogen and oxygen in flue gas must have come from air. **[05]**

Q.5 (a) Calculate the heat of formation of gaseous ethyl alcohol at 298 K. **[06]**

Data:

Standard heat of formation of $CO_2(g)$ = - 393.51 kJ/mol

Standard heat of formation of $H_2O(l)$ = - 285.83 kJ/mol

Standard heat of combustion of gaseous ethyl alcohol at 298 K = - 1410.09 kJ/mol

(b) Calculate the heat of reation at 298.15 K of the following reaction: **[07]**

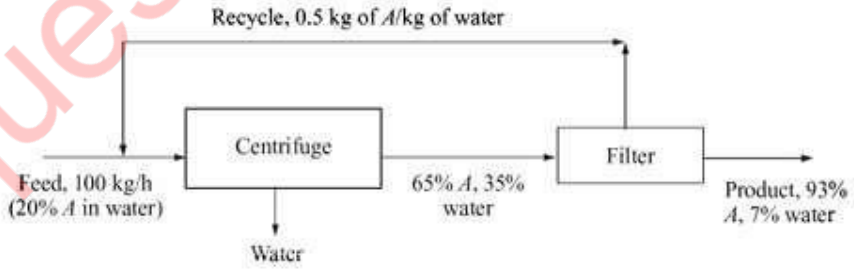
$$C_2H_6\,(g) \rightarrow C_2H_4\,(g) + H_2\,(g)$$

Data:

Component	$\Delta H_c^0\ kJ/mol$
C_2H_6	-1560.69
C_2H_4	-1411.2
H_2	-285.83

(c) In production of chlorine gas by oxidation of hydrochloric acid gas, air is used 30% in excess of that theoretically required. Based on 4 kmol HCl, calculate: (i) the weight ratio of air to hydrochloric acid gas in feed. (ii) If oxidation is 80% complete, find the composition of product stream on mole basis. **[07]**

Q.6 (a) Final purification stage in the preparation of a pharmaceutical product A from natural sources requires centrifuging and continuous filtration as depicted in figure. Determine the flow rate of the recycle stream in kg/h. **[10]**



(b) Give the step wise procedure to calculate the reboiler load in a distillation unit. List the parameters required for the computation of the above. **[10]**

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