

24 NOV 2025 SE CHEMICAL (SEM-III) C SCHEME PC QP CODE: 10098324

Time: 03 Hr.

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

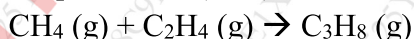
- Q.1 (a) H_2SO_4 solution has a molarity of 11.24 and molality of 94. Calculate the density of solution. [5]
 (b) Describe (i) Dalton's law, (ii) Amagat's law, (iii) Raoult's law, (iv) Partial pressure, and (v) Vapour pressure. [5]
 (c) Explain the limiting and excess reactant. [5]
 (d) Discuss the extraction unit operation based on material balance without chemical reactions. [5]

- Q.2 (a) Calculate the available nitrogen content of solution having 30% urea (NH_2CONH_2), 20% ammonia sulphate and 20% ammonium nitrate. [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) The spent acid from nitrating process contains 21% HNO_3 , 55% H_2SO_4 and 24% water by weight. This acid is to be concentrated to contain 28% HNO_3 , 62% H_2SO_4 by addition of concentrated sulphuric acid containing 93% H_2SO_4 and concentrated nitric acid containing 90% HNO_3 . Calculate the weights of spent acid, concentrated sulphuric acid and concentrated nitric acid that must be combined to obtain 1000 kg of the desired mixture. [10]
 (b) Ethylene oxide is prepared by oxidation of ethylene. 100 kmol of ethylene and 100 kmol of O_2 are charged to a reactor. The percent conversion of ethylene is 85 and percent yield of $\text{C}_2\text{H}_4\text{O}$ is 94.12. Calculate the composition of product stream leaving the reactor. The reactions taking place are:



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



Data: $\Delta H^\circ_{\text{R}}$ at 298 K = -82.66 kJ/mol

$$C_p^\circ = a + bT + cT^2 + dT^3, \text{ kJ}/(\text{kmol}\cdot\text{K})$$

Component	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
$\text{CH}_4 (\text{g})$	19.2494	52.1135	11.973	-11.3173
$\text{C}_2\text{H}_4 (\text{g})$	4.1261	155.0213	-81.5455	16.9755
$\text{C}_3\text{H}_8 (\text{g})$	-4.2227	306.264	-158.6316	32.1455

- (b) A sample of dry flue gas has the following composition by volume: $\text{CO}_2 = 13.4\%$, $\text{N}_2 = 80.5\%$, $\text{O}_2 = 6.1\%$. 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. [5]

- Q.5 (a) Calculate the heat of formation of liquid ethyl acetate at 298 K. [7]

Data:

Standard heat of formation of $\text{CO}_2(g) = -393.51 \text{ kJ/mol}$

Standard heat of formation of $\text{H}_2\text{O}(l) = -285.83 \text{ kJ/mol}$

Standard heat of combustion of liquid ethyl acetate $\text{C}_4\text{H}_8\text{O}_2 = \Delta H^\circ_c = -2230.91 \text{ kJ/mol}$

- (b) A stream of carbon dioxide flowing at a rate of 100 kmol/min is heated from 298 K to 383 K. Calculate the heat that must be transferred using C_p° . [7]

Data: $C_p^\circ = a + bT + cT^2 + dT^3$, $\text{kJ}/(\text{kmol} \cdot \text{K})$

Gas	a	$b * 10^3$	$c * 10^6$	$d * 10^9$
CO_2	21.3655	64.2841	-41.0506	9.7999

- (c) In manufacture of acetic acid by oxidation of acetaldehyde, 100 kmol of acetaldehyde is fed to a reactor per hour. The product leaving the reactor contains 14.81% acetaldehyde, 59.26% acetic acid, and rest oxygen (on mole basis). Find the percentage conversion of acetaldehyde. [6]

- Q.6 (a) Formaldehyde is Produced by dehydrogenation of methanol. [12]



The per pass conversion is 67 %. The product leaving the reactor is fed to a separation unit battery where formaldehyde is separated from methanol and hydrogen. The separated methanol is recycled to the reactor. If the production rate of formaldehyde is 1000 kg/h. Calculate: The combined feed ratio, Recycle ratio and The flow rate of methanol required to the process as fresh feed.

- (b) Give the step wise procedure to calculate the reboiler load in a distillation unit. [8]
List the parameters required for the computation of the above.
