

[3 Hours]

[Total Marks: 80]

- (1) Q.1 is compulsory.
- (2) Attempt **any 3** from the remaining **5** questions.
- (3) Use **graph paper**, if required.
- (4) Assume suitable **data** if **required** and **justify the same**.

- 1 (a) Define the following : Normality, molarity, net calorific value of fuel, theoretical air requirement for combustion and yield of a reaction **10**
- (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 H_2SO_4 to be taken to prepare these solutions. **10**

- 2 (a) The spent acid from a nitrating process contains 21% HNO_3 55% H_2SO_4 and rest H_2O by weight. This acid is to be concentrated to contain 26% HNO_3 and 62% H_2SO_4 by addition of 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) 2000 kg of wet solids 70% solids by weight are fed to a tray of water where it is dried by hot air. The product finally obtained is found to contain 1% moist weight, calculate : **10**
 - (a) The kg of water removed from wet solids.
 - (b) The kg of product obtained.

- 3 (a) Gaseous benzene (C_6H_6) reacts with hydrogen in the presence Ni catalyst as per the reaction: **12**

$$C_6H_6(g) + 3H_2(g) \rightarrow C_6H_{12}(g)$$

30% excess hydrogen is used above that required by the above reaction. Conversion is 50% and yield is 90%. Calculate the requirement of benzene and hydrogen gas for 100 moles of cyclohexane.
- (b) If 60kg of ethane reacts with air and reaction, goes to completion find the composition of the product stream. Given 50% excess air was fed in to the combustion chamber. **08**

- 4 (a) A gas mixture containing 15 mole % 'A' and 85 mole % inert's is fed to an absorption tower where it is contacted with liquid solvent 'B' which absorbs 'A'. The mole ratio of solvent to gas entering the tower is 1.5:1. The gas leaving the absorber contains 2.5% 'A', 1.5% 'B' and rest inerts on mole basis. 10

Calculate:

- i) The percentage of the original solute 'A' that remains uncovered and
 - ii) The fraction of solvent 'B' fed to the tower lost in gas leaving the column (during the process some solvent evaporates and gets added in gas leaving the column).
- (b) A spent lye sample obtained from a soap- manufacturing unit is found to contain 9.6% of glycerol and 10.3% salt (NaCl). It is concentrated at the rate of 4000 kg/h in a double effect evaporator system until the final solution contains 80% of glycerol and 6% of salt. Assume that 5% of glycerol is lost by entertainment. All percentages are by weight. Calculate the amount of evaporation taking place in the system and the amount of salt that is crystallized in the saltbox of the evaporator. 10

- 5 (a) Calculate the heat of formation of liquid ethyl acetate at 298K Given that the heat of combustion (kJ/mol) of liquid ethyl acetate=-2230.91 and heat of formation (kJ/mol) of CO₂(g) and H₂O(l) are -393.51 & -285.83 respectively. 10

(b) State Hess's law and its application 05

(c) Temperature of methane is raised from 303K to 523K. Calculate the amount of heat that must be supplied for raising the temperature of 1 kmol methane for the C_p (J/mol K)=a+bT+cT²+dT³ data given as following:- 05

a	b × 10 ³	c × 10 ⁶	d × 10 ⁹
19.2494	52.1135	11.973	-11.3173

- 6 (a) Describe the use of psychrometric chart. Define humidity, % saturation, wet bulb temperature and vapour pressure. 15

(b) Explain recycle and purging operation. 5