(3 Hours) **80 Marks**

Note : i) Q.No 1 is compulsory.
ii) Answer any three of the remaining five question.

Q1.a) 98gm of sulphuric acid is dissolved in water to produce 1L of solution. Calculate Normality and Molarity of solution. **(5 Marks)**

b) Give material balance equation for distillation process? **(5 Marks)**

c) Write short note on bypass operation? **(5 Marks)**

d) Explain Recycle ratio, Combined feed ratio and Purge ratio in detail? **(5 Marks)**

Q2.a) Benzene and toluene are to be separated. Feed has 45% by weight benzene. Overhead stream has 98% benzene by weight and 8% benzene by weight was found in bottom product. If feed rate is 2500kg/hr calculate overhead product rate. **(5 Marks)**

b) Discuss the different methods of expressing the composition of mixtures and solutions? **(15 Marks)**

Q3. a) 10,000 kg/h of solution containing 20% methanol is continuously fed to the distillation column. Distillate is found to contain 98% methanol and the waste solution from the column carries 1% methanol. All percentages are by weight. Calculate a) the mass flow rate of distillate and bottom product and b) the percent loss of methyl alcohol? **(10 Marks)**

b) A mixture of benzene and dry air at a temperature of 303K and a pressure of 101.325kPa is found to have a dew point of 288 K. Calculate i) the percentage by volume of benzene. ii) the moles of benzene per mole dry air. Take vapour pressure of benzene at 288 K = 7.999 kPa. **(5 Marks)**

c) Equal masses of CO and nitrogen are mixed together in the container at 300K. The total pressure was found to be 405.3kPa. Find the partial pressure of CO gas. **(5 Marks)**

Q4. a) Prove that Pressure% = Volume% = Mole%. **(10 Marks)**

b) A coke is known to contain 90% carbon and 10% non-combustible ash (by weight) .i) Find the moles of oxygen theoretically required to burn 100 kg of coke completely? ii) If 50% excess air is supplied, calculate the analysis of gases at the end of combustion? **(10 Marks)**

Q5.a) Formaldehyde is produced by dehydrogenation of methanol.

$$CH_3OH \longrightarrow HCHO + H_2$$

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 i) the combined feed ratio ii) the flow rate of methanol required to the process (as fresh feed). **(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 to be 1.075 g/cm^3, calculate the quantities of H_2SO_4 to be taken to prepare these solutions. **(10 Marks)**

Q6. a) Define :

i) Yield ii) Selectivity iii) Conversion iv) Vander Waal's Equation v) hess's Law. **(10 Marks)**

b) Define

i) Saturation humidity ii) Percentage humidity iii) Heat of combustion iv) Adiabatic flame temperature v) Drying. **(10 Marks)**

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