17315

16172

3 Hours / 100 Marks Seat No. | | | | | | | | |

Instructions : *(1)* ***All*** *questions are* ***compulsory****.*
(2) Answer ***each*** *next main question on a* ***new*** *page.*
(3) Figures to the ***right*** *indicate* ***full*** *marks.*
(4) Assume suitable data, if ***necessary****.*
(5) Mobile Phone, Pager and any other Electronic Communication devices are ***not*** *permissible in Examination Hall.*

Marks

1. Attempt **any ten** : **(2×10=20)**

a) State ideal gas law and mention the terms involved in it.

b) Give mathematical expression of Van der Waal's equation.

c) Define conversion of chemical reaction.

d) Define excess component in a chemical reaction.

e) Define sensible heat and latent heat.

f) Draw a material balance diagram for crystallisation.

g) Define heat of combustion.

h) Define heat capacity at constant volume.

i) State Raoult's law and give mathematical expression.

j) What is law of conservation of energy ?

k) Define stoichiometric equation and stoichiometric ratio.

l) State Dalton's law.

2. Attempt **any two** : **(8×2=16)**

a) What is meant by Recycling and Bypassing operation ? Explain in detail with diagram.

b) Calculate average molecular weight and density of air at NTP. Assume 21% O_2 and rest N_2.

c) An evaporator system concentrating a weak liquor from 5% to 50% solids handles. 100 kg of solids per hours. If the same system is to concentrate a weak liquor from 6% to 36%. Find the capacity of the system in terms of solids that can be handled per hour assuming water evaporation capacity to be same in both the cases.

P.T.O.

Marks

3. Attempt **any two :** **(8×2=16)**

a) The waste acid from nitrating process contains 28% H_2SO_4, 35% HNO_3 and 37% H_2O by weight. The acid is to be concentrated to contain 40% H_2SO_4 and 41% HNO_3 by addition of conc. H_2SO_4 containing 98% H_2SO_4 and conc. HNO_3 containing 72% HNO_3 (by wt.). Calculate the quantities of three acids to be mixed to get 1000 kg of desired mixed acid.

b) A combustion reactor is fed with 50 kmol/hr of butane and 2100 kmol/hr of air. Calculate % excess air used.

c) Write down the material balance procedure for solving material balance problems without chemical reactions.

4. Attempt **any two** : **(8×2=16)**

a) 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 C_2H_4O is 94.12. Calculate the composition of product stream leaving the reactor. The reactions taking place are $C_2H_4 + \frac{1}{2} O_2 \rightarrow C_2H_4O$

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

b) A stream flowing at a rate of 15000 mol/h containing 25 mole% N_2 and 75 mole % of H_2 is to be heated from 298 K to 473 K. Calculate the heat that must be transferred using Cp^o data given below :

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

Gas	a	b ×10³	c ×10⁶	d ×10⁹
N_2	29.5909	– 5.41	13.1829	– 4.968
H_2	28.6105	1.0194	– 0.1476	0.769

Marks

c) Calculate the standard heat of reaction of the following reaction

$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$.

Data :

Component	ΔH_f^o KJ/mol at 25^oC
C_5H_{12}	– 173.49
CO_2	– 393.51
H_2O	– 285.83

5. Attempt **any two** : **(8×2=16)**

a) 10,000 kg/h of solution containing 30% methanol is continuously fed to a distillation column. Distillate is found to contain 97% methanol and waste solution from the column carries 1% methanol. All percentages are by weight. Calculate :

a) The mass flow rates of distillate and bottom product.

b) The percent loss of methyl alcohol.

b) The Henry's law constant for oxygen in water at 298 K is 4.46×10^6 kPa/mole fraction. Find the solubility of oxygen in water at 298 K for a partial pressure of oxygen of 25.33 kPa.

c) Ethylene oxide is produced by oxidation of ethylene. 100 kmol of ethylene are fed to a reactor and the product is found to contain 80 kmol ethylene oxide and 10 kmol CO_2. Calculate :

a) the % conversion of ethylene

b) the % yield of ethylene oxide.

6. Attempt **any four** : **(4×4=16)**

a) 2000 kg of wet solids containing 70% solids by weight are fed to a tray dryer where it is dried by hot air. The product finally obtained is found to contain 1% moisture by weight. Calculate :

a) the kg of water removed from wet solids

b) the kg of product obtained

Marks

b) The CO is reacted with H_2 to produce methanol. Calculate from the reaction :

   a) the stoichiometric ratio of H_2 to CO.

   b) kmol of CH_3OH produced per kmol CO reacted

   c) the weight ratio of CO to H_2 if both are fed to reactor in stoichiometric proportion

   d) the quantity of CO required to produce 1000 kg of CH_3OH.

c) Write down the procedure of solving material balance with chemical reaction.

d) Explain Hess's law of constant heat summation and its application.

e) A sample of gas having volume of $1m^3$ is compressed to half of its original volume. The operation is carried for a fixed mass of gas at constant temperature. Calculate the percent increase in pressure.

f) A feed containing A, B and inerts enters a reactor. The reaction taking place is $2A + B \rightarrow C$.

The product stream leaving the reactor is having the following composition by mole : A = 23.08%, B = 11.54%, C = 46.15%, inerts = 19.23%. Find the analysis of feed on mole basis.