17315

11718

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

Instructions : *(1)* ***All*** *questions are* ***compulsory****.*
(2) Answer ***each*** *next main question on a* ***new*** *page.*
(3) Illustrate your answers with neat sketches ***wherever*** *necessary.*
(4) Figures to the ***right*** *indicate* ***full*** *marks.*
(5) Assume suitable data, if ***necessary****.*
(6) Use of Non-programmable Electronic Pocket Calculator is ***permissible****.*
(7) Mobile Phone, Pager and any other Electronic Communication devices are ***not permissible*** *in Examination Hall.*

Marks

1. A) Attempt **any four** of the following : **(4×2 = 8)**

a) Write down Dalton's law and give its mathematical statement.

b) Define pure component volume.

c) Convect 5 kg of oxygen in its moles.

d) Define law of conservation of mass.

e) Draw a labelled block diagram of extraction operation.

f) Define selectivity.

B) Attempt **any two** of the following : **(2×6 = 12)**

a) The analysis of a gas sample on mole basis CH_4 = 66% CO_2 = 30% and NH_3 = 4% calculate the density of the gas sample at a pressure of 304 KPa and temperature 303 K. (Atomic Weight C = 12 H = 1 N = 14 O = 16).

b) A mixture of H_2 and O_2 contains 11.1% H_2 by weight. Calculate a) Average molecular weight of a gas mixture b) Partial pressure of O_2 and H_2 at 100 KPa and 303 K.

c) Equal masses of CO and N_2 are mixed together in a container at 300K. The total pressure was found to be 405.3 KPa. Find partial pressure of CO gas.

Marks

2. Attempt **any four** of the following : **(4×4= 16)**

a) Explain outline of a procedure for material balance without chemical reaction calculation.

b) A sample of coal is found to contain 63% carbon and 24% ash on a weight basis. The analysis of refuse after combustion shows 7% carbon and rest ash. Calculate the percentage of the original carbon unburnt in refuse.

c) Define the following terms with example

1) Stoichiometric Equation.

2) Stoichiometric Ratio.

d) In production of SO_3, 100 kmol of SO_2 and 200 kmol of O_2 are fed to a reactor. The product stream is found to contain 80 kmol SO_3. Find the % conversion of SO_2.

e) Differentiate conversion and Yield.

f) Calculate the heat that must be added to 3 kmol air to heat it from 298K to 473K using the mean molal heat capacity data for air given below.

C°_{pm} (between 473K and 298K) for air = 29.3955 KJ/(Kmol K).

3. Attempt **any two** of the following : **(2×8= 16)**

a) Monochloro acetic acid ($CH_2ClCOOH$) is manufactured in a semibatch reactor by the action of acetic acid with chlorine using catalyst at 373 K.

$CH_3COOH + Cl_2 \rightarrow CH_2ClCOOH + HCl$

The chlorine is used 15% excess (on mole basis) of that theoretically required. The reaction is 95% complete. Calculate the amount of the raw materials required for the production of 3000 Kg of monochloroacetic acid (Atomic weight of Cl = 35.5).

b) It is desired to make up 1000 kg of a solution containing 35% by weight of a substance 'A'. Two solutions are available, one containing 10 Wt% 'A' and other containing 50 Wt% A. How many kilograms of each solution will be required ?

c) 10,000 kg/hr of solution containing 20% methanol is continuously fed to a distillation column. Distillate is found to contain 98% methanol and waste solution from the column carries 1% methanol. All percentages are by weight. Calculate – the mass flow rates of distillate and bottom product.

Marks

4. Attempt **any two** of the following : **(2×8= 16)**

a) Calculate the standard heat of reaction (ΔH°_{R}) of the following reaction.

$2FeS_2$ (s) + 5.5 O_2 (g) $\rightarrow Fe_2O_3$(s) + 4 SO_2(g)

Data :

Component	ΔH°_{f} **KJ/mol at 298K**
FeS_2(s)	–178.02
Fe_2O_3 (s)	– 822.70
SO_2(g)	– 296.81

b) 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.

c) A feed containing 50% benzene and 50% toluene is fed to a distillation column at a rate of 5000 kg/hr. The top product contains 95% benzene and the bottom product contains 92% toluene by weight. Calculate :

a) the mass flow rates of top and bottom products.

b) The percent recovery of benzene.

5. Attempt **any two** of the following : **(2×8= 16)**

a) An evaporator is fed with 15000 kg/hr of a solution containing 10% NaCl, 15% NaOH and rest water. In operation water is evaporated and NaCl is precipitated as crystals. The thick liquor leaving the evaporator contains 45% NaOH, 2% NaCl and rest water. Calculate :

i) kg/hr water evaporated.

ii) kg/hr salt precipitated.

iii) kg/hr thick liquor.

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.

Marks

c) Methane gas is heated from 303 K to 523K at atmospheric pressure. Calculate the heat added per kmol methane using C_p° data given below :

Data $C_p^\circ = a + bT + cT^2 + dT^3$, KJ/(Kmol.K)

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
Methane	19.2494	52.1135	11.973	_11.3173

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

a) Explain Hess's law of constant heat summation with example.

b) Define adiabatic reaction and adiabatic reaction temperature.

c) A coke contains 90% carbon and 10% ash by weight. If air is used 10% excess for combustion, calculate moles of air supplied per 100 kg of coke burned.

d) For manufacture of NH_3, 4 kmoles of N_2 and 10 kmoles of H_2 are fed. Identify excess component and calculate % excess.

e) A tray dryer is fed with 1000 kg of wet orthonitroaniline containing 10% water. The dried product contains 99.5% orthonitroaniline and the rest water. Find the percentage of original water that is removed in the dryer.

f) In manufacture of sulphur trioxide, feed to a reactor consists of 50 kmol SO_2 and 150 kmol air. Calculate the % excess air is used.