



17315

11718

3 Hours / 100 Marks

Seat No.

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- 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) Convert 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 $\text{CH}_4 = 66\%$ $\text{CO}_2 = 30\%$ and $\text{NH}_3 = 4\%$ 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.

P.T.O.



2. Attempt **any four** of the following :

(4×4= 16)

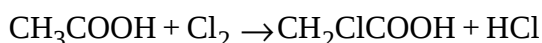
- Explain outline of a procedure for material balance without chemical reaction calculation.
- A sample of coal is found to contain 63% carbon and 24% ash on a weight basis. The analysis of refuse after combustion shows 7% carbon and rest ash. Calculate the percentage of the original carbon unburnt in refuse.
- Define the following terms with example
 - Stoichiometric Equation.
 - Stoichiometric Ratio.
- 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 .
- Differentiate conversion and Yield.
- 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)

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

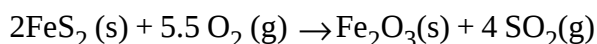


The chlorine is used 15% excess (on mole basis) of that theoretically required. The reaction is 95% complete. Calculate the amount of the raw materials required for the production of 3000 Kg of monochloroacetic acid (Atomic weight of Cl = 35.5).

- 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 10Wt% 'A' and other containing 50Wt%A. How many kilograms of each solution will be required ?
- 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.

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

- a) Calculate the standard heat of reaction (ΔH°_R) of the following reaction.



Data :

Component	ΔH°_f KJ/mol at 298K
$\text{FeS}_2(\text{s})$	-178.02
$\text{Fe}_2\text{O}_3(\text{s})$	- 822.70
$\text{SO}_2(\text{g})$	- 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.

$$\text{CO}_2 = 13.4\% \quad \text{N}_2 = 80.5\% \quad \text{O}_2 = 6.1\%.$$

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.



- 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)

- Explain Hess's law of constant heat summation with example.
- Define adiabatic reaction and adiabatic reaction temperature.
- 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.
- For manufacture of NH_3 , 4 kmol of N_2 and 10 kmol of H_2 are fed. Identify excess component and calculate % excess.
- 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.
- 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.
