313336

12425

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answer with neat sketches wherever necessary.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Define partial pressure.

b) State Amagat's law and give its mathematical statement.

c) State law of conservation of mass.

d) Define limiting reactant and excess reactant.

e) Define standard heat of combustion.

f) Define GCV and NCV.

g) Define complete and incomplete combustion.

Marks

2. Attempt any THREE of the following: **12**

a) Describe relation between vol%, mol% and pressures % for an ideal gas.

b) A single effect evaporator is fed with 1000 kg/hr of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight caustic (NaOH).

Calculate:

i) kg/hr of water evaporated.

ii) kg/hr of thick liquor obtained.

c) Describe % conversion with example.

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

3. Attempt any THREE of the following: **12**

a) A mixture of CH_4 and C_2H_4 has the average molecular weight of 22.4. Find mole % CH_4 and C_2H_4 in the mixture.

b) The groundnut seed containing 45% oil and 45% solids are fed to expeller, the cake coming out of expeller is found to contain 80% solid and 5% oil. Find % recovery of oil.

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:

i) Percent conversion of ethylene.

ii) Percent yield of ethylene oxide.

d) A stream of nitrogen flowing at a rate of 100 kmol/hr is heated from 303 K to 373 K. Calculate the heat that must be transferred. Data : $C°_p$ for nitrogen = $29.5909 - 5.141 \times 10^{-3}T + 11.1829 \times 10^{-6} T^2 - 4.968 \times 10^{-9} \times T^3$.

Marks

4. Attempt any <u>THREE</u> of the following: **12**

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

b) The waste acid from nitrating process containing 20% HNO_3, 55% H_2SO_4 and 25% H_2O by weight is to be concentrated by addition of concentrated sulphuric acid containing 95% H_2SO_4 and concentrated nitric acid containing 90% HNO_3 to get desired mixed acid containing 26% HNO_3, and 60% H_2SO_4. Calculate the quantities of waste and concentrated acids required for 10000 Kg of desired mixed acid

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

d) Calculate the heat of formation of liquid ethyl acetate ($C_4H_8O_2$) at 298 K.
Data:
Standard heat of formation of CO_2 (g) = –393.51 kJ/mo1.
Standard heat of formation of H_2O (l) = –285.83 kJ/mol.
Standard heat of combustion of liquid ethyl acetate = –2230.91 kJ/mol.

e) Calculate the standard heat of reaction of the following reaction.
$4NH_3$ (g) + 5 O_2 (g) $\longrightarrow$ 4NO(g) + $6H_2O$ (g).
Data:

Component	$\Delta H°f$ kJ/mol at 298.15 K
NH_3 (g)	– 45.94
NO (g)	90.25
H_2O (g)	– 241.82

Marks

5. Attempt any TWO of the following: **12**

a) Calculate the density of air containing 21% O_2, 79% N_2 by volume at 503K and 1519.87 kPa.

b) A feed to a continuous fractionating column analyses by weight 28% benzene and 72% toluene. The analysis of the distillate shows 52 weight percent benzene and 5 weight percent benzene was found in bottom product. Calculate the amount of distillate and bottom product per 1000 kg of feed per hour. Also calculate the percent recovery of benzene.

c) A feed containing A, B and inerts enters a reactor. The reaction taking place is

$2A + B \longrightarrow C$

The product stream leaving the reactor is following composition by mole.

A = 23.08% B = 11.54% C = 46.15% and inerts = 19.23%.

Find the analysis of feed on mole basis.

6. Attempt any TWO of the following: **12**

a) A gas mixture containing 15 mole% A and 85 mole% inerts 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 tower is 2:1. The gas leaving the absorber contains 2.5% A. 1.5% B and rest inerts on mole basis. Find

i) The percentage recovery of solute A.

ii) The fraction of solvent B fed to the column lost in gas leaving the tower.

Note that during the process some solvent evaporates and gets added in the gas leaving the tower.

b) In the manufacture of acetic acid by oxidation of acetaldehyde, 100 kmol of acetaldehyde is fed to a reactor per hour. The product leaving the reactor contains 14.81% acetaldehyde, 59.26% acetic acid, and rest oxygen (on mole basis) Find the percentage conversion of acetaldehyde.

c) Explain proximate and ultimate analysis of coal.
