17315

14115

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

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

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(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 <u>TEN</u> of the following: **20**

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

b) Define standard heat of combustion.

c) Define vapour pressure.

d) Write numerical value of universal gas constant when P is in Kpa, vis in m^3, mass in Kmol, temp.in K.

e) Write Hess's law of constant summation.

f) What is stoichiometric equation?

g) Write Vanderwaal's equation.

h) State Charl's law and give its mathematical expression.

i) Define yield of chemical reaction.

Marks

j) Calculate the volume of 1 mole of air at STP.

k) Why oxygen is always supplied in excess in combustion reaction?

l) Convert 101.325 Kpa.g into absolute pressure.

m) State Raoult's law.

n) State Amagat's law.

2. Attempt any <u>FOUR</u> of the following: **16**

a) A gas mixture has the following composition by volume, CH_4 = 70%, C_2H_6 = 22% and N_2 = 8%. Calculate the average molecular weight of gas mixture.
(Atomic weight : C = 12, H = 1, N = 14)

b) A combustion reactor is fed with 50 Kmol/hr of butane (C_4H_{10}) and 2100 Kmol/hr of air. Calculate percentage excess air used.

c) A sample of gas having volume 1 m^3 is compressed in such manner so that its pressure is increased by 85%. The operation is done for a fixed mass of gas at constant temperature. Calculate the final volume of gas.

d) A single effect evaporator is fed with 10,000 Kg/hr of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight caustic. Calculate

(i) Kg/hr water evaporated

(ii) Kg/hr of thick liquor obtained.

e) Calculate the weight of chlorine in vessel having 5m^3 volume, the pressure and temperature being 100 Kpa and 400 K.

f) 10 moles of N_2 is reacted with 60 moles of H_2 to form NH_3. Calculate % excess of H_2 supply.

Marks

3. Attempt any <u>TWO</u> of the following: **16**

a) 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.

b) 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% and interts = 19.23%.
Find the analysis of feed on mole basis.

c) 10,000 Kg/hr of solution containing 20% methanol is continuously fed to a distillation column. Distillate (product) is found to contain 98% methanol and waste solution from the column carries 1% methanol. All percentage are by weight. Calculate

(i) the mass flow rate of distillate and bottom product and
(ii) % loss of methanol.

4. Attempt any <u>TWO</u> of the following: **16**

a) A gas containing 25% CO, 5% CO_2, 2% O_2 and rest N_2 (by volume) is burnt with 20% excess air. If the combustion is 80% complete. Calculate the composition of flue gases leaving the combustion chamber by volume.

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

$$Cp = a + bT + CT^2 + dT^3, \text{ KJ/(Kmol.k)}$$

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
N_2	29.5909	-5.41	13.1829	-4.968
H_2	28.6105	1.0194	-0.1476	0.769

P.T.O.

Marks

c) The waste acid from nitrating process containing 30% H_2SO_4, 35% HNO_3 and 35% H_2O by weight. The acid is to be concentrated to contain 39% H_2SO_4 and 42% HNO_3 by addition of concentrated sulphuric acid containing 98% H_2SO_4 and conc. nitric acid containing 72% HNO_3 (by weight). Calculate the quantities of three acids to be mixed to get 1000 Kg of desired mixed acid.

5. Attempt any <u>TWO</u> of the following: **16**

a) Describe bypassing operation in details with example.

b) Calculate heat of formation of liquid 1 – 3 butadiene at 298.15 K using following data.

Data: Std. heat of formation of CO_2 (g) = – 393.51 KJ/mol
Std. heat of formation of H_2O (*l*) = –285.83 KJ/mol
Heat of combustion of C_4H_6(*l*) at 298.15 K
= –2520.11 KJ/mol.

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

(i) Percentage conversion of ethylene and

(ii) Percentage yield of ethylene oxide.

Marks

6. Attempt any <u>FOUR</u> of the following: 16

a) Write general material balance procedure.

b) Calculate the heat needed to raise the temperature of 1 Kmol of ammonia from 311 K to 422 K using mean molal heat capacity.

Data: C°pm for NH_3 between 311 K and 298 K = 35.864 KJ/Kmol K

C°pm for NH_3 between 422 K and 298 K = 37.7063KJ/Kmol K

c) Feed containing 60% A, 30% B and 10% inert enters a reactor. The product stream leaving the reactor is found to contain 2 mole % A. Reaction is $2A + B \rightarrow C$. Find conversion of A.

d) 4000 Kg of wet solids containing 70% solid by weight are fed to the dryer where they are dried by hot air. The product from the dryer is found to contain 1% moisture by weight. Calculate Kg of water removed from solid's and Kg of product obtained.

e) Methane gas is heated from 298 K to 523 K at atmospheric pressure calculate the heat added per Kmole of methane gas using C°p data given below.

C°p = $19.2494 + 52.1135 \times 10^{-3}\ T + 11.973 \times 10^{-6}\ T^2$ for methane gas in KJ/Kmole K.

f) In the production of sulphur trioxide, feed to the reactor contains 75 Kmol. SO_2 and 200 Kmol air. Calculate the % excess air used. The reaction is as follows,

$$SO_2 + \frac{1}{2} O_2 \rightarrow SO_3$$