22315

11920

3 Hours / 70 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.

Marks

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

(a) Convert a pressure 800 mm Hg to the following units :

(i) PSi (ii) kPa

(b) State Raoult's law and Ideal gas law.

(c) Draw block diagram for evaporation.

(d) Write the stoichiometric coefficient of the given reaction. Also write weight ratio of CO to H_2 $CO + 2H_2 \rightarrow CH_3OH$

(e) Define Net Calorific value.

(f) Define latent heat & sensible heat.

(g) Define force and write its SI unit.

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

(a) A distillation column fed with 5000 kg/hr of Benzene-toluene mixture containing 40% Benzene. The distillate obtained contains 30% Benzene & bottom product contains 90% toluene. Calculate flow rate of top & bottom product.

(b) Describe Recycle and Bypass operation.

(c) SO_3 is prepared by following reaction :

$SO_2 + ½ O_2 \rightarrow SO_3$

If 10 kmol of SO_2 reacts with 100 kmol air.

Calculate % excess air used.

(d) Calculate the heat of formation of $C_7H_6O_2$ at 298.15 K using following 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

Std. heat of combustion of $C_7H_6O_2 = –3226.95$ kJ/mol

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

(a) Air contains 21% O_2 and 79% N_2 by volume. Calculate average molecular weight of air.

(b) Describe stepwise procedure for material balance without chemical reaction for the chemical system.

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

(d) Calculate std. heat of reaction of following reaction :

$C_2H_5OH(g) \rightarrow CH_3CHO(g) + H_2(g)$

Data given as follows :

Component	ΔH °C kJ/mol
$C_2H_5OH(g)$	– 1410.09
$CH_3CHO(g)$	– 1192.65
$H_2(g)$	– 285.83

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

(a) A force equal to 20 kgf is applied on a piston with a diameter of 5 cm. Calculate the pressure exerted on a piston in kPa.

(b) A gas mixture contain 0.274 kmol HCl, 0.337 kmol N_2 and 0.089 kmol O_2. Calculate : (a) Average molecular weight of gas (b) Volume occupied by this mixture at 405.3 kPa and 303 K.

(c) 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 & 42% HNO_3 by addition of conc. sulphuric acid containing 98% H_2SO_4 and conc. nitric acid containing 72% HNO_3 by weight. Calculate the quantities of acids to be mixed to get 1000 kg of desired mixed acid.

(d) Feed containing 60% A, 30% B and 10% inerts entering 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.

(e) State classification of fuels with four example of each class used in Chemical Industry.

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

(a) Calculate the vapour pressure of pure butane at 20 °C if its partial pressure is 698 mm Hg in a butane-acetone mixture. The mole-fraction of acetone in the mixture is 0.577.

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

Calculate (i) kg/hr water evaporated (ii) kg/hr salt precipitated (iii) kg/hr thick liquor.

(c) Ethylene oxide is produced by oxidation of ethylene. 100 kmol of ethylene are fed to reactor and product is found to contain 80 kmol ethylene oxide and 10 kmol CO_2. Calculate (i) % conversion of ethylene (ii) % yield of ethylene oxide.

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

(a) In the manufacturing of chlorine, feed containing hydrochloric acid gas and air are fed an oxidiser. The product gases leaving the oxidiser are found to contain 13.2% HCl, 6.3 % O_2, 42.9% N_2, 30% Cl_2, 7.6% H_2O by weight. Calculate :

(i) The % excess air used.

(ii) The composition by wt. of gases entering the oxidiser.

(b) A coke containing 90% carbon and 10% non-combustible ash (by wt.) is burned in air. If 50% excess air is supplied. Calculate kmol of air actually supplied.

(c) A steam of carbon dioxide flowing at rate of 100 kmol/min is heated from 298 K to 383 K. Calculate the heat that must be transferred using Cp°.

Data : $Cp° = a + bT + CT^2 + dT^3$, kJ/(kmol.K)

Gas	a	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CO_2	21.3655	64.2341	– 41.0506	9.7999

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