Scheme – G

Sample Question Paper

Course Name : Diploma in Chemical Engineering

Course Code : CH

Semester : Third **17315**

Subject Title : Stoichiometry

Marks : 100 **Time: 3 Hrs**

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. Preferably, write the answers in sequential order

Q1. A) Attempt any FOUR of the following. **(2×4=8)**

a) Give the value of Universal gas constant in SI system &the value of volume occupied by 1 mol of gas at NTP.

b) Based on Law of conservation of mass, write material balance statement for physical process & for a physical process involving chemical reaction.

c) State Dalton's law& give it's mathematical statement.

d) Define partial pressure. Write relationship between partial pressure & total pressure for any component A

e) Differentiate between conversion & yield (any two points)

f) Draw a labeled diagram of distillation operation & an overall material balance equation for the same.

B) Attempt any TWO of the following. **(2×6=12)**

a) The analysis of a gas sample on a mole basis is

CH_4=66%,CO_2=30%,and NH_3=4%

Calculate the density of the gas sample at a pressure of 304Kpa & at a

temperature 303k (Atomic weight C=12,H=1,N=14 & O=16)

b) 25 g of cyclohexane (C6H12) and 20 g of ethanol (C_2H_5OH) are both volatile component present in a solution. What is the partial pressure of ethanol? The vapour pressure of pure ethanol at the temperature of solution is 52.3 torr (mm of Hg)

c) A sample of gas having a volume of 10 *l* at 101.325 kpa & at a temp. of 298k is compressed to a high pressure so that its volume reduces to 4.5 *l* . If the pressure rises by 0.10Mpa, what will be the rise in temperature?

Q2. Attempt any FOUR of the following. **(4×4=16)**

a) Explain any two general methods for solving material balance problems of systems involving no chemical reaction.

b) 2000 kg of wet solids containing 70% solids by weight are fed to a 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 solids & kg of product obtained.

c) A feed containing 60 mole% A,30mole% B & 10 mole% inerts enters a reactor.80% of A reacts according to the reaction $2A+B \rightarrow C$. find the composition of the product stream on mole basis.

d) In manufacture of sulphur trioxide, feed to a reactor contains 50kmol SO2 & 150Kmol air. Calculate the %excess air used. The reaction is $SO_2 + 1/2\ O_2 \rightarrow SO_3$

e) The gas phase reaction $A \rightarrow 2B+C$ takes place isothermally in a constant pressure reactor. Starting with a feed containing 75mole% A & 25 mole % inerts , in a specified time the volume doubles. Calculate the % conversion of A.

f) Methane gas is heated from 303 k to 523 k at atmospheric pressure. Calculate the heat added per kmol of methane gas using Cp^0 data given below

$Cp^0 = 19.2494 + 52.1135\times10^{-3}\ T + 11.973\times10^{-6}$ for methane gas in KJ/kmol.k

Q3. Attempt any TWO of following **(2×8=16)**

a) Monochloro acetic acid (CH2ClCOOH) is manufactured in a semibatch reactor by the acion of acetic acid with chlorine using suitable catalyst at 373 k.

$CH3COOH + Cl_2 \rightarrow CH_2ClCOOH + HCl$

The chlorine is used 15% excess (on mole basis) of that theoretically required. The reaction is 95% complete. calculate the amount of the row materials required for the production of 3000 kg of monochloro acetic acid.

b) In order to carry out the nitration reaction, it is desired to have mixed acid containing 39%HNO_3, 42%H_2So_4& 19% H_2O by weight. Nitric acid of 68.3%(by weight) is available for this purpose. Calculate: i) strength of Sulphuric acid to obtain desired mixed acid ii) the weight ratio of HNO_3 to H_2So_4 acid to be mixed

c) A feed containing 50% benzene & 50% toluene is fed to a distillation column at a rate of 5000 kg/h. the top product contains 95% benzene & bottom product contains 92% toluene. All percentages are by weight. Calculate i) mass flow rates of top & bottom product ii) % recovery of benzene

Q4. Attempt any TWO of the following. **(2×8=16)**

a) Calculate the standard heat of reaction (ΔH^0R)of the following reaction & state the nature of reaction based on ΔH^0R obtained.

$2FeS_2(s) + 5.5\ O_2\ (g) \rightarrow FeO_3\ (s) + 4SO_2\ (g)$

Data:

Component	**ΔH^0f, kj/mol , at 298 k**
$FeS_2(S)$	-178.02
$Fe_2O_3(s)$	-822.70
$SO_2(g)$	-296.81

b) An aqueous solution of pyridine containing 27% pyridine & 73%water is to be exrtracted with chlorobenzene. The feed & solvent are mixed well in a batch exrtractor.& the mixture is allowed to stand for phase separation. The extract phase contains 11% pyridine, 88.1% chlorobenzene &0.9% water and raffinate phase contains 5% pyridine & 95% water. All percentages are by weight. Calculate the quantities of two phases based on 100kg feed.

c) The analysis of gas entering a secondary convertor is 4%SO_2, 13%O_2& 83% N_2 by volume. The gas leaving the convertor is found to contain 0.45%SO_2 on SO_3 free basis by volume. Calculate the actual analysis of the gas mixture leaving the convertor on volume (i.e. mole) basis

Q5. Attempt any TWO of following **(2×8=16)**

a) A gas containing 25%CO, 5%CO_2, 2%O_2 & 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 sample of coal obtained from a colliery is found to contain 67.2%carbon & 22.3% ash by weight. The refuse obtained at the end of combustion is analysed to contain 7.1% carbon & 92.9% ash. Calculate the percentage of original carbon remain unburnt in the refuse.

c) Obtain an imperial equation for calculating the heat of reaction at any temp. T(in k) for the reaction $CO(g) + 2H_2(g) \rightarrow CH_3OH(g)$

Data: i) ΔH^0R for the reaction = -90.41 kJ/mol

ii)$CP^0 = a+bT+cT^2$ data in kJ/(mol.k)

DATA:

Component	a	$b\times10^3$	$c\times10^6$
CO(g)	29.03	-2082	11.64
$H_2(g)$	28.61	1.02	-0.148
$CH_3OH(g)$	21.14	70.84	25.86

Q6. Attempt any FOUR of following **(4×4=16)**

a) Ethylene oxide is prepared by the oxidation of ethylene. The product stream leaving a reactor is found to contain 9.38%C_2H_4, 50% C_2H_4O, 6.25%CO_2, 6.25%H_2O& 28.12% O_2

by mole. Calculate the % conversion of ethylene & % yield of ethylene oxide. The reactions are

$C_2H_4+1/2\ O_2 \rightarrow C_2H_4O$

$C_2H_4+3\ O_2 \rightarrow 2CO_2+ 2H_2O$

b) The NH_3 - air mixture containing 0.20kg NH_3 per kg of air enters into an absorption tower where NH_3 is absorbed in water. The gas leaving the tower is found to contain 0.004kg NH_3 per kg of air. Find the % recovery of ammonia.

c) Define recycling & state any four reasons for performing recycling operation in industry.

d) A cock is known to contain 90% carbon &10% ash by weight. Air is used 20% excess for combustion (on mole basis).Calculate the moles of air supplied per 100 kg of coke burned.

e) In the manufacture of acetic acid (CH_3COOH) by oxidation of acetaldehyde(CH_3CHO), 100 kmol of CH_3CHO are fed to a reactor per hour. The product leaving the reactor contains 14.81% CH_3CHO , 59.26% CH_3COOH & rest oxygen(on mole basis) Calculate the % conversion of acetaldehyde

f) Calculate the heat of formation of gaseous ethyl alcohol at 298.15 k using following data.

Data: i) standard heat of formation of $CO_2(g)$=-393.51kJ/mol

ii) standard heat of formation of $H_2O(l)$=-285.83 kJ/mol

iii) standard heat of formation of $C_2H_5OH(g)$=-1410.09 kJ/mol