

Sample Test Paper – I

9197

Course Name :- Diploma in Chemical Engineering
Course code :- CH
Semester :- Third
Subject :- Stoichiometry
Duration :- 3hours

Marks : 80

Instructions:

- 1) All the questions are compulsory
- 2) Figures to the right indicate full marks
- 3) Assume suitable additional data if necessary
- 4) Non-programmable pocket calculator is allowed

Q1. Attempt any eight.

Marks: 16

- a) State Charles's law and give its mathematical expression.
- b) Give the value of R in S.I. and M.K.S. units.
- c) State Vander waal's equation and give its application
- d) What do you mean by overall balance and component balance?
- e) Define excess component with suitable example.
- f) Define latent heat of vaporization.
- g) State Hess's law and give its application.
- h) Define standard heat of formation.
- i) Convert 0.5 Btu into calories.
- j) Calculate the volume of 1 mole of air at STP

Q.2 Attempt any three.

Marks: 12

- a) A gas mixture contains 20% O₂, 30% CO₂ and 50 % N₂ (by mol). Calculate the average molecular weight of gas mixture.
- b) A gas mixture contains 0.5 kg moles CH₄, 0.3 kg moles C₂ H₆ and 2.6 kg moles N₂. Find out the density of gas mixture at 300⁰K and 101.325 kpa.
- c) A sample of gas having volume of 0.5 m³ is compressed in such a manner so that pressure is increased by 60%. The operation is done for a fixed mass of gas at constant temperature. Calculate the final volume of gas.
- d) For the reaction $\text{CO} + 1/2 \text{O}_2 \longrightarrow \text{CO}_2$, 100 kmoles of CO and 300 kmoles air are fed. The product stream contains 80 kmoles CO₂. Calculate the % conversion of CO.

Q3. Attempt any two.

Marks: 12

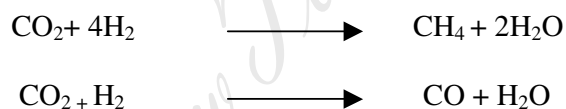
- a) 1000 kg/hr of methanol water mixture containing 50% methanol is fed to a distillation tower. Distillate contains 90% methanol and residue contains 8% methanol (% are by weight). Calculate
 - (i) kg/hr of distillate
 - (ii) kg/hr of residue
 - (iii)% recovery of methanol

- b) The groundnut seeds containing 45% oil and 45% solids are fed to expeller, the cake coming out of expeller is found to contain 80% solids and 5% oil. Find the percentage recovery of oil.
- c) It is desired to prepare 1000 kg of a solution containing 35% by weight of a substance A. Two solutions are available, one containing 10 weight % A and other containing 50 weight % A. How many Kgs of each solution will be required?

Q4. Attempt any two.

Marks: 16

- a) In production of chlorine gas by oxidation of hydrochloric acid gas, air is used 30% excess of that theoretically required. Based on 4 kmol HCL, calculate
- Weight ratio of air to HCl gas fed
 - If oxidation is 80% complete, find the composition of product stream on mol basis.
- b) Pure sulphur is burnt in a sulphur burner with dry air. Oxygen is used 20% excess above that required for the complete combustion of sulphur to SO₃. The efficiency of burner is such that only 30% of the sulphur burns to SO₃ remainder goes to SO₂. Calculate
- The analysis of the resulting mixture in mol%.
 - The weight of gas per kg of sulphur burnt
- c) A mixture of pure CO₂ and H₂ is passed over a nickel catalyst. The temperature of the catalyst bed is 588 k and the reactor pressure is 2 MPag. The analysis of the gases leaving the reactor showed CO₂ = 57%, H₂ = 41.1%, CH₄ = 1.68 and CO = 0.12% by volume on a dry basis. The reaction taking place are



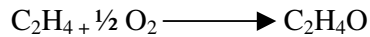
- Find
- The conversion of CO₂ per pass
 - The yield of CH₄ in terms of CO₂ reacted
 - The composition of feed on volume basis.

Q5. Attempt any two.

Marks: 12

- a) Calculate the heat of formation of benzoic acid crystals (C₇H₆O₂) at 298 k using following data.
- Data:-
- Standard heat of formation of CO₂ (g) = -393.51 KJ/mol
- Standard heat of formation of H₂O (l) = -285.83 KJ/mol
- Standard heat of combustion of benzoic acid crystals = - 3226.95 KJ/mol
- b) Ethylene oxide is produced by oxidation of ethylene. 100 kmoles of ethylene is fed to a reactor and product is found to contain 80 kmol ethylene oxide and 10 kmol CO₂. Calculate
- conversion of ethylene:
 - Yield of ethylene oxide.

c) Oxidation of ethylene to produce ethylene oxide is given by the reaction.

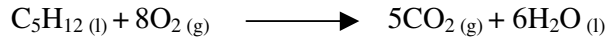


If air is used 20% in excess of that theoretically required, calculate the quantity of air supplied based on 100 Kmol of ethylene fed to reactor.

Q6. Attempt any three.

Marks: 12

a) Calculate the standard heat of reaction of the following reaction.



Data

Component	ΔH_f^0 KJ/mol at 298 K
$\text{C}_5\text{H}_{12}(\text{l})$	-173.49
$\text{CO}_2(\text{g})$	-393.51
$\text{H}_2\text{O}(\text{l})$	-285.83

b) Calculate the heat needed to raise the temperature of 1 Kmol of ammonia from 311^o k to 422^o K using meal molal heat capacity

$C_{p,m}^0$ for NH_3 between 311^o and 298^o K = 35.86 KJ/mol.K

$C_{p,m}^0$ for NH_3 between 422^ok and 298^o K = 37.70 KJ/mol.K.

c) A single effect evaporator is fed with 1000 kg/hr of weak liquor containing 20% caustic by weight and is concentrated to get thick liquor containing 50% caustic by weight. Calculate

(i) kg/hr of water evaporated

(ii) kg/hr of thick liquor obtained

d) A sample of coal is found to contain 63% carbon & 24% ash on weight basis. The analysis of refuse after combustion shows 7% carbon and rest ash. Calculate Kg of carbon in refuse.