M.Sc. 2nd Semester Examination, 2012

CHEMISTRY

(*Industrial*)

PAPER– CEM-204

Full Marks : 40

Time : 2 hours

Answer any **four** questions

The figures in the right-hand margin indicate marks

1. (*a*) Define grass and net calorific value of a fuel.

(*b*) Write the significance of the proximate analysis of coal.

(*c*) What do you mean by ultimate analysis.

(*d*) Write the origin of coal. 2 + 3 + 1 + 4

2. (*a*) Define crude oil.

(*b*) Name the sulphur and nitrogen compound present the crude oil.

(*c*) Write the function of desalting of crude oil.

(*d*) Describe the desalting operation in details. 2+3+2+3

3. (*a*) State and explain Fisk's law of diffusion.

(*b*) Distinguish between adsorption and absorption.

(*c*) Show that $D_{AB} = D_{BA}$.

(*d*) In an oxygen-nitrogen gas mixture at 1 atm. 25 °C, the concentration of oxygen at two planes 0·2 cm apart are 10% and 20% (by vol.%) respectively. Calculate the flux of oxygen when (*i*) nitrogen is non-diffusion and (*ii*) there is equimolal counter diffusion.

Given, diffusivity of oxygen in nitrogen = 0·215 cm^2/s. 2+2+2+4

4. (*a*) The diffusivity of CCl_4 through O_2 was determined in a steady state Arnold evaporating cell. The cell, having a cross sectional area of 0·82 cm^2, was operated at 273 K and 755 mm Hg pressure. The average length of the diffusion path was 17·1 cm. if 0·0208 cc of CCl_4 was evaporated in 10 hrs. of

steady state operation, what should be the value of the diffusivity of CCl_4 through O_2?
Given, Vapour pressure of CCl_4 at 273 K = 33 mm Hg
Density of CCl_4 = 1·59 gm/cc.

(*b*) A crystal of copper sulphate $CuSO_4.5H_2O$ falls through a large tank of pure water at 20 °C. Estimate the rate at which the crystal dissolves by calculating the flux of $CuSO_4$ from the crystal surface to the bulk solution. Molecular diffusion occurs through a film of water uniformly 0·0305 mm surrounding the crystal. At the inner side of the film, adjacent to the crystal surface, the concentration of $CuSO_4$ is 0·0229 mole fraction $CuSO_4$ (solution density = 1193 kg/m^3). The outer surface of the film is pure water. Given, diffusivity of $CuSO_4$ = $7{\cdot}29 \times 10^{-10}$ m^2/s; T = 293 K, molecular weight of $CuSO_4$ = 160. 4 + 6

5. (*a*) Discuss the integral method of analysis and differential method of analysis for interpretation of the batch reactor data. Mention also the advantages and disadvantages of these methods.

(*b*) Define space velocity and space time.

(*c*) Write the characteristic of plug flow reactor.

(*d*) For a liquid phase zero order reaction A $\rightarrow$ B, the conversion of A in a CSTR is found to be 0·3 at a space velocity of 0·1 min^{-1}. What will be the conversion for a PFR with a space velocity of 0·2 min^{-1} ? Assume that all the other operating conditions are the same for CSTR and PFR.

4 + 2 + 1 + 3

6. (*a*) The decomposition of N_2O_5 is postulated by the following mechanism,

$$N_2O_5 \underset{k_2}{\overset{k_1}{\rightleftharpoons}} NO_2 + NO_3^*$$

$$NO_3^* \xrightarrow{k_3} NO^* + O_2$$

$$NO^* + NO_3^* \xrightarrow{k_4} 2NO_2$$

Using the steady state approximation, derive an expression for the rate of decomposition of N_2O_5.

(*b*) Consider the set of elementary reactions.

$$A \xrightarrow{k_1} B$$

$$A + B \xrightarrow{k_2} C$$

$$A + D \xrightarrow{k_3} 2E$$

At time $t = 0$, a batch reactor id filled with mixture of A and D. What is the relation between the concentration of B and D after a time t ? 5 + 5

7. (*a*) Define ore.

(*b*) Discuss the factors to be consider for mining and processing of any ore.

(*c*) Discuss the principle of Froth Flotation and Magnetic separation used in ore dressing. 2 + 3 + 5

8. (*a*) Classify refractories on the basis of refractoriness.

(*b*) Discuss the following properties of refractories :

(*i*) spalling

(*ii*) slag resistance.

(*c*) Mention the uses of silica refractories.

(*d*) Mention at least four desirable properties of a good refractory. 2 + (2 + 2) + 2 + 2