

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 gross 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.

(Turn Over)

- (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 Fick'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 equimolar counter diffusion.
- Given, diffusivity of oxygen in nitrogen = 0.215 cm²/s. 2 + 2 + 2 + 4
4. (a) The diffusivity of CCl₄ through O₂ was determined in a steady state Arnold evaporating cell. The cell, having a cross sectional area of 0.82 cm², 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 CCl₄ 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 $\text{CCl}_4 = 1.59 \text{ gm/cc.}$

- (b) A crystal of copper sulphate $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ 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 $\text{CuSO}_4 = 7.29 \times 10^{-10} \text{ m}^2/\text{s}$; $T = 293 \text{ K}$, molecular weight of $\text{CuSO}_4 = 160$. 4 + 6

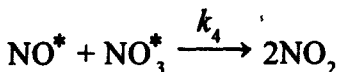
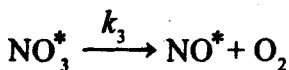
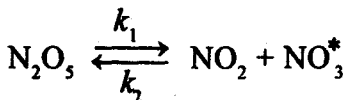
5. (a) Discuss the integral method of analysis and differential method of analysis for interpretation of the batch reactor data. Mention also the advantages and disadvantages of these methods.

- (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.

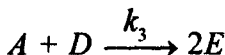
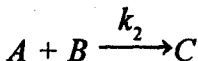
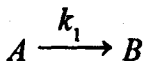
4 + 2 + 1 + 3

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



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

- (b) Consider the set of elementary reactions.



At time $t = 0$, a batch reactor is 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 considered 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
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