# CSM : 14

## CHEMISTRY

## PAPER - I

Time Allowed : 3 hours | Full Marks : 100

*Marks for each question is indicated against it.*

*Attempt any 5 (five) questions taking not more than 3 (three) questions from each Part.*

### PART A

**1.** (a) Derive Bragg's equation for the diffraction of X-rays by crystal lattice. **(5)**

(b) Draw and explain the phase diagram for sulfur system and mention its salient features. **(5)**

(c) What is radius ratio? How does Coordination number vary with the radius ratio? **(1+4=5)**

(d) Iron (II) oxide, FeO, crystal has a cubic structure and each edge of the unit cell is 5.0 Å. Considering the density of the oxide as 4.0 $gcm^{-3}$ , calculate the number of $Fe^{2+}$ and $O^{2-}$ ions present in each unit cell. **(5)**

**2.** (a) Discuss in details Maxwell's distribution of molecular velocities. **(6)**

(b) Calculate the root mean square velocity of nitrogen at 27°C and 70cm pressure. Density of Hg = 13.6 $gcm^{-3}$ . **(4)**

(c) How does free energy change with temperature and pressure? **(5)**

(d) What is Joule-Thomson Effect? Show that Joule-Thomson coefficient is zero in an ideal gas while it has a positive value in the case of a real gas. **(1+4=5)**

**3.** (a) Differentiate between physical and chemical adsorption, giving suitable example. **(4)**

(b) Derive the equation for Langmuir adsorption isotherm. **(5)**

(c) What are concentration cells? Derive an expression for e.m.f. of a concentration cell without transference. **(1+5=6)**

(d) Mention the advantages of hydrogen-oxygen fuel cells. **(2)**

(e) Calculate the e.m.f. of the cell : **(3)**

$Zn/Zn^{2+}$ (0.001m) || $Ag^{+}$ (0.1m) /Ag

Given : $E^{0}_{Zn^{2+}/Zn} = -0.76$ v and $E^{0}_{Ag^{+}/Ag} = 0.80$ v

**4**. (a) Discuss the kinetics of consecutive reaction, taking a suitable example. **(4)**

(b) What is a first order reaction? Derive an expression for the rate constant of a first order reaction. **(1+4=5)**

(c) Discuss the kinetics of photochemical decomposition of HI. **(6)**

(d) The decomposition of an aqueous solution of ammonium nitrite was studied by placing the apparatus in a thermostat maintained at particular temperature. The volume of nitrogen gas collected at different intervals of time was as follows:

| | | | | | |
|---|---|---|---|---|---|
| Time (Minutes) : | 10 | 15 | 20 | 25 | $\infty$ |
| Volume of $N_2$ (mL) : | 6.25 | 9.00 | 11.40 | 13.65 | 35.05 |

From the above data prove that the reaction is of the first order. **(5)**

## PART B

**5.** (a) What are the main conditions which $\psi$ must satisfy to give meaningful solutions of Schrodinger wave equation? **(5)**

(b) Discuss neutron-proton ratio and its relation to nuclear stability. **(5)**

(c) Explain the variation of electron affinity in a group and along the period of p-block elements. **(4)**

(d) What is meant by tracer technique? Write two applications of this technique. **(1+2=3)**

(e) Calculate the de Broglie wavelength of an electron moving with a velocity of $6\times10^5 ms^{-1}$ (mass of electron $= 9.1\times10^{-31}$ kg, $h = 6.62\times10^{-34}$ Js ). **(3)**

**6**. (a) Explain the hybridization and structure of $SF_4$ molecule. **(3)**

(b) Draw molecular orbital energy level diagram of oxygen molecule and comment on the bond order and magnetic properties of $O_2$ and $O_2^+$ ion. **(3+2=5)**

(c) Write the effect of hydrogen bonding on the physical properties of the compounds containing hydrogen bonds citing suitable example. **(4)**

(d) Explain the structural aspects of haemoglobin. **(5)**

(e) Discuss the role of alkaline earth metals in biological systems with special reference to $Ca^{2+}$ ions. **(3)**

**7.** (a) What is inert pair effect? How does it affect the oxidation states of p-block elements? **(1+4=5)**

(b) Explain giving appropriate reasons: **(3×2=6)**

(i) $BCl_3$ exists as a monomer whereas $AlCl_3$ is dimerised.

(ii) LiCl is more covalent in nature than the other alkali metal chloride.

(iii) Cu(I) is colourless but Cu(II) is deep blue in colour.

(c) Why do transition metals form complexes? **(4)**

(d) Compare the oxidation states of 4d transition elements with their 3d analogues. **(5)**

**8.** (a) What do you mean by number average molecular weight of polymers? Describe osmotic pressure method used to determine the molecular weight of polymers. **(2+4=6)**

(b) Give reasons why the separation of Lanthanides is difficult. **(4)**

(c) Discuss the oxidizing properties of $KMnO_4$ in acidic and alkaline medium. **(4)**

(d) How will you prepare linear silicones? Mention the advantages of silicone rubbers. **(4+2=6)**

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