

CSM : 15

CHEMISTRY PAPER - I

Time Allowed : 3 hours

Full Marks : 100

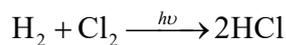
Marks for each question is indicated against it.

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

PART A

- How does the coordination number of ions and radius ratio depend on each other? (5)
 - Considering a unit cell of hexagonal closed packed structure, calculate the percentage of vacant space. (5)
 - Derive the Bragg's equation $n\lambda = 2d \sin \theta$ where d is the inter-planer distance, λ is the wave length of light used, n is the order of diffraction and θ is the glancing angle. (5)
 - State and explain Nernst distribution law. How is the law modified when solutes undergo association in one of the solvents? (2+3=5)
- Derive an expression for root mean square velocity of a gas using Maxwell distribution of molecular velocities. (5)
 - Discuss the principle of equipartition of energy. (5)
 - For oxygen gas, calculate the (i) average velocity and (ii) root mean square velocity at 25°C. (2½+2½=5)
 - What is Joule-Thomson effect? Show that enthalpy remains constant in Joule-Thomson effect. (2+3=5)
- State the assumptions of Langmuir Adsorption Isotherm and derive the expression for it. (2+3=5)
 - Derive Michaelis-Menten equation for an enzyme catalysed reaction and define Michaelis constant (K_M). (5)
 - What are concentration cells? Derive an expression for *emf* of a concentration cell with transference. (1+4=5)
 - Calculate the *emf* of the given cell $Zn/Zn^{2+}(aq)||Cu^{2+}(aq)/Cu$. Given that $E^\circ_{Zn^{2+}/Zn}$ and $E^\circ_{Cu^{2+}/Cu}$ are -0.76 and +0.34V respectively. Also write the cell reaction. (5)

4. (a) Discuss the kinetics of the following photochemical reaction: (6)



- (b) State and explain temperature coefficient of a reaction. What is meant by the energy of activation? Explain how energy of activation is determined with the help of the Arrhenius equation? (2+2+3=7)
- (c) What is quantum yield? Calculate the number of moles of HCl(g) produced by the absorption of one joule of radiant energy of wave length 480 nm in the reaction $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$ if the quantum yield of the photochemical reaction is 1.0×10^6 . (2+5=7)

PART B

5. (a) Explain Heisenberg's uncertainty principle. Show that this principle is valid only for small particles and not for large objects. (3+2=5)
- (b) Set up and solve the Schrödinger wave equation for a particle in an infinite one dimensional box, with potential energy to be zero inside the box. (5)
- (c) How does radio carbon dating help in the age determination of a sample? (5)
- (d) Explain the stability of an atomic nuclei in terms of the ratio of protons and neutrons. (5)
6. (a) Draw the molecular orbital diagram to demonstrate the formation of CO molecule and explain its magnetic behaviour. (4+1=5)
- (b) Discuss the shape of H_2O and BF_3 molecules in the light of VSEPR theory. (2½+2½=5)
- (c) Mention the salient features of hybridisation and explain the formation of PCl_5 molecule. (3+2=5)
- (d) What are metalloporphyrins? Elucidate the structure and function of myoglobin. (1+4=5)
7. (a) Mention the general trends of *p*-block elements with increasing atomic number with respect to (i) atomic size (ii) Ionization energy (2½+2½=5)
- (b) Comment on the relative stability of +2 and +3 oxidation states of Fe and Mn in aqueous solution. (5)
- (c) Compare with suitable example, the oxidation state exhibited by 4*d* and 5*d* transition elements with their 3*d* analogue. (5)
- (d) What are the factors that affect the colour of transition metal complexes. Explain why $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ is green-blue whereas $[\text{Co}(\text{NH}_3)_6]^{3+}$ is yellow-orange. (3+2=5)

8. (a) What are the causes of lanthanide contraction? Mention few consequences of lanthanide contraction taking suitable example. (2+3=5)
- (b) Discuss the structure and bonding of diborane. (5)
- (c) Define weight average molecular weight of polymers. Discuss viscosity method used to determine the molecular weight of the polymers. (2+4=6)
- (d) What are silicones? Mention their uses. (2+2=4)

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