

3516

5. (a) Determine the hybridization of the central atom and the shape of the following molecules:
 $\text{XeOF}_4, \text{NO}_3^-, \text{ClO}_4^-, \text{SF}_4, \text{CO}_2$ 5
- (b) (i) Explain on the basis of Molecular orbital theory why N_2 is diamagnetic and O_2 is paramagnetic. 3
- (ii) Differentiate between bonding and antibonding molecular orbitals ? 2
- (c) Write the Born-Landé equation for calculating the lattice energy of an ionic crystal and explain the various terms involved. 5
6. (a) (i) Calculate the percentage of ionic character in HCl molecule, given that the bond length is $1.275 \text{ \AA}$ and the observed dipole moment is 1.03 D. 2.5
- (ii) What is resonance ? Draw the resonance structures of CO_3^{2-} 2.5
- (b) Write a short note on the following: $2 \times 2.5 = 5$
- (i) Lattice energy
- (ii) Hydration energy
- (c) Explain Fajan's rules and based on these rules compare the covalent character of the following compounds. 5
- (i) NaCl and CuCl
- (ii) AgCl and AgI

[This question paper contains 4 printed pages]

Your Roll No. :,.....

Sl. No. of Q. Paper : 3516 I

Unique Paper Code : 2174001001

Name of the Paper : Atomic Structure and Chemical Bonding

Name of the Course : B.Sc.(H)/ B.Sc. Prog.

Semester : I/III/V

Time : 2 Hours **Maximum Marks : 60**

Instructions for Candidates :

- (a) Write your Roll No. on the top immediately on receipt of this question paper.
- (b) Attempt any **four** questions out of six.
- (c) **All** question carry equal marks.
1. (a) (i) Why are electronic configurations with half-filled and fully filled orbitals more stable than the other configurations. Explain with suitable example. 3
- (ii) Differentiate between the terms 'shell' and 'subshell.' 2
- (b) (i) Write the significance of $\Psi(x)$ and $\Psi^2(x)dx$, where Ψ is representing an electronic wave-function. 2.5

- (ii) What are some special properties which must be fulfilled by acceptable wave function ? 2.5
- (c) (i) Calculate the wavelength of electron (mass = 10^{-30} kg) moving with kinetic energy 10^{-14} J ($h = 6.626 \times 10^{-34}$ Js) 2.5
- (ii) What do you understand by the Aufbau Principle ? Why is the 4s orbital filled before the 3d orbital ? 2.5
2. (a) Write the time-independent Schrodinger wave equation (three dimensional) for the electron in a hydrogen atom in Cartesian coordinates and explain all the terms involved. What three quantum numbers are derived from its solution ? 5
- (b) State and explain the Pauli Exclusion principle and the Heisenberg uncertainty Principle. 5
- (c) The Lyman series of emission lines in the hydrogen atom's emission spectrum corresponds to electronic transitions from excited states to the $n = 1$ orbit. Calculate the wavelength of the lowest energy line in the Lyman series and specify the region of the electromagnetic spectrum in which it occurs. 5
3. (a) Draw the radial probability distribution curves for the 1s, 2s and 2p orbitals, labeling the nodes present and the most probable distance for each. 5

- (b) Write a short note on the following : ($2 \times 2.5 = 5$)
- (i) Bohr's theory and its limitations
- (ii) Radial and angular parts of a wave function and their significance
- (c) Give the values of all four quantum numbers for the 2s, 5p and 4d orbitals. 5
4. (a) Draw Born Haber cycle and the enthalpy of formation (ΔH_f°) for MgF_2 using the following data- 5
- Enthalpy of sublimation of Mg = 146.4 KJ/mol
 Ionization energy of Mg to Mg^{2+} = 2184 KJ/mol
 Dissociation energy of F_2 = 158.9 KJ/mol
 Electron gain enthalpy of F(g) = -334.7 KJ/mol
 Lattice energy of MgF_2 = -2922.5 KJ/mol
- (b) What do you understand by the term VSEPR theory ? Write the postulates of VSEPR theory. 5
- (c) (i) What is Madelung constant ? Is the Madelung constant same or different for NaCl and CsCl ionic structures ? 3
- (ii) Why is the bond order of O_2^+ is more than that of O_2 ? 2