

This question paper contains 4 printed pages]

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S. No. of Question Paper : **5309**

Unique Paper Code : **2174001001**

Name of the Paper : **GE : Atomic Structure and Chemical Bonding**

Name of the Course : **All Undergraduate Courses except with
Chemistry Discipline**

Semester : **II/IV/VI**

Duration : **2 Hours**

Maximum Marks : **60**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt any *four* questions out of six.

All questions carry equal marks.

1. (a) What is the significance of the wave function ψ and ψ^2 in quantum mechanics ? Why is ψ^2 more important than ψ in physical interpretations ?
- (b) Illustrate and explain the shapes of the five d orbitals. Why do some d orbitals lie in the plane while others lie between the axes ?
- (c) Explain the reasons behind the extra stability of half-filled and completely filled orbitals. How do exchange energy and symmetry contribute to this stability ?

5,5,5

P.T.O.

2. (a) Name the different spectral series observed in the hydrogen spectrum. How did the hydrogen spectrum indicate the need for a new atomic model ?
- (b) What are the quantum numbers that arise from the solution of the Schrödinger equation for the hydrogen atom ? Explain the physical meaning of each.
- (c) The uncertainty in the momentum of a particle is 3.3×10^{-24} kg.m/s. Calculate the uncertainty in its position.
- (d) Find the de Broglie wavelength of a ball of mass 0.1 kg moving with a speed of 10 m/s. Why is this wavelength not observable ? 5,4,3,3
3. (a) Using the molecular orbital theory, determine the bond order in carbon monoxide (CO) and explain its implication on the stability and bond length of the molecule.
- (b) Explain the shapes of the following molecules using VSEPR theory : H_2O , NH_3 and PCl_5 . Discuss the role of lone pairs and bonding pairs in determining the geometry.
- (c) Draw all possible resonating structures of the following compounds and explain the resonance effect in each (any two) :
- (i) Benzene
- (ii) CO_2
- (iii) O_3 .

4. (a) Define radius ratio rule. Calculate the radius ratio for a compound in which the cation has a radius of 0.1 nm and the anion has a radius of 0.25 nm. Predict the coordination number and geometry.
- (b) Compare the covalent character in LiI and NaI. Justify your answer using Fajan's rules.
- (c) What is the Born-Haber cycle ? Explain its significance in determining lattice enthalpy.
- (d) Predict the shape and hybridization of the following :
- (i) ClF_3
 - (ii) PCl_5
 - (iii) SF_4 .
5. (a) Explain Fajan's rules in detail. How do these rules help in predicting the covalent character in ionic compounds ? Give suitable examples.
- (b) Explain how molecular geometry affects dipole moment. Why does BF_3 have zero dipole moment despite having polar bonds ?
- (c) What are the formulas to calculate the number of radial, angular and total nodes ? Calculate the radial, angular and total nodes for 2s and 3p orbitals.
- (d) Why is the Madelung constant important in the Born-Landé equation and what does the Born exponent (n) represent ?

4,4,4,3

5,4,3,3

P.T.O.

6. (a) Draw the radial probability curve for $1s$, $2s$ and $3p$ orbitals, labeling the node present and most probable distance for $1s$ and $2s$.
- (b) Give the values of all the four quantum numbers for $3s$, $4d$, $5f$ and $3p$ orbitals.
- (c) State and explain the Heisenberg's uncertainty principle and Pauli's exclusion principle.

5,5,5