

(c) Give reasons for the following :

- (i) LiF flouts the radius ratio rules.
- (ii) Half-filled and fully filled orbitals are associated with extra stability (5,5,5)

[This question paper contains 8 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1354

I

Unique Paper Code : 2172011101

Name of the Paper : DSC: Atomic Structure and
Chemical Bonding (Inorganic
Chemistry – I)

Name of the Course : **B.Sc. (H) Chemistry**

Semester : I

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

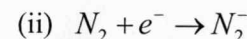
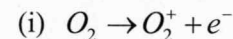
1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **6** questions in all. **All** the questions carry equal marks.
3. The questions should be numbered in accordance to the number in the question paper.
4. Calculators and log tables may be used.

1. Explain the following (Any Five)

- (i) The bond angle of $\text{OF}_2 < \text{H}_2\text{O}$ whereas $\text{Cl}_2\text{O} > \text{H}_2\text{O}$.
- (ii) NF_3 has a dipole moment, while BF_3 has zero dipole moment.
- (iii) PF_5 exists but PH_5 does not.
- (iv) Though the radii of Ag^+ is comparable with the radii of K^+ , but the melting point of AgCl is much lower than that of KCl .
- (v) The first electron gain enthalpy of O is exothermic, whereas its second electron gain enthalpy is endothermic; still, it exists as O^{2-} in oxides.
- (vi) Electronic configuration of Cr is $3d^5 4s^1$ and not $3d^4 4s^2$. (5×3)

2. (a) Name the quantum numbers which arise as a consequence of the solution of the wave equation for H-atom. What idea do you get from all these quantum numbers?

- (b) Arrange the following in increasing order of dipole moment: BF_3 , NH_3 , NF_3 . Justify your answer.
- (c) Define Bent's Rule. How does it help to decide the bond angles of CH_2F_2 ?
- (d) What is the expected change in Bond order during the following ionization processes :



8. (a) What do you understand by the term effective nuclear charge? Calculate the shielding constant and effective nuclear charge (Z_{eff}) for the electron present in 4s and 3d of Scandium ($Z = 21$).

(b) Differentiate between :

(i) Orbit and orbital.

(ii) Electronegativity and electron affinity

6. (a) (i) What is a radial node? How many radial nodes are there in a 3s orbital?

(ii) What is radial probability distribution function? Explain it for 1s orbital.

(b) "In case of B_2 , C_2 and N_2 molecules s- p_z mixing cannot be neglected while in case of O_2 and F_2 , MO diagrams explain most of the characteristics of these molecules without considering s- p_z mixing." Justify the statement.

Draw MO diagram of N_2 molecule using s- p_z mixing.

(c) On which law is the Born-Haber cycle based? Set up a Born-Haber cycle for the formation of MgO from magnesium metal and oxygen, i.e.



7. (a) The bond angle in water molecule is 104.5° . Calculate the s character used by the oxygen atom directed to the two bonded orbitals and two non-bonded orbitals.

(b) Write the Kaputinskii equation for lattice energy and define the terms involved. What are the advantages and disadvantages over Born-Landé equation?

(c) What do you understand by partial ionic character in a covalent bond? The electronegativity of hydrogen and bromine are 2.2 and 3.0 respectively. Calculate percent ionic character of HBr. Also predict the nature of HBr molecule.

(d) On the basis of the Slater's rule, explain why 4s orbital is filled before the filling up of 3d orbitals in potassium atom? (4,5,4,2)

3. (a) Given the equation :

$$\Psi_{4,1,0} = R_{4,1} \cdot \theta_{1,0} \cdot \phi_0$$

Based upon the equation, answer the following questions.

(i) Name the equation.

(ii) Define the terms involved in the equation.

(iii) Which orbital is related with the equation?

(b) Why the covalent radius of Ge (122 pm) is almost the same as that of Si (117 pm) even though Ge has 18 electrons more than Si?

(c) Arrange the following in order of increasing bond angles X – P – X and justify your answer.



(d) The dipole moment of HX molecule is 1.92 D and the bond distance 1.2 Å. Calculate the percent ionic character of HX. ($1\text{D} = 3.336 \times 10^{-30} \text{ Cm}$, charge on one electron = $1.6 \times 10^{-19} \text{ C}$).

(4,3,4,4)

4. (a) Draw the radial probability distribution curves for 3s, 3p, and 3d orbitals. Based on these plots explain their shielding effect and penetration power.

(b) Calculate the limiting radius ratio of cation to that of anion when coordination number is six.

Given $r_{\text{A}^{2+}} = 59 \text{ pm}$ and $r_{\text{B}^{2-}} = 170 \text{ pm}$, predict the geometry of AB.

(c) Using VSEPR theory, predict the shapes of the following species :



5. (a) Give the mathematical expression for the conditions of orthogonality and normalization wave function. What is meant by well-behaved wave function?

(b) Write the following in order of as mentioned in each case with suitable reasons:

(i) Increasing acidity – Acetylene, ethane and ethene.

(ii) Decreasing melting points – KF, KCl, KBr, KI

(c) Ψ_{A} and Ψ_{B} are wave functions of two atomic orbitals A and B. Draw the molecular orbital diagrams obtained by combination of the atomic orbitals when

(i) $\chi_{\text{A}} = \chi_{\text{B}}$

(ii) $\chi_{\text{A}} < \chi_{\text{B}}$

where χ_{A} and χ_{B} are the electronegativities of atoms A and B. (6,6,3)