

Total number of printed pages-7

3 (Sem-3) CHM M2

2021

(Held in 2022)

CHEMISTRY

(Major)

Paper : 3:2

(Chemical Bonding)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following as directed : $1 \times 7 = 7$

(a) Which has higher bond order, N_2 or NO ?

(b) Explain briefly why there is no inter-electronic repulsion in H_2^+ molecule.

Contd.

(c) The shape of XeF_4 molecule is

(Fill in the blank)

(d) How many octahedral voids are there in one mole of a compound having ccp structure?

(e) What do you mean by a hydrogen bond?

(f) Which of the following pairs has zero dipole moment?

(i) CH_2Cl_2 and NF_3

(ii) SiF_4 and BF_3

(iii) PCl_3 and ClF

(iv) BF_3 and NF_3

(Choose the correct option)

(g) What are the hybridization of N-atom in NO_3^- and NO_2^+ ?

2. Answer the following questions : $2 \times 4 = 8$

(a) Draw the Lewis structure of HNO_3 and H_2CO_3 .

(b) How is the molecular orbital different from atomic orbital? What is the maximum number of electrons that can occupy the molecular orbital?

(c) The molecule of $MgCl_2$ is linear whereas $SnCl_2$ is angular. Explain why.

(d) In the mineral spinel, $MgAl_2O_4$, what percentage of tetrahedral and octahedral voids are occupied by Mg^{2+} and Al^{3+} ions respectively?

3. Answer **any three** questions : $5 \times 3 = 15$

(a) Using VSEPR theory, identify the type of hybridization and draw the structure of OF_2 .

(b) How does bond length vary with the extent of 's' character in the hybrid orbitals involved in bonding? Calculate the percentage of 's' character in sp^3 , sp^2 and sp hybrid orbitals.

(c) Explain the poor reactivity of N_2 in terms of MO theory.

(d) Copper crystallizes in FCC lattices. The atomic radius of copper atom is 128pm . Calculate the density of copper.

(e) $CsCl$ is more stable than $NaCl$. Explain this stability with the help of both Fajans' rule and closed packed arrangement.

4. Answer **any three** questions : $5 \times 3 = 15$

(a) (i) Prepare a molecular orbital energy level diagram for CO . 3

(ii) What is bond order and how many unpaired electrons does CO have ?

2

(b) Describe the molecular geometry of *any three* hybrid orbitals formed by *s*, *p*, and *d* orbitals of an atom. 5

(c) Describe the band theory of metallic bonding. What is an *n*-type semiconductor ? 4+1=5

(d) (i) Define Radius Ratio. State how radius ratio is helpful in predicting coordination number of ions.

1+2=3

(ii) Write a note on Perovskites. 2

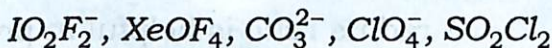
(e) Compare the following pairs of molecules with respect to the parameters cited within the parenthesis : 5

(i) Benzene and pyridine (resonance energy)

- (ii) SiCl_4 and CCl_4 (bond angle)
- (iii) H_2Se and H_2O (boiling point)
- (iv) PI_3 and SbI_3 (bond angle)
- (v) CH_3Cl and CHCl_3 (dipole moment).

5. Answer **any three** questions : $5 \times 3 = 15$

(a) What type of hybridization is expected in bonding on the central atom of each of the following molecules ?



(b) Derive the Born-Landé equation for lattice energy calculation.

(c) Discuss how steric and electronic factors affect the molecular properties.

(d) Discuss the probable electron density of bonding and antibonding orbitals.

- (e) The solubility and stability of ionic solids largely depend on their lattice energies. Explain giving suitable examples.
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