

## **“CHEMICAL BONDING AND MOLECULAR STRUCTURE”**

1. Water is a liquid while H<sub>2</sub>S is a gas.

a) Suggest the reason for the above fact.

(1)

b) Explain the phenomenon.

(2)

*[February 2008]*

2. a) What do you understand by bond pair electrons and lone pair electrons?

(2)

b) Explain the bond pair electrons and lone pair electrons in H<sub>2</sub>O and NH<sub>3</sub> molecules with suitable drawings.

(3)

*[March 2009]*

3. The stability and magnetic properties of a molecule can be explained using the molecular orbital theory

proposed by F. Hund and R.S. Mulliken.

a) Define bond order according to the M.O theory.

(1)

b) Draw the energy level diagram for the formation of O<sub>2</sub> molecule.

(2)

c) Calculate the bond order and predict the magnetic character of O<sub>2</sub> molecule. (2)

*[March 2010]*

4. VSEPR theory is used to predict the shape of covalent molecules.

a) State the main postulates of VSEPR theory.

(3)

b) Based on VSEPR theory predicts the shape of H<sub>2</sub>O and NH<sub>3</sub>.

(2)

*[October 2010]*

5. The attractive force which holds atoms together in a molecule is called a chemical bond.

a) Explain the formation of a H<sub>2</sub> molecule on the basis of the valence bond theory (VBT). (2½)

b) Using the molecular orbital theory (MOT), explain why Ne<sub>2</sub> molecule does not exist? (1½)

c) Calculate the bond order of dinitrogen (N<sub>2</sub>).

(1)

*[March 2011]*

6. a) Hydrogen bonding plays an important role in determining the physical properties of substances.

i) Illustrate hydrogen bonding using an example.

(1½)

ii) Compare the boiling points of o-nitro phenol and p-nitro phenol based on hydrogen bonding.

(1½)

b) Describe the hybridisation and structure of PCl<sub>5</sub> molecule.

(2) *[September 2011]*

7. Valence Bond Theory (VBT) and Molecular Orbital Theory (MOT) are the two important theories of chemical bonding.

a) Out of the following which is the hybridisation of phosphorus in  $\text{PCl}_5$ ? ( $\text{sp}^3$ ,  $\text{sp}^2$ ,  $\text{dsp}^2$ ,  $\text{sp}^3\text{d}$ ) (1)

b) Explain the geometry of  $\text{PCl}_5$  molecule and account for its high reactivity. (2)

c) Write the molecular orbital configuration of the  $\text{C}_2$  molecule and calculate its bond order. (2)

*[March 2012]*

8. a) The ionic bonds have partial covalent character and the covalent bonds also show some ionic character.

i) Explain the covalent character of Lithium chloride using Fajan's rule (1)

ii)  $\text{NF}_3$  and  $\text{NH}_3$  show dipole moment. But the dipole moment of  $\text{NF}_3$  is less than that of  $\text{NH}_3$ . Why? (1)

iii) The covalent bond can be explained by Molecular Orbital Theory (MOT). Using MO diagram explain the paramagnetic nature of oxygen molecule. (3) *[September 2012]*

9. The Valence Shell Electron Pair Repulsion (VSEPR) theory helps in predicting the shapes of covalent molecules.

a) Arrange the bond pair electron and lone pair electron in the decreasing order of the repulsive interactions among them. (1)

b) A molecule of the type  $\text{AB}_3\text{E}_2$  has three bond pairs and two lone pairs of electrons. Predict the most stable arrangement of electron pairs in this molecule. (1)

c) The bond order value is an important property of a molecule. How is bond order related to bond length? (1)

d) Write the electronic configuration of an oxygen molecule and justify its magnetic character. (2)

10. a) Only valence electrons of atoms take part in chemical combination. Draw the Lewis representation of  $\text{NF}_3$ . (1)

b) Define dipole moment. The dipole moment of  $\text{BF}_3$  is zero. Why? (2)

c) Based on bond order compare the relative stability of  $\text{O}_2$  and  $\text{O}_2^{2-}$ . (1)

11. a)  $\text{He}_2$  cannot exist as stable molecule. Justify this statement on the basis of bond order. (1)

b) State Fajan's rule regarding the partial covalent character of an ionic bond.

(1)

c) Which has higher boiling point – o-nitrophenol or p-nitrophenol? Give reason. (3)

*[March 2014]*

12. a) Molecular orbitals are formed by the linear combination of atomic orbitals (LCAO). Give the salient features of molecular orbital theory.

(3)

b) Explain  $sp^3d$  hybridisation with a suitable example.

(2)

13. a) The shape of the molecules is based on the VSEPR theory. Give the salient features of this theory. (3)

b) Draw the potential energy curve for the formation of a hydrogen molecule on the basis of inter nuclear distance of the hydrogen atoms.

(2)

*[August 2014]*

14. Molecular orbital theory was developed by F. Hund and R.S. Mulliken.

a) One-half of the difference between the number of electrons in the bonding and antibonding molecular orbitals is called .....

(1)

b) i) Write the molecular electronic configuration of the  $N_2$  molecule.

(1)

ii) Predict the stability and magnetic property of  $N_2$  with reasons.

(3)

15. In order to explain the geometrical shapes of molecules, the concept of hybridisation was introduced.

a) The geometry of  $SF_6$  molecule is .....

i)

Tetrahedral

ii) Planar

iii) Octahedral

iv) Trigonal bipyramidal (1)

b) i) Define the term hybridisation. (1)

ii) Explain  $sp^3$  hybridisation taking methane ( $CH_4$ ) as an example.

(3)

*[March 2015]*

16. a) The net dipole moment of a polyatomic molecule depends on the spatial arrangement of various

bonds in the molecule. The dipole moment of  $BF_3$  is zero while that of  $NF_3$  is not zero. Justify.

(2)

b) The type of hybridization indicates the geometry of a molecule. In water molecule, the oxygen atom is

$sp^3$  hybridized. But water molecule has no tetrahedral geometry. Explain

(2)

17. The formation of molecular orbitals can be described by the linear combination of atomic orbitals.

a) Which one of the following correctly represents the formation of bonding molecular orbital from the

atomic orbitals having wave functions  $\psi_A$  and  $\psi_B$ ?

i)

$\psi_A \times \psi_B$

ii)  $\psi_A / \psi_B$

iii)  $\psi_A + \psi_B$

iv)  $\psi_A - \psi_B$

(1)

b) Write the electronic configuration of oxygen molecule on the basis of Molecular Orbital Theory.

Justify the presence of double bond in it and account for its paramagnetic character.

(2)

*[October 2015]*

18. a) The electronic configuration of a molecule can give information about bond order.

i)

Write the molecular orbital configuration of  $F_2$  molecule.

ii)

Find its bond order.

(2)

b) Give any two factors influencing the formation of an ionic bond.

(2)

c) Give the shape of the following species. i)  $NH_4^+$

ii)  $HgCl_2$

19. VSEPR theory is used to predict the shape and bond angle of molecules.

a) Write the postulates of VSEPR theory.

(2)

b) Explain the shape and bond angle of  $NH_3$  molecule using VSEPR theory.

(2)

c)  $PCl_5$  molecule is unsymmetric. Why?

(2) [

20. The geometry of the molecule is decided by the type of hybridisation.

a) Discuss the shape of  $PCl_5$  molecule using hybridisation.

(2)

b) Give the reason for the high reactivity of  $PCl_5$ .

(2)

c) Isoelectronic species have the same bond order. Among the following choose the pair having same

bond order.

$CN^-$ ,  $O_2^-$ ,  $NO^+$ ,  $CN^+$

(1)

*[March 2017]*

21. a) The hybridization of C in ethene is .....

i)

sp

ii)  $sp^2$  iii)  $sp^3$  iv)  $sp^3d$

(1)

b) Explain  $sp^3d^2$  hybridization with an example.

(3)

c) Calculate the bond order of Lithium molecule. (At. no. of Li is 3)

(1)

*[July 2017]*

22. Predict the shape of  $XeF_4$  molecule, according to VSEPR theory.

(1)

23. By using the concept of hybridization, explain the structure of  $H_2O$  molecule.

(2)

24. Write the molecular orbital electronic configurations of  $N_2$  and  $O_2$  and calculate their bond orders. Give a

comparison of their stability and magnetic behaviour.

(4)

*[March 2018]*

25. If Z-axis is the internuclear axis, name the type of covalent bond formed by the overlapping of two  $p_y$  orbitals.

(1)

26. Write any two limitations of octet rule.

(2)

27. The diatomic species  $Ne_2$ , does not exist, but  $Ne_2^-$  can exist. Explain on the basis of molecular orbital theory.

(4)

*[August 2018]*

28. Represent the Lewis structure of Ozone ( $O_3$ ) molecule and assign the formal charge on each atom. (2)

29. Among  $NaCl$ ,  $BeCl_2$  and  $AlCl_3$ , which one is more covalent? Justify the answer.

(2)

30. Write the molecular orbital electronic configuration of  $N_2$  and  $O_2$  molecules. Compare the stability and magnetic behaviour of these molecules on the basis of M. O. theory.

(3)

*[March 2019]*

31. The dipole moment of  $BeF_2$  is zero, while that of  $H_2O$  is 1.85 D. Account for this on basis of their molecular structure.

(2)

32. (a) A molecule of the type  $AB_4E$  has 4 bond pairs of electrons and 1 lone pair of electron. Predict the most stable structure of this compound.

(1)

(b) Hydrogen fluoride is a liquid, while hydrogen chloride is a gas. Why ?

(1)

33. Draw the molecular orbital diagram for  $F_2$  molecule. Account for its magnetic character. (3)

*[July 2019]*

34. (a) Give two examples of compounds having expanded octet.

(1)

(b) Draw the Lewis dot symbols of (i)  $Cl_2$

(ii)  $NF_3$

(2)

35. (a) Predict the hybridisation of phosphorous atom in  $PCl_5$  molecule.

(1)

(b) Account for the high reactivity of  $PCl_5$  molecule.

(1)

(c) Draw the MO energy level diagram of  $O_2$  molecule.

(2)

*[March 2020]*

36. (a) Define Bond angle.

(1)

(b)  $NH_3$  and  $NF_3$  molecules have a pyramidal shape with a lone pair of electrons on nitrogen atom. But

the dipole moment of  $NH_3$  is  $4.9 \times 10^{-30}$  Cm and that of  $NF_3$  is  $0.8 \times 10^{-30}$  Cm. Give reason.

(2)

37. (a) The bond angle in water is lower than the tetrahedral angle. Why?

(1)

(b) Give 1 example of a molecule in which the central atom is in  $sp$  hybridisation. Predict its geometry. (1)

(c) Write the MO configuration of  $N_2$  molecule and calculate its bond order.

(2)

*[December 2020]*

38. Fill in the blanks :

Molecule

Structure

Bond Angle

$BF_3$

.....

$120^\circ$

$BeCl_2$

Linear

.....

(2)

39. (i) What is bond order according to M.O. theory ?

(1)

(ii) He<sub>2</sub> molecule does not exist, why ?

(2)

40. (i) Write any two postulates of VSEPR theory.

(2)

(ii) Hydrogen bonds are of two types, which are they ? Write one example for each. (2)

41. (i) Hybridisation of Carbon in CH<sub>4</sub> is

(A) sp<sup>2</sup>

(B) sp

(C) sp<sup>3</sup>

(D) sp<sup>3</sup>d

(1)

(ii) Write any two characteristics of hybridisation.

(1)

(iii) O<sub>2</sub> molecule is paramagnetic, explain using M.O. theory.

(2)

*[March 2021]*

42. Draw the potential energy curve for the formation of a hydrogen molecule on the basis of inter-nuclear

distance between the hydrogen atoms.

(2)

43. (i) What is meant by dipole moment ?

(1)

(ii) Dipole moment of BF<sub>3</sub> is zero, but that of NH<sub>3</sub> is not zero. Why ?

(2)

44. (i) A molecule of the type AB<sub>2</sub>E<sub>2</sub> has 2 bond pairs of electrons and 2 lone pairs of electrons. The most

stable structure of this molecule is \_\_\_\_\_ .

(A) Tetrahedral

(B) Bent

(C) Square planar

(D) Square pyramid (1)

(ii) Write the important postulates of VSEPR theory.

(3)

45. (i) Write the molecular orbital configuration of O<sub>2</sub> molecule. Account for its paramagnetic character. (2)

(ii) Calculate the bond order of O<sub>2</sub> molecule.

(2)

*[December 2021]*

46. With the help of Fajans rules, explain why the ionic compound LiCl exhibit covalent character. (2)

47. Complete the following table :

(2)

48. Write the molecular orbital configuration of  $N_2$ . Calculate its bond order and predict its magnetic behaviour.

(4) *[March 2022]*

49. Based on molecular orbital theory, calculate the bond order of  $O_2$  and  $O_2^{2-}$ .

(2)

50. Write any two postulates of VSEPR theory.

(2)

51. (a) Explain hydrogen bonding using suitable example.

(2)

(b) Explain hybridisation and structure of  $BF_3$  molecule.

(2)

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52. (i) What is dipole moment ?

(1)

(ii) Dipole moment of  $NH_3$  is higher than that of  $NF_3$ . Why ?

(2)

53. (i) What is octet rule ?

(1)

(ii) Write any two drawbacks of octet rule.

(2)

54. (i) Write any two salient features of molecular orbital theory.

(2)

(ii) Match the molecules given in Column A with their hybridization given in Column B (2)

*[March 2023]*

55. (i) Write the molecular orbital configuration of fluorine molecule.

(1)

(ii) Find the bond order of fluorine molecule.

(2)

56. (i) Write any two postulates of Valence Shell Electron Pair Repulsion (VSEPR) theory.

(2)

(ii) What is the hybridisation of sulphur in  $SF_6$ .

(1)

57. (i) Define dipole moment.

(1)

(ii) Dipole moment of  $BF_3$  is zero. Why?

(1)

(iii) Explain the shape and bond angle of  $NH_3$  molecule using VSEPR theory.

(2)

*[October 2023]*

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