



# CHEMISTRY

## BOOKS - V PUBLICATION

### CHEMICAL BONDING AND MOLECULAR STRUCTURE

#### Question Bank

1. Explain the formation of a chemical bond



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2. Write Lewis symbols for atoms of the following elements : 'Mg, Na, B, O, N, Br'.



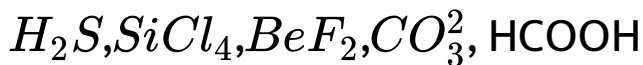
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3. Write Lewis symbols for the following atoms and ions: 'S' and 'S<sup>(-2)</sup>'



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4. Draw the Lewis structures for the following molecules and ions:



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5. Define octet rule



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6. Write the favourable conditions for the formation of ionic bond



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7. Discuss the shapes of the following molecules using VSEPR theory:



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8. Although geometries of  $NH_3$  and  $H_2O$  molecules are distorted tetrahedral, bond angle in water is less than that of ammonia. Discuss.



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9. How is bond strength related to bond order?



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10. Define the bond length.



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11. Explain the structure of  $CO_3^{-2}$  ion in terms of resonance.



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12. Write the resonance structures of  $SO_3$ ,  $NO_2$  and  $NO_3^-$





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**13.** Use Lewis symbols to show electron transfer between the following atoms to form cations and anions: (a) 'K' and 'S'



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**14.** Although both  $CO_2$  and  $H_2O$  are triatomic molecules, the shape of  $H_2O$  molecular is bent while that of  $CO_2$  is linear. Explain these on the basis of dipole moment.



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**15.** Write the application's of dipole moment.



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**16.** Electronegativity differs from electron gain enthalpy.

a) Do you agree ?

b) What do you mean by electronegativity?



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**17.** Explain with the help of a suitable example polar covalent bond.



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**18.** Arrange the bonds in order of increasing ionic character in the molecules :  $\text{LiF}$ , ' $\text{K}_2\text{O}$ ', ' $\text{N}_2$ ,  $\text{S O}_2$ ' and ' $\text{C I F}_3$ '



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19. The skeletal structure of 'CH<sub>3</sub> COOH' as shown below is correct, but some of the bonds are shown incorrectly. Write the correct Lewis structure for acetic acid.

'(##VPU\_HSS\_CHE\_XI\_C04\_E01\_020\_Q01##)'



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20. Apart from tetrahedral geometry, another possible geometry for 'CH<sub>4</sub>' is square planar with the four H atoms at the corners of the

square and the C atom at the centre. Explain why 'CH<sub>4</sub>' is not square planar.



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21. Explain why  $BeH_2$  molecule has zero dipole moment even though the  $Be - H$  bonds are polar.



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22. Which out of  $NH_3$  and  $NF_3$  has higher dipole moment and why?



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23. What is meant by hybridisation of atomic orbitals ? Describe the shapes of 'sp,  $sp^2$ ,  $sp^3$ ' hybrid orbitals.



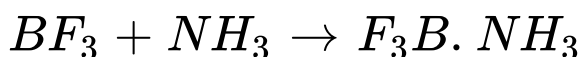
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24. Describe the change in hybridisation (if any) of the Al atom in the following reaction.



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25. Is there any changes in the hybridisation of B and N atoms as a result of the following reaction



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**26.** Draw diagrams showing the formation of a double bond and a triple bond between carbon atoms in

(a) ' $C_2H_4$ '

(b). ' $C_2H_2$ ' molecules.



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**27.** What is the total number of sigma and pi bonds in the following molecules?

(a) 'C<sub>2</sub>H<sub>2</sub>'

(b) 'C<sub>2</sub>H<sub>4</sub>' ?



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**28.** Considering x- axis as the internuclear axis, which out of the following will not form a sigma bond and why?



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29. Which hybrid orbitals are used by carbon atoms in the following molecules?



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30. What do you understand by bond pairs and lone pairs of electrons? Illustrate with example.



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**31.** Give any two differences between sigma and pi bonds



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**32.** The attractive force which holds atoms together in a molecule is called a chemical bond. Explain the formation of a  $H_2$  molecule on the basis of the valence bond theory (VBT)



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**33.** Write the favourable conditions for the formation of ionic bond



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**34.** Use molecular orbital theory to explain why the ' $\text{Be}_2$ ', molecule does not exist.



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**35.** Compare the relative stability of the following species and indicate their magnetic

properties:

' $O_2$ ,  $O_2^+$ ,  $O_2^-$ ' (superoxide) and ' $O_2^{(2-)}$ ' (peroxide)?.



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**36.** Write the significance of a plus and a minus sign shown in representing the orbitals.



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**37.** What is the hybridisation of p in  $PCl_5$ .

Why are axial  $P - Cl$  bonds longer than the equatorial bonds?



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**38.** Define hydrogen bond. Is it weaker or stronger than the van der Waals' forces?



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**39.** What is meant by the term bond order?

Calculate the bond order of:  $N_2$ ,  $O_2$ ,  $O_2^+$  and

$O_2^-$  .



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**40.** What is meant by formal charge?



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**41.** HCl is a polar compound, Why HCl shows polar nature?



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**42.** Why covalent bonds are called directional bonds whereas ionic bonds are called non-directional?



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**43.**  $\text{AlF}_3$  is a high melting solid whereas  $\text{SiF}_4$  is a gas. Explain why??



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**44.** Which out of  $\text{CH}_3\text{F}$  and  $\text{CH}_3\text{Cl}$  has a higher dipole moment and why?



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**45.** Out of 'p-' orbital and sp-hybrid orbital which has greater directional character and why?



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**46.** Which has higher lattice energy: NaCl or MgO? Why?



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47. What is percentage of s-character in (i) 'sp<sup>3</sup>' (ii) 'sp<sup>2</sup>' (iii) sp-hybridized orbitals?



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48. Write resonating structures of 'O<sub>3</sub>'



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49. Out of 'H-H' and 'Cl-Cl' bonds, which is expected to have higher bond enthalpy and

why?



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**50.** Account for the following:

i) ' $\text{NF}_3$ ' is pyramidal while ' $\text{BF}_3$ ' is trigonal planar.

ii) Bond angle in ' $\text{H}_2\text{O}$ ' is larger than bond angle in ' $\text{H}_2\text{S}$ '.



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51. Compare the relative stability of the following species and comment on their magnetic (diamagnetic or paramagnetic) behaviour: ' $O_2^-$ ' and ' $N_2^+$ '.



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52. What is meant by bond order? Calculate the bond order of ' $He^{(2+)}$ '.



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53. Draw the molecular structures of (i)  $XeF_2$   
(ii)  $XeOF_2$  and (iii)  $XeF_4$



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54. What is meant by hydrogen bond? What is bond energy of hydrogen bond? Why is HF, 'H<sub>2</sub>O' are liquids whereas 'HCl, HBr, HI' and 'H<sub>2</sub>S' are gases?



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**55.** In Lewis notations, the valence electrons are represented by dots.

a: Give the Lewis structure of  $CaF_2$

b. Carbon Suboxide,  $C_3O_2$  has recently been shown as a compound of the atmosphere of venus. Suggest Lewis structure for  $C_3O_2$  [Hint: Oxygen atoms are at the terminals]



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**56.** Complete the following table.

'(##VPU\_HSS\_CHE\_XI\_C04\_E02\_017\_Q01##)'



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57. How is molecular orbital different from atomic orbital? Give electronic configuration of (i) ' $H_2^+$ ' (ii) ' $Li_2$ ' (iii) ' $B_2$ ' (iv) ' $C_2$ '. Calculate their bond orders and predict their paramagnetic behaviour.



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58. The dipole moment of  $BF_3$  is zero eventhough the B-F bonds are polar, Justify.



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**59.** What are the important conditions for hybridisation?



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**60.** Oxygen and sulphur belong to the same group. But the hydride of oxygen '(H<sub>2</sub>O)' is a liquid while the hydride of sulphur '(H<sub>2</sub>S)' is a gas at room temperature. Why?



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61. Arrange the following in decreasing order of their bond angle ' $\theta$ ':  $\text{H}_2\text{O}$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{S}$



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62. Why is  $\text{NaCl}$  a bad conductor of electricity in the solid state?



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**63.** Arrange the following sets of molecules in the decreasing order of bond angle :

i) ' $\text{SF}_6$ ,  $\text{CCl}_4$ ,  $\text{H}_2\text{O}$ ,  $\text{NH}_3$ '

ii) ' $\text{CH}_4$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{BF}_3$ '

iii) ' $\text{AlCl}_3$ ,  $\text{H}_2\text{S}$ ,  $\text{BeH}_2$ ,  $\text{H}_2\text{O}$ '



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**64.** Draw resonating structure of ' $\text{CO}_2$ ' molecule?



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**65.** Why does formic acid exist as dimer? What is its one consequence?



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**66.** Select the molecule or ion having larger property mentioned in each of the following pairs:

a)  $\text{NF}_3$ ,  $\text{NH}_3$  ;dipole moment

b)  $\text{NH}_3$ ,  $\text{PH}_3$  ;bond angle

c)  $\text{CO}_2$ ,  $\text{BF}_3$  ;bond angle.



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67. The 'H-S-H' bond angle in ' $H_2S$ ' is ' $92^\circ$ .  
2. whereas the 'H-O-H' bond angle in ' $H_2O$ ' is ' $104.5^\circ$ , why?



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68. Will  $CCl_4$  give a precipitate of  $AgCl$  on heating with  $AgNO_3$ ? Why?



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**69.** All carbon-carbon bond lengths in benzene are equal, why?



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**70.** Molecular nitrogen is not reactive. Why



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**71.** Compare the properties of ionic and covalent compounds.



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72. Write the difference, between B.M.O and A.B.M.O.



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73. What is the difference. between electron affinity and electronegativity?



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**74.** The order of repulsion of electron pairs as written by students is given below:

lone pair-lone pair repulsion > lone pair -bond pair repulsion > bond pair -bond pair repulsion.

Name the theory behind this



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**75.** "Molecular orbital is polycentric while atomic orbital is monocentric." Explain.



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**76.** How many antibonding electrons are present in 'O<sub>2</sub>' molecule and how many are unpaired?



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**77.** Write the similarities between 'V . B', theory and 'M.O'. Theory



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**78.** You are given with the following molecules.



Classify the molecules into ionic and covalent'



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**79.** When two  $H$  -atoms are coming closer, electron of one atom is attracted by the nucleus of the other and vice versa. Nucleus - nucleus and  $\bar{e} - \bar{e}$  repulsion are also there.

a. Construct a potential energy level diagram



for the molecule.

b. Indicate the 'bond length of  $H - H$  bond in the diagram.

c. How do you-determine radius of one  $H$  - atom?



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**80.** draw the pictoric representation I showing the formation of a p-p sigma bond and. a p-p pi bond.



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**81.** The simplest alkyne, acetylene has linear structure.

a. Find out the hybridisation of 'C' in acetylene.

b. How many 'sigma' - bonds and 'pi' bonds are there in acetylene?

c. Draw the structure of acetylene molecule which shows overlapping of orbitals.



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**82.** Dipole moment is used to predict the shape of molecules.

a) Justify the statement based on the shapes of  $CO_2$  and  $H_2O$ .



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**83.**  $He_2$  cannot exist as stable molecule. Justify this statement on the basis of bond order



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**84.** i. Consider the hydrocarbons ethane, ethene and ethyne. The carbon atoms in these molecules are in different hybridised states, What are these hybridisations?

ii. Give the complete structural formulae of these molecules and sketch diagrams to illustrate the formation of a bonds in ethane and 'pi' bond in ethene.



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**85.** Draw the electron dot diagram of the formation of chlorine molecule by combining two chlorine atoms?



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**86.**  $H_2S$  is a gas at ordinary condition, while  $H_2O$  is liquid. Account for the above statement.



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**87.** What do you understand by bond pair electrons and lone pair electron



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**88.** The stability and magnetic properties of a molecule can be well explained using the molecular orbital theory developed by F. Hund and R.S. Mulliken

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



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**89.** Maximum number of bonds between two atoms of a covalent bond can be :

A. four

B. two

C. three

D. one

**Answer: C**



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90. Which of the following combinations is most likely to form covalent bonds?

A. Sodium and hydrogen.

B. Magnesium and oxygen

C. chlorine and oxygen

D. calcium and bromine

**Answer: C**



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91. In which of the following, the bond angle between two covalent bond is maximum?

A.  $\text{H}_2\text{O}$

B.  $\text{NH}_3$

C.  $\text{CO}_2$

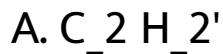
D.  $\text{CH}_4$

**Answer: C**



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92. Multiple covalent bonding does not exist in



**Answer: D**



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**93.** Electronegativity values of elements help in predicting :- strength of the element, polarity of the molecules, size of the molecules, valency of the elements

A. strength of the element

B. polarity of the molecules

C. size of the molecules

D. valency of the elements

**Answer: C**



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94. Which of the following is max. covalent character?

A. LiI

B. LiF

C. LiCl

D. LiBr

**Answer: A**



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95. Born Haber cycle can be used for the calculation of:- lattice energy of ionic crystals, electron affinity of elements, heats of formation of ionic crystals, all the above.

A. lattice energy of ionic crystals

B. electron affinity of elements

C. heats of formation of ionic crystals.

D. all the above. '

**Answer: D**

96. Which of the following has high boiling point?



**Answer: A**

97. Among the following, the pair in which the two species are not isostructural is  $SiF_4$  and  $SF_4$ ,  $IO_3^-$  and  $XeO_3$ ,  $BH_4^-$  and  $NH_4^+$ ,  $PF_6^-$  and  $SE_6$

- A.  $SiF_4$  and  $SF_4$
- B.  $IO_3^-$  and  $XeO_3$
- C.  $BH_4^-$  and  $NH_4^+$
- D.  $PF_6^-$  and  $SE_6$

**Answer: A**



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**98.** In an octahedral structure, the pair of d-orbitals involved in ' $d^2 sp^3$ ' hybridisation is

- A.  $d_{(x^2-y^2)}$ ,  $d_{(xz)}$ '
- B.  $d_{(z^2)}$ ,  $d_{(zx)}$ '
- C.  $d_{(xy)}$ ,  $d_{(yz)}$ '
- D.  $d_{(x^2-y^2)}$ ,  $d_{(z^2)}$ '



**Answer: D**



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**99.** In a regular octahedral molecule, 'MX<sub>6</sub>', the number of 'X' - 'M-X' bonds at '180°' is

A. Three

B. Two

C. Six

D. Four

**Answer: A**



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**100.** The molecule with high % of ionic character is

A. HI

B. HBr

C. HCl

D. HF

**Answer: D**



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**101.** The molecule that will have no dipole moment is :

A. 2,2 -dimethyl propene

B. Trans '-2' - pentane

C. cis-3-hexene

D. 2,2,3,3-' tetramethy '-1' - butane.

**Answer: A**



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**102.** Hydrogen bonding is not present in

- A. Glycerine
- B. Water
- C. Hydrogen sulphide
- D. Hydrogen fluoride

**Answer: C**



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103. largest dipole moment in

A.  $\text{NH}_3$

B.  $\text{H}_2\text{O}$

C.  $\text{HI}$

D.  $\text{SO}_3$

**Answer: B**



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104. bond angle is maximum in?



**Answer: B**



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**105.** Which of the following arrangement of molecule is correct on the basis of their dipole moment? 1.  $\text{BF}_3 > \text{NF}_3 > \text{NH}_3$  2.  $\text{NF}_3 > \text{BF}_3 > \text{NH}_3$   
3.  $\text{NH}_3 > \text{BF}_3 > \text{NF}_3$  4.  $\text{NH}_3 > \text{NF}_3 > \text{BF}_3$

A.  $\text{BF}_3 > \text{NF}_3 > \text{NH}_3$

B.  $\text{NF}_3 > \text{BF}_3 > \text{NH}_3$

C.  $\text{NH}_3 > \text{BF}_3 > \text{NF}_3$

D.  $\text{NH}_3 > \text{NF}_3 > \text{BF}_3$

**Answer: D**



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**106.** The geometry of 'H<sub>2</sub>S' and dipole moment are:

- A. angular and non zero
- B. angular and zero
- C. linear and non-zero
- D. linear and zero

**Answer: A**



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**107.** The hybridisation of atomic orbitals of nitrogen in  $\text{NO}_2^+$ ,  $\text{NO}_3^-$  and  $\text{NH}_4^+$  are 1. sp, sp and sp respectively 2. sp,  $\text{sp}^2$  and  $\text{sp}^3$  respectively 3.  $\text{sp}^2$ , sp and  $\text{sp}^3$  respectively 4.  $\text{sp}^2$ ,  $\text{sp}^3$  and sp respectively.

A. sp, sp and sp respectively

B. sp,  $\text{sp}^2$  and  $\text{sp}^3$  respectively

C.  $\text{sp}^2$ , sp and  $\text{sp}^3$  respectively

D.  $\text{sp}^2$ ,  $\text{sp}^3$  and sp respectively

**Answer: B**



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**108.** Draw the molecular structures of (i)  $XeF_2$   
(ii)  $XeOF_2$  and (iii)  $XeF_4$

A. the same with 2,0 and 1 lone pairs of  
electrons respectively

B. the same with 1,1 and 1 lone pairs of  
electrons respectively

C. different with 0,1 and 2 lone pairs of electrons respectively

D. different with 1,0 and 2 lone pairs of electrons respectively.

**Answer: B**



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**109.** The correct order of hybridisation of the central atom in the following species: 'NH<sub>3</sub>, [PtCl<sub>4</sub>]<sup>(2-)</sup> and 'BCl<sub>3</sub>' is

A.  $dsp^2$ ,  $dsp^3$ ,  $sp^2$  and ' $sp$ '

B.  $sp^3$ ,  $dsp^2$ ,  $dsp^3$ ,  $sp^2$ '

C.  $dsp^3$ ,  $sp^2$ ,  $sp^3$ ,  $dsp^3$ '

D.  $dsp^2$ ,  $sp^3$ ,  $sp^2$ ,  $dsp^3$ '

**Answer: D**



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**110.** Among ' $KO_2$ ,  $AlO_2^-$ ,  $BaO_2$ ' and ' $NO_2^+$ ',  
unpaired electron is present in :

A.  $\text{NO}_2^+$  and  $\text{BaO}_2$

B.  $\text{KO}_2$  and  $\text{AlO}_2^-$

C.  $\text{KO}_2$  only

D.  $\text{BaO}_2$  only

**Answer: A**



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**111.**  $\text{PCl}_5$  molecule has the following geometry

A. Trigonal bipyramidal

B. Octahedral

C. square planar

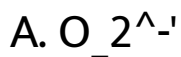
D. planar triangular

**Answer: A**



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**112.** Which of the following is paramagnetic and has a bond order of  $1/2$ ?



**Answer: A**



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**113.**  $CO_2$  is isostructural with :-  $SnCl_2$ ,  $ZnCl_2$ ,  
 $HgCl_2$ ,  $C_2H_4$

A.  $\text{SnCl}_2$

B.  $\text{ZnCl}_2$

C.  $\text{HgCl}_2$

D.  $\text{C}_2\text{H}_4$

**Answer: C**



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**114.** The geometry of ' $\text{H}_2\text{S}$ ' and dipole moment are:



A. angular and non-zero

B. angular and zero

C. linear and non zero

D.

**Answer: A**



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**115.** The linear structure is not assumed by

A.  $\text{SnCl}_2$

B.  $\text{CS}_2$

C.  $\text{NO}_2^+$

D.

**Answer: A**



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**116.** Which of the following molecules is not an exception to octet rule?

A.  $\text{BF}_3$

B. PF\_5'

C. CO\_2'

D. IF\_7'

**Answer: C**



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