CHEMISTRY

BOOKS - MODERN PUBLISHERS CHEMISTRY (HINGLISH)

CHEMICAL BONDING AND MOLECULAR STRUCTURE

SOLVED EXAMPLES

1. Write Lewis dot symbols for the following atoms and ions :

(i) O (ii) O^{2-} (iii) Mg^{2+} (iv) P^{3-} (v) Br

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2. Write Lewis dot symbols for the following atoms and ions :

(i) S and S^{2-} (ii) P and P^{3-} (iii) Al and Al^{3+} (iv) H and H^{-} (v) Na and Na^{+}

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3. Give the Lewis structures and empirical formulae for the ionic compounds formed between the following pairs of elements :

(i) Ba, Cl (ii) Na, S (iii) Al, F (iv) Mg, N (v) Na, P

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4. Use Lewis symbols to show electron transfer between the following atoms to form cations and anions :

(i) K and S (ii) Ca and O (iii) Al and N

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5. Draw Lewis structures for the following molecules and identify the atoms in each of the following which do not obey octet rule :

H_2S SF_2 BF_3 SO_2 PCl_3

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6. Calculate the formal charge on each atoms in nitrite ion .

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7. Calculate the formal charge on

(i) Cl in $HClO_4$

(ii) S in HSO_4^-

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8. Sketch the bond moments and resultant dipole moments in

(i) SO_2 (ii) cis - and trans of $C_2H_2Cl_2$

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9. Calculate the percentage ionic and covalent character of HF molecule having bond distance $= 0.92\text{Å}$ and dipole moment $= 1.78D$

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10. The dipole moment of HBr molecule is 0.78 D and the bond distance is 1.41Å. Calculate the fractional charges δ on H and Br atoms in HBr (electronic charge, $e = 4.8 \times 10^{-1}$ esu).

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11. The dipole moment of lithium hydride is $1.962 \times 10^{-29} cm$ and interatomic distance between Li and H in the molecule is 0.1592 nm. Calculate the percentage ionic character of the molecule.

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12. What is the total number of sigma and pi bond in the following molecules :

(i) CH_2Cl_2

(ii) $H_3C-\overset{H}{\underset{|}{C}}=\overset{H}{\underset{|}{C}}-C\equiv C-H$

(iii) C_2H_3Cl

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

(a)CH_3-CH_3,(b)$CH_3-CH=CH_2$,(c)CH_3-CH_2OH,

(d)CH_3-CHO,(e)CH_3-CHO (f)CH_3COOH

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14. Is there any change in hybridisation of the B and N atom as a result of the following reaction?

$BF_3 + NH_3 \rightarrow F_3B.NH_3$

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15. Label the molecular orbitals formed by the following combinations of atomic orbitals (Assume z - axis as internuclear axis):

(i) $2s + 2s$

(ii) $2p_x - 2p_x$

(iii) $2p_z + 2p_z$

(iv) $1s - 1s$

(v) $2p_y + 2p_y$.

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16. Arrange the following species in the decreasing order of their bond dissociation enthalpies :

O_2, O_2^+ and O_2^-

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17. With the help of molecular orbital theory predict which of the following species are diamagnetic ?

H_2^+, $O_2O_2^{2+}$

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18. Explain why N_2 has a greater bond dissociation energy than N_2^+ while O_2 has lesser bond dissociation energy than O_2^+.

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19. Which of the two peroxide ion or superoxide ion has larger bond length ?

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Practice Problems

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

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2. Write the Lewis dot symbols of the following ions :

Li^+, Cl^-, O^{2-}, Mg^{2-} and N^{3-}

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3. Draw Lewis dot symbols for the following elements :

(i) Magnesium (ii) Phosphorus
(iii) Chlorine (iv) Boron
(v) Xenon (vi) Silicon

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4. Draw Lewis dot symbols for the elements of third period of the periodic table.

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5. Draw the Lewis structures for the following ionic compounds :

(i) Li_2O (ii) $CaCl_2$ (iii) LiF

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6. Draw the Lewis structures for K_2O and $MgCl_2$.

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7. Draw Lewis dot structures for the following molecules :

$(a) CCl_4$ $(b) F_2O$ $(c) PF_3$ $(d) F_2$
$(e) ClF_3$ $(f) NCl_3$ $(g) HONO$

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8. The skeleton structure for acetaldehyde (CH_3CHO) is :

$$H \quad \overset{H}{\underset{H}{C}} \quad \underset{H}{C} \quad O.$$

Draw its Lewis structure.

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

$AlI_3, \quad SiCl_4, \quad CO_3^{2-}, \quad HCOOH$

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10. Write the Lewis structures for

(i) CO

(ii) NH_2CONH_2 (urea)

(iii) H_2CCH_2 (ethene)

(iv) HNO_3

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11. Which molecule is polar in each of the following pairs ?

(i) HF, F_2 (ii) CO_2, H_2O

(iii) n_2, NH_3 (iv) $CH_4, CH_3Cl.$

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12. Which of the following hydrogen halides has the most polar bond ?

(i) HF $(ii) HCl$

(iii) HBr $(iv) HI.$

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13. Which of the following moleules have electric dipoles ?

$(i) CCl_4$ $(ii) CHCl_3$ $(iii) CH_2Cl_2$
$(iv) CH_3Cl$ $(v) CH_4$

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14. Predict the dipole moment of :

(i) a molecule of the type AX_2 having a linear geometry.

(ii) a molecule of the type AX_4 having tetrahedral geometry.

(iii) a molecule of the type AX_2 having angular geometry.

(iv) a molecule of the type AX_4 having square planar geometry.

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

(i) SF_6, CCl_4, H_2O, NH_3

(ii) CH_4, NH_3, H_2O, BF_3

(iii) $AlCl_3, H_2S, BeH_2, H_2O$

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16. Out of the following data assign the correct bond angle associated with each of the given compounds.

Compounds	Bond angles
H_2O, CO_2, CCl_4, BF_3	$180^\circ, 109^\circ 28', 104.5^\circ,$
$BeF_2, AlCl_3, PF_5, SF_6$	$107^\circ, 120^\circ, 90^\circ$
NH_3, CH_4	

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17. Give one example each of molecules which have the following geometries :

(a) Linear

(b) Trigonal bipyramidal

(c)Tetrahedral.

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18. If z - axis is the internuclear axis, which of the following combinations are not allowed ?

(i) 2s and 2s (ii) 1s and $2p_x$ (iii) $2pP_y$ and $2p_y$

(iv) $2p_x$ and $2p_z$ (v) $2p_z$ and $2p_z$ (vi) $2s$ and $2p_z$

(vii) $2p_x$ and $2p_y$.

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19. Which out of O_2^+ and O_2^- is more stable?

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20. Arrange the following in the increasing order of bond length : O_2, O_2^-, O_2^+

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21. Calculate the bond order in

(i) H_2^+ (ii) H_2^- and H_2^{2-} have the same bond order?

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22. Which two of H_2^+, H_2^- and H_2^{2-} have the same bond order ?

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23. Compare bond order in N_2 and N_2^+.

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24. Calculate bond order in N_2 and N_2^+.

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25. Calculate the bond order of He_2^+ molecular ion.

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26. Write which out of O_2^+ and O_2^- is more stable.

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27. Indicate which one from O_2^- and O_2^{2-} may exhibit paramagnetism?

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28. Arrange the following in the decreasing order of their boiling points

HF, HCl, HBr

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29. Do o - nitrophenol and p - nitrophenol have hydrogen bonding in their molecules? Explain which of the two has higher boiling point?

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Conceptual Questions (1)

1. Out of MgO and $NaCl$, which has higher lattice energy and why?

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2. Why is $NaCl$ a bad conductor of electricity in the solid state?

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3. Use Lewis dot symbols to show electron transfer between the following atoms to form cations and anions :

(a) Na and Cl

(b) K and S

(c) Ca and O

(d) Al and N

(e) Li and H

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4. Write Lewis dot symbols for the following elements :

Mg, Na, B, O, N, Br

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5. Write Lewis symbol for the following atoms and ions :

S and S^{2-}, Al and Al^{3+}, H and H^{-}

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6. Write Leiws dot symbols for O and O^{2-}

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7. Which of the two is more hard : MgO or CaO? The internuclear distances of MgO and CaO are 2.05 and 2.40Å respectively.

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8. Why does $NaCl$ give a white precipitate with $AgNO_3$ solution but CCl_4 does not ?

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9. Calculate the formal charge on each atom in

$:\overset{\cdot\cdot}{\underset{\cdot\cdot}{O}}-\overset{\cdot\cdot}{S}=\underset{\cdot\cdot}{O}:$

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10. Identify the compound/compounds in which S does not obey octet rule :

$SO_2, SO_3, SF_4, SF_6, SF_2, H_2S$

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11. How is lattice enthalpy related to stability of an ionic compound?

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12. Give one example of a molecule not obeying octet rule.

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Conceptual Questions (2)

1. Out of σ and $\pi -$ bonds, which one is stronger and why?

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2. Which of the following molecules will have zero dipole moment:

$SiCl_4, H_2O, CO_2, BF_3, NH_3$?

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3. Why NF_3, is pyramidal while BF_3 is triangular planar, though both are tetra atomic molecules?

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4. Which of the following has larger bond angle in each pair ?

$(i) CO_2, BF_3 (ii) NH_3, CH_4 (iii) H_2O, H_2S (iv) SF_4, C_2H_2.$

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5. How many σ and π bonds are present in naphthalene?

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6. Draw resonating structures of (i) nitrous oxide (N_2O) and (ii) hydrazoic acid (HN_3) molecule.

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7. Arrange H_2O, NH_3 and CH_4 in the decreasing order of bond angle.

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8. Benzene ring has alternate single and double bonds, yet all the $C-C$ bonds are of equal lengths. Why?

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9. Arrange the following bonds in order of increasing polarity:

$P-H, H-O, C-Cl$

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10. Arrange the following carbon atoms numbered $C-1, C-2$ and $C-3$ in the decreasing order of s - character :

$$H_3 - \overset{1}{C}H_2 - \overset{O}{\overset{||}{\overset{2}{C}}} - CH_2 - \overset{3}{C} \equiv C - CH_3$$

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

$(a) NF_3, NH_3$: dipole moment

$(b) NH_3, PH_3$: bond angle

$(c) CO_3, BF_3$: bond angle

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12. What type of hybridisation is involved in carbon atoms of benzene ?

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13. Indicate4 whether the following statement is TRUE or FALSE. Justify your answer in not more than three lines.

The dipole moment of CH_3F is greater than that of CH_3Cl.

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14. Which of the following has maximum bond angle ?

H_2O, CO_2, NH_3, CH_4

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15. CO_2 is non - polar while H_2O is polar. What conclusion do you draw about their structures from these?

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16. Select the correct choice (no reasons)

(a) Which of the two is more hard : MgO or CaO?

(b) Which of the two has more ionic character : HCl or HBr?

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17. Arrange the following in order of increasing ionic character :

C-H,F-H,Br-H,Na-I, K-F and Li-Cl

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18. Arrange the bonds in order of increasing ionic character in the molecules: LiF, K_2O, N_2, SO_2 and ClF_3.

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19. Out of CS_2 and OCS which have higher dipole moment and why?

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20. Which type of hybridisation explain the trigonal bipyramidal shape of SF_4?

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21. Nitrous oxide (N_2O) may be represented by the following structures

$$\overset{-}{:}\underset{\cdot\cdot}{N}=N^{+}=\overset{\cdot\cdot}{O}:\leftrightarrow :N\equiv N^{+}-\overset{\cdot\cdot}{\underset{\cdot\cdot}{O}}:^{-}\leftrightarrow \overset{2-}{:}\overset{\cdot\cdot}{\underset{\cdot\cdot}{N}}-N^{+}\equiv O:^{+}$$

(a) (b) (c)

Which of these contributes least?

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Conceptual Questions (3)

1. In going from O_2 to O_2^+, the bond dissociation energy increases and bond length decreases. Do we expect the same behaviour for the change N_2 to N_2^+?

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2. Which of the two $:O_2^-$ or O_2^{2-} has higher bond order and why?

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3. Why is the energy of $\pi 2p_x$ and $\pi 2p_y MOs$ lower than $\sigma 2p_x MO$ in N_2 molecule?

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4. Which out of O_2^+ and O_2^- is more stable on the basis of bond order calculations ?

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5. Use molecular orbital theory to explain why the Be_2 molecules do not exist?

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6. Compare the relative stability of the following species and indicate their magnetic properties:

$O_2, O_2^{\oplus}, O_2^{\ominus}$ (superoxide), O_2^{-2} (peroxoide).

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7. What is the effect of the following processes on the bond order of N_2 and O_2?

(a) $N_2 \rightarrow N_2^+ + e^-$ $(b) O_2 \rightarrow O_2^+ + e^-$

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8. List two main conditions for forming hydrogen bonds.

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

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10. Select the molecule in each of the following having higher property mentioned

$(i) F \ldots . H-, -H \ldots \ldots O$	:	stronger hydrogen bond
$(ii) CH_4, SiH_4$	:	boiling point
$(iii) HF, HCl$	:	boiling point
(iv) Ice, water	:	density

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11. How can one non - polar molecule induced a dipole in a nearby non - polar molecule?

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12. Considering z - axis as the internuclear axis, which of the following will not form sigma bond?

(a) $2s$ and $2s$ (b) $2p_y$ and $2p_y$ (c) $2s$ and $2p_z$ (d) $2p_x$ and $2p_z$ (e) $2p_z$ and $2p_z$.

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13. Which of the following substances exhibit bonding? Draw the hydrogen bonds between two moleculas of the substance where appropriate : (i) CH_3CH_2OH (ii) $CH_3\overset{\overset{O}{||}}{C}-CH_3$ (iii) $CH_3-\overset{\overset{O}{||}}{C}-OH$ (iv) $CH_3-\overset{\overset{O}{|}}{C}-NH_2$

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NCERT FILE (NCERT)(Textbook Exercises)

1. Explain the formation of a chemical bond.

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2. Write Lewis dot 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^{2-}, Al, and Al^{3+}, H and $H^{\ominus}$

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

H_2S, $SiCl_4$, BeF_2, CO_3^{2-}, $HCOOH$

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5. Define octet rule. Write its significance and limitations.

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

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7. Discuss the shape of the following molecules using the $VSEPR$ model:

$BeCl_2, BCl_3, SiCl_4, AsF_5, H_2S, PH_3$

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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 do you express the bond strength in terms of bond order?

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10. Define the bond length.

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11. Explain the important aspects of resonance with reference to the CO_3^{2-} ion.

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12. H_3PO_3 can be represented by structures I and II shown below. Can these two structures be taken as the canonical forms of the resonance hybride representing H_3PO_3? If not, give resonance hybrid representing H_3PO_3? If not, give reasons for the same.

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13. Write the resonance structures for SO_3,NO_2, and $NO_3^{\ominus}$.

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14. Use Lewis symbols to show electron transfer between the following atoms to form cations and anions : (a) K and S (b) Ca and O (c) Al and N.

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15. Although both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecules in bent while that of CO_2 is linear. Explain this on the basis of dipole moment.

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16. APPLICATION OF DIPOLE MOMENT

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17. Define electronegativity. How does it differ from electron gain enthalpy ?

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18. Explain with the help of suitable example polar covalent bond.

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19. Arrange the bonds in order of increasing ionic character in the molecules : LiF, K_2O, N_2, SO_2 and ClF_3.

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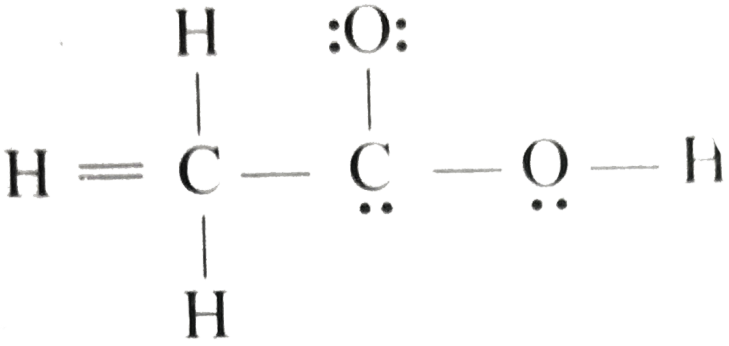
20. The skeletal structure of CH_3COOH as shown below is correct, but some of the bonds are shown incorrectly. Write the correct Lewis structure for acetic acid.



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21. Apart from tetrahedral geometry, another possible geometry for CH_4 is square planar with the four H atoms at the corners of the square and the C atom at its centre. Explain why CH_4 is not square planar?

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22. Explain why BeH_2 molecule has a zero dipole moment although the $Be-H$ bonds are polar?

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

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24. What is meant by hybridisation of atomic orbitals? Describe the shape of sp, sp^2, sp^3 hybrid orbitals.

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25. Describe the change in hybridisation (if any) of the AI atom in the following:

$AlCl_3 + Cl^{\ominus} \rightarrow AlCl_4^{\ominus}$

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26. Is there any change in hybridisation of the B and N atom as a result of the following reaction?

$BF_3 + NH_3 \rightarrow F_3B.NH_3$

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27. Draw diagrams showing the formation of a double bond and a triple bond between carbon atoms in C_2H_4 and C_2H_2 molecules.

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

(a) C_2H_2 $(b)C_2H_4$

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29. Considering x - axis as the internuclear axis which out of the following will not form a sigma bond and why? (a) 1s and 1s (b) 1s and $2p_x$ (c) $2p_y$ and $2p_y$ (d) s and 2s.

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

(a) $CH_3 - CH_3$

(b) $CH_3 - CH = CH_2$

(c) $CH_3 - CH_2 - OH$

(d) $CH_3 - CHO$

(e) CH_3COOH

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31. What do you understand by bond pairs and lone pairs of electrons? Illustrate by giving one example of each type.

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32. Distinguish between a sigma and a pi bond.

Watch Video Solution

33. Explain the formation of H_2 molecule on the basis of valance bond theory.

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34. Use molecular orbital theory to explain why the Be_2 molecules do 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), 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. Describe the hybridisation in case of PCl_2. Why are the axial bonds longer as compared to 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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NCERT (Exemplar Problems) (Multiple Choice Questions (Type-I))

1. Isostructural species are those which have the same shape and hybridisation. Among the given identify the isostructural pairs.

A. $[NF_3 \text{ and } BF_3]$

B. $[BF_4^- \text{ and } NH_4^+]$

C. $[BCl_3 \text{ and } BrCl_3]$

D. $[NH_3 \text{ and } NO_3^-]$

Answer: B

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2. Polarity in a molecule and hence the dipole moment depends primarily on electronegativity of the constituent atoms and shape of a molecule.

Which of the following has the highest dipole moment?

A. CO_2

B. HI

C. H_2O

D. SO_2

Answer: C

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3. Hydrogen bonds are formed in many compounds e.g. H_2O, HF, NH_3. The boiling point of such compounds depends to a extent on the strength of hydrogen bond and the number of hydrogen bonds. The correct decreasing order of the boiling points above compounds is

A. sp, sp^3 and sp^2

B. sp, sp^2 and sp^3

C. sp^2, sp and sp^3

D. sp^2, sp^3 and sp

Answer: C

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4. In PO_4^{3-} ion the formal charge on the oxygen atom of P-O bond is

A. $HF > H_2O > NH_3$

B. $H_2O > HF > NH_3$

C. $NH_3 > HF > H_2O$

D. $NH_3 > H_2O > HF$

Answer: B

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5. In NO_3^- ion the formal charge on the oxygen atom of $N - O$ bond is

A. $+1$

B. -1

C. -0.75

D. $+0.75$

Answer: C

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6. In NO_3^- ion, the number of bond pairs and lone pairs of electrons on nitrogen atom are :

A. $2, 2$

B. $3, 1$

C. $1, 3$

D. $4, 0$

Answer: D

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7. Which of the following species has tetrahedral geometry?

A. BH_4^-

B. NH_2^-

C. CO_3^{2-}

D. H_3O^+

Answer: A

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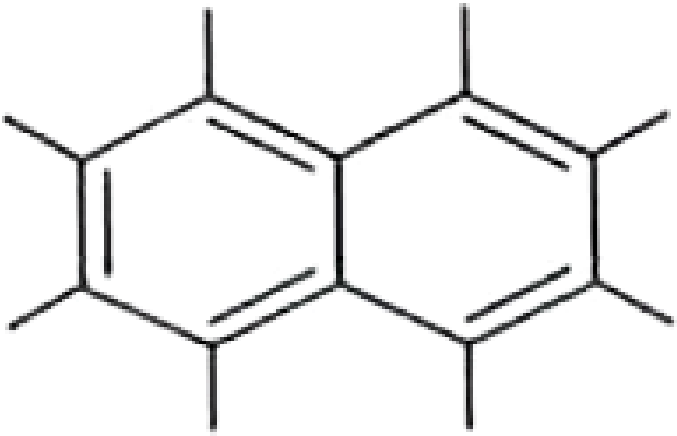
8. Number of π bonds and σ bonds in the following structure is :



A. 6, 19

B. 4, 20

C. 5, 19

D. 5, 20

Answer: C

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9. Which of the following molecules/ions does not contain unpaired electrons?

A. N_2^+

B. O_2

C. O_2^{2-}

D. B_2

Answer: C

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10. In which of the following molecule/ion all the bonds are not equal?

A. XeF_4

B. BF_4^-

C. C_2H_4

D. SiF_4

Answer: C

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11. In which of the following substances will hydrogen bond be strongest?

A. HCl

B. H_2O

C. HI

D. H_2S

Answer: B

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12. If the electronic configuration of an element is $1s^2 2s^2 2p^2 3s^2 3p^6 3d^2 4s^2$, four electrons involved in chemical bond formation will be ..... .

A. $3p^6$

B. $3p^6, 4s^2$

C. $3p^6, 3d^2$

D. $3d^2, 4s^2$

Answer: D

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13. The electronic configuration ofhte elements. A, B and C are given below. Answer the question from 14 to 17 on the basis of these configuration.

$A \quad 1s^2 \quad 2s^2 \quad 2p^6$

$B \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^3$ `

$C \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^5$

The bond between B and C will be

A. 90°

B. 120°

C. 180°

D. 109°

Answer: B

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14. The electronic configuration ofhte elements. A, B and C are given below. Answer the question from 14 to 17 on the basis of these configuration.

$A \quad 1s^2 \quad 2s^2 \quad 2p^6$

$B \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^3$

$C \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^5$

Stable form of A may be represented by the formula.

A. A

B. A_2

C. A_3

D. A_4

Answer: A

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15. The electronic configuration ofhte elements. A, B and C are given below. Answer the question from 14 to 17 on the basis of these configuration.

$A \quad 1s^2 \quad 2s^2 \quad 2p^6$

$B \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^3$

$C \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^5$

Stable form of C may be represented by the formula

A. C

B. C_2

C. C_3

D. C_4

Answer: B

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16. The electronic configuration ofhte elements. A, B and C are given below. Answer the question from 14 to 17 on the basis of these configuration.

$A \quad 1s^2 \quad 2s^2 \quad 2p^6$

$B \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^3$

$C \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^5$

The molecular formula of the compound formed from B and C will be

A. BC

B. B_2C

C. BC_2

D. BC_3

Answer: D

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17. The electronic configuration ofhte elements. A, B and C are given below. Answer the question from 14 to 17 on the basis of these

configuration.

$A \quad 1s^2 \quad 2s^2 \quad 2p^6$

$B \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^3$ `

$C \quad 1s^2 \quad 2s^2 \quad 2p^6 \quad 3s^2 \quad 3p^5$

The bond between B and C will be

A. ionic

B. covalent

C. hydrogen

D. coordinate

Answer: B

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18. Which of the following order of energies of molecular orbitals of N_2 is correct?

A. $(\pi 2p_y) < (\sigma 2p_z) < (\pi^* 2p_x) \approx (\pi^* 2p_y)$

B. $(\pi 2p_y) > (\sigma 2p_z) > (\pi^* 2p_x) \approx (\pi^* 2p_y)$

C. $\left(\pi 2p_y\right) > (\sigma 2p_z) < (\pi^* 2p_x) \approx \left(\pi^* 2p_y\right)$

D. $\left(\pi 2p_y\right) > (\sigma 2p_z) < (\pi^* 2p_x) \approx \left(\pi^* 2p_y\right)$

Answer: A

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19. Comprehension given below is followed by some multiple choice question, Each question has one correct options. Choose the correct option.

Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic orbitals combine to form two molecular orbitals called bonding molecular orbital (BMO) and anti-bonding molecular orbital (ABMO). Energy of anti-bonding orbital is raised above the parent atomic orbitals that have combined and hte energy of the bonding orbital is lowered than the parent atomic orbitals.

energies of various molecular orbitals for elements hydrogen to nitrogen increase in the order

$\sigma 1s < \sigma^\star 1s < \sigma^\star 2s < \left((\pi 2p_x) = \left(\pi 2p_y\right)\right) < \sigma 2p_z < \left(\pi^\star 2p_x = \pi^\star 2p_y\right) <$

and For oxygen and fluorine order of enregy of molecules orbitals is given below.

$\sigma 1s < \sigma^{\star} 1s < \sigma 2s < \sigma^{\star} 2s < \sigma p_z < \left(\pi 2p_x \approx \pi 2p_y\right) < \left(\pi^{\star} 2p_x \approx \pi^{\star} 2py\right)$

Different atomic orbitalsof one atom combine with those atoms orbitals of the second atom which have comparable energies and proper orientation.

Further, if the overlapping is head on, the molecular orbital is called sigma, σ andif the overlap is lateral, the molecular orbital is called pi, π. The molecular orbitals are filled with electrons according to the same rules as followed for filling of atomic orbitals.

However, the order for filling is not the same for all molecules or their ions. Bond order is one of the most important parameters to compare the strength of bonds.

67) Which of the following pair is expected to have the same bonod order?

A. Be_2 is not a stable molecule.

B. He_2 is not stable but He_2^+ is expected to exist.

C. Bond strength of N_2 is maximum amongst the homonuclear diatomic molecules belogning to the second period.

D. The order of energies of molecular orbitals in N_2 molecule is

Answer: D

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20. Which of the following options represents the correct bond order ?

A. $O_2^- > O_2 > O_2^+$

B. $O_2^- < O_2 < O_2^+$

C. $O_2^- > O_2 < O_2^+$

D. $O_2^- < O_2 > O_2^+$

Answer: B

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21. The electronic configuration of the outermost shell of the most electronegative element is

A. $2s^2 2p^5$

B. $3s^2 3p^5$

C. $4s^2 4p^5$

D. $5s^2 5p^5$

Answer: A

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22. Amongst the following elements (whose electronic configuration an given below) the one having highest ionization energy is

A. $[Ne]3s^2 3p^1$

B. $[Ne]3s^2 3p^2$

C. $[Ne]3s^2 3p^2$

D. $[Ar]3d^{10}4s^24p^3$

Answer: B

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NCERT (Exemplar Problems) (Multiple Choice Questions (Type-II))

1. Which of the following have identical bond order?

A. CN^-

B. NO^+

C. O_2^+

D. O_2^{2-}

Answer: A::B

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2. Which of the following attain the linear structure ?

A. $BaCl_2$

B. NCO^+

C. NO_2

D. CS_2

Answer: A::D

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3. CO is isoelectronic with

A. NO^+

B. N_2

C. $SnCl_2$

D. NO_2^-

Answer: A::B

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4. Which of the following species have the same shape?

A. CO_2

B. CCl_4

C. O_3

D. NO_2^-

Answer: C::D

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5. Which of the following statements are correct about CO_3^{2-} ?

A. The hybridisation of central atom is sp^3.

B. Its resonance structure has one $C-O$ single bond and two $C=O$ double bonds.

C. The average formal charge on each oxygen atom is 0.67 units.

D. All $C-O$ bond lengths are equal.

Answer: C::D

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6. Which among the following are diamagnetic?

A. N_2

B. N^{2-}

C. O_2

D. O_2^{2-}

Answer: A::D

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7. Species having same bond order are

A. N_2

B. N_2^-

C. F_2^+

D. O_2^-

Answer: C::D

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8. Which of the following statements are not correct?

A. $NaCl$ being an ionic compound is a good conductor of electricity in the solid state.

B. In canonical structures, there is a difference in the arrangement of atoms.

C. Hybrid orbitals form stronger bonds than pure orbitals.

D. VSEPR theory can explain the squre planar geometry of XeF_4.

Answer: A::B

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NCERT (Exemplar Problems) (Short Answer Type Questions)

1. Interpret the non-linear shape of H_2S molecule and non-planar shape of PCl_3 using valence shell electron pair repulsion (VSEPR) theory.

(Atomic number : $H = 1, P = 15, S = 16, Cl = 17$)

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2. Using molelcular orbital theory, compare the bond energy and magnetic character of O_2^+ and O_2^- species.

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3. Explain the shape of BrF_5.

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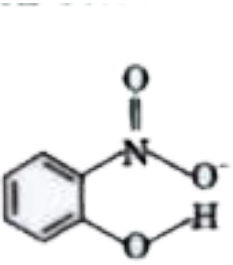
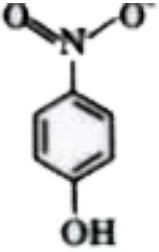
4. Structures of molecules of two compounds are given below :



(I)



(II)

(a) Which of the following compounds will have intermolecular hydrogen bonding and which compound is expected to show intramolecular

hydrogen bonding?

(b) Which of the above two compounds will show higher melting point?

(c) Which of the above compounds will form hydrogen bond with water easily and be more soluble in it?

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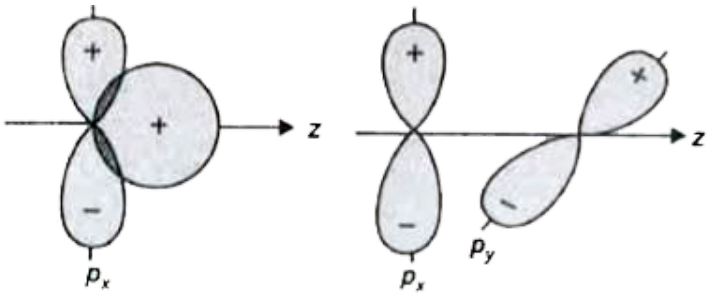
5. Why does type of overlap given in the following figure not result in bond formation?



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6. Explain why PCl_5 is trigonal bipyramidal whereas IF_5 is square pyramidal ?

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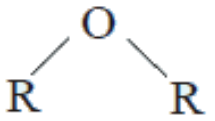
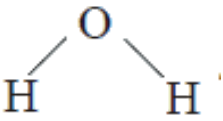
Ether  *and water* 

7.

have same hybridization at oxygen yet they have different bond angles. Which one has greater bond angle? Give reason.

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8. Write Lewis structure of the following compounds and show format charge on each atom.

HNO_3, NO_2, H_2SO_4

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9. The energy of $\sigma 2p_z$, molecular orbital is greater than $\pi 2p_x$ and $\pi 2p_y$ molecular orbitals in nitrogen molecule. Write the complete sequence of

energy levels in the increasing order of energy in the molecule. Compare the relative stability and the magnetic behaviour of the following species.

$N_2, N_2^+, N_2^-, N_2^{2+}$

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10. What is the effect of the following processes on the bond order of N_2 and O_2?

(a) $N_2 \rightarrow N_2^+ + e^-$ $(b) O_2 \rightarrow O_2^+ + e^-$

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11. Give reasons for the following :

(i) Covalent bonds are directional while ionic bonds are non-directional.

(ii) Water molecule has bent structure whereas carbon dioxide molecule is linear.

(iii) Ethyne molecule is linear.

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12. What is an ionic bond ? With two suitable examples, explain the diference between an ionic and a covalent bond ?

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13. Arrange the following bonds in order of increasing ionic character giving reason.

N-H, F-H, C-H and O-H

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14. Explain why CO_3^{2-} ion cannot be represented by a single Lewis structure. How can it be best represented ?

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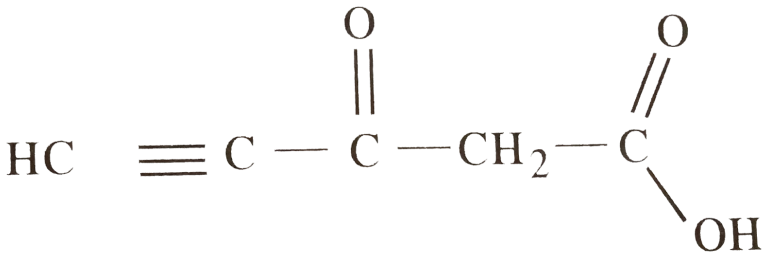
15. Predict the hybridisation of each carbon in the molecule of organic compound given below. Also indicate the total number of sigma and pi bonds in this molecule.



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16. Group the following as linear and non-linear molecules :

$H_2O, HOCl, BeCl_2, Cl_2O$

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17. Elements X,Y and Z have 4,5 and 7 valence electrons respectively, (i) Write the molecular formula of the compounds formed by these elements

individually with hydrogen (ii) which of these compounds will have the highest dipolw moment ?

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18. Draw the resonating structure of

(i) Ozone molecule

(ii) Nitrate ion.

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19. Presict the shapes of the following molecules on the basis of hybridisation.

BCl_3, CH_4, CO_2, NH_3

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20. All the C-O bonds in carbonate in $\left(CO_3^{2-}\right)$ are equal in length. Explain.

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21. What is meant by the term average bond enthalpy? Why is there difference in bond enthalpy of O-H bond in ethanol (C_2H_5OH) and water (H_2O) ?

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NCERT (Exemplar Problems) (Matching Type Questions)

1. Match the species in Column I with the type of hybrid orbitals in Column II.

Column I		Column II	
A.	SF_4	1.	sp^3d^2
B.	IF_5	2.	d^2sp^3
C.	NO_2^+	3.	sp^3d
D.	NH_4^+	4.	sp^3
		5.	sp

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2. Match the species in Column I with the geometry/shape in Column II.

Column I	Column II
$(i) H_3O^+$	(a) Linear
$(ii) HC \equiv CH$	(b) Angular
$(iii) ClO_2^-$	(c) Tetrahedral
$(iv) NH_4^+$	(d) Trigonal bipyramidal
	(e) Pyramidal

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3. Match the species in Column I with the bond order in Column II.

Column I		Column II	
A.	NO	1.	1.5
B.	CO	2.	2.0
C.	O_2^-	3.	2.5
D.	O_2	4.	3.0

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4. Match the items given in column i with example given in Column II

Column I		Column II	
A.	Hydrogen bond	1.	C
B.	Resonance	2.	LiF
C.	Ionic solid	3.	H_2
D.	Covalent solid	4.	HF
		5.	O_3

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5. Match the shape of molecules in Column 1 with the type of hybridisation in Column II.

Column I	Column II
(a) Tetrahedral	$(i)\ sp^2$
(b) Trigonal	$(ii)\ sp$
(c) Linear	$(iii)\ sp^3$
(d) Trigonal bipyramidal	$(iv)\ sp^3d$

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NCERT (Exemplar Problems) (Assertion and Reason Type Questions)

1. Assertion (A): Sodium chloride formed by the action of chlorine gas on sodium metal is a stable compound.

Reason: (R) This is because sodium and chloride ions acquire octet in sodium chloride formation.

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2. Assertion (A): Though the central atom of both NH_3 and H_2O molecules are sp^3 hybridised, yet H-N-H bond angle is greater thant that of H-O-H.

Reason(R): This is because nitrogen atom has one lone pair and oxygen atom has two lone pairs.

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3. Assertion (A): Among the two O-H bonds in H_2O molecule, the energy required to break the first O-H bond and the other O-H bond is the same.

Reason (R) This is because the electronic environment around oxygen is the same even after brekage of one O-H bond.

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NCERT (Exemplar Problems) (Long Answer Questions)

1. a) Discuss the significance/applications of dipole moment.

b) Represent diagrammatically the bond moments and the resultant dipole moment in CO_2, NF_3 and $CHCl_3$

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2. Use the molecular orbital energy level diagram to show that N_2 would be expected to have a triple bond. F_2, a single bond and Ne_2 , no bond.

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3. Briefly describe the valence bond theory of covalent bond formation by taking an example of hydrogen. How can you interpret energy changes taking place in the formation of dihydrogen?

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4. Describe hybridisation in the case of PCl_5 and SF_5 The axial bonds are longer as compared to rwuatorial bonds in PCl_5 whereas in SF_6 both axial bonds and equatorial bonds and have the same bond length. Explain.

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5. (i) Discuss the concept of hybridisation. What are its different types in a carbon atom.

(ii) What is the type of hybridisation of carbon atoms marked with star.

(a) $\overset{*}{C}H_2 = CH - \overset{*}{\overset{O}{\overset{||}{C}}} - O - H$

(b) $CH_3 - \overset{*}{C}H_2 - OH$

(c) $CH_3 - CH_2 - \overset{*}{\overset{O}{\overset{||}{C}}} - H$

(d) $\overset{*}{C}H_3 - CH = CH - CH_3$

(e) $CH_3 - \overset{*}{C} \equiv CH$

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NCERT (Exemplar Problems) (MCQ Based on Given Comprehension)

1. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic called bonding molecular orbital (BMO) and anti - bonding molecular orbital (ABMO). Energy of anti - bonding molecular orbital (BMO) and anti - bonding molecular orbital ABMO). Energy of anti - bonding orbitals is raised above the parent atomic orbitals that have combined and the energy of the bonding orbital is lowered than the parent atomic orbitals. Energies of various molecular orbitals for elements hydrogen to nitrogen increase in the order : $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \left(\pi 2p_x \approx \pi 2p_y\right) < \sigma 2p_z < \left(\pi^* p 2p_x \approx \pi^* 2p\right.$ and for oxygen and fluorine order of energy of molecular orbitals is given as :

$\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < \left(\pi 2p_x \cong 2\pi 2p_y\right) < \left(\pi^* 2p_x \cong \pi^* 2p\right.$

Different atomic orbitals of one atom combine with those atomic orbitals of the second atom which have comparable energies and proper orientation. Further, if the overlapping is head on, the molecular orbital is called 'sigma', (σ) and if the overlap is lateral, the molecular orbital is called 'pi', (π). The molecular orbitals are filled with electrons according

to the same rules as followed for filling of atomic orbitals. However, the order for filling is not the same for all moleculas or their ions. Bond order is one of hte most important parameters to compare the strength of bonds.

Which of the following statements is correct?

A. In the formiation of dioxygen from oxygen atoms 10 molecular orbitals will be formed.

B. All the molecular orbitals in the dioxygen will be completely filled.

C. Total number of bonding molecular orbtials will not be same as total number anti - bonding orbitals in dioxygen.

D. Number of filled bonding orbitals will be same as number of filled anti - bonding orbitals?

Answer: A

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2. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic called bonding molecular orbital (BMO) and anti - bonding molecular orbital (ABMO). Energy of anti - bonding molecular orbital (BMO) and anti - bonding molecular orbital ABMO). Energy of anti - bonding orbitals is raised above the parent atomic orbitals that have combined and the energy of the bonding orbital is lowered than the parent atomic orbitals. Energies of various molecular orbitals for elements hydrogen to nitrogen increase in the order : $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \left(\pi 2p_x \approx \pi 2p_y\right) < \sigma 2p_z < \left(\pi^* p 2p_x \approx \pi^* 2p$ and for oxygen and fluorine order of energy of molecular orbitals is given as :

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order for filling is not the same for all moleculas or their ions. Bond order is one of hte most important parameters to compare the strength of bonds.

Which of the following molecular orbitals has maximum number of nodal planes?

A. $sigam^{*}1s$

B. $\sigma^{*}2p_z$

C. $\pi 2p_x$

D. $\pi^{*}2p_y$

Answer: D

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3. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic called bonding molecular orbital (BMO) and anti - bonding molecular orbital (ABMO). Energy of anti - bonding molecular orbital (BMO) and anti - bonding molecular orbital ABMO). Energy of anti -

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Which of the following pair is expected to have the same bond order?

A. O_2, N_2

B. O_2^+ , N_2^-

C. O_2^- , N_2^+

D. O_2^- , N_2^-

Answer: B

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4. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic called bonding molecular orbital (BMO) and anti - bonding molecular orbital (ABMO). Energy of anti - bonding molecular orbital (BMO) and anti - bonding molecular orbital ABMO). Energy of anti - bonding orbitals is raised above the parent atomic orbitals that have combined and the energy of the bonding orbital is lowered than the parent atomic orbitals. Energies of various molecular orbitals for elements hydrogen to nitrogen increase in the order : $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \left(\pi 2p_x \approx \pi 2p_y\right) < \sigma 2p_z < \left(\pi^* p2p_x \approx \pi^* 2p$ and for oxygen and fluorine order of energy of molecular orbitals is given

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Different atomic orbitals of one atom combine with those atomic orbitals of the second atom which have comparable energies and proper orientation. Further, if the overlapping is head on, the molecular orbital is called 'sigma', (σ) and if the overlap is lateral, the molecular orbital is called 'pi', (π). The molecular orbitals are filled with electrons according to the same rules as followed for filling of atomic orbitals. However, the order for filling is not the same for all moleculas or their ions. Bond order is one of hte most important parameters to compare the strength of bonds.

In which of the following molecules, $\sigma 2p_z$ molecular orbital is filled after $\pi 2p_x$ and $\pi 2p_y$ molecular orbitals?

A. O_2

B. Ne_2

C. N_2

D. F_2

Answer: C

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Revision Exercises (Objective Questions)(Passage Based Questions)

1. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic orbitals combine to form two molecular orbitals called bonding and antibonding MOs. The molecular orbitals are filled with electrons following the same rules as followed for filling of atomic orbitals. The molecular orbitals electronic configurations help us to calculate bond order when which give important information about bond strength and bond length.

Why are H_2^+ ions more stable than H_2^- ions, though they have the same bond order?

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2. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic orbitals combine to form two molecular orbitals called bonding and antibonding MOs. The molecular orbitals are filled with electrons following the same rules as followed for filling of atomic orbitals. The molecular orbitals electronic configurations help us to calculate bond order when which give important information about bond strength and bond length.

Considering Z - axis as internuclear axis, which one of the following will be for sigma antibonding MO?

(i) $2p_y + 2p_y$ $2p_x - 2p_y$

(iii) $2s + 2p_z$ $(iv) 2p_z - 2p_z$

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3. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic orbitals combine to form two molecular orbitals called bonding and antibonding MOs. The molecular orbitals are filled with electrons following the same rules as followed for filling of atomic orbitals. The

molecular orbitals electronic configurations help us to calculate bond order when which give important information about bond strength and bond length.

Why does Be_2 molecule not exist?

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4. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic orbitals combine to form two molecular orbitals called bonding and antibonding MOs. The molecular orbitals are filled with electrons following the same rules as followed for filling of atomic orbitals. The molecular orbitals electronic configurations help us to calculate bond order when which give important information about bond strength and bond length.

Which out oof O_2^+ and O_2^- is more stable?

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5. Molecular orbitals are formed by the overlap of atomic orbitals. Two atomic orbitals combine to form two molecular orbitals called bonding and antibonding MOs. The molecular orbitals are filled with electrons following the same rules as followed for filling of atomic orbitals. The molecular orbitals electronic configurations help us to calculate bond order when which give important information about bond strength and bond length.

Which has smaller bond length No or NO^+?

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6. Hybridisation helps us to understand the geometry of the molecules. This is because hybridised orbitals are directed in space in some preferred directions to have stable arrangement, which determine the geometry. The common hybridisation are sp (linear), sp^2 (trigonal planar), sp^3 (tetrahedral), sp^3d (trigona bipyramidal), sp^3d^2 (octahedral) and sp^3d^3 (pentagonal bipyramidal). The presence of lone pairs in addition to bond pairs distort the geometry because

lone pair – lone pair repulsion > lone pair – bond repulsion > bo

.

Which d - orbitals are involved in sp^3d^2 hybridisation in SF_6 molecule?

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7. Hybridisation helps us to understand the geometry of the molecules. This is because hybridised orbitals are directed in space in some preferred directions to have stable arrangement, which determine the geometry. The common hybridisation are sp (linear), sp^2 (trigonal planar), sp^3 (tetrahedral), sp^3d (trigona bipyramidal), sp^3d^2 (octahedral) and sp^3d^3 (pentagonal bipyramidal). The presence of lone pairs in addition to bond pairs distort the geometry because lone pair – lone pair repulsion > lone pair – bond repulsion > bo

.

Give an example of molecule involving sp^3 hybridisation.

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8. Hybridisation helps us to understand the geometry of the molecules. This is because hybridised orbitals are directed in space in some preferred directions to have stable arrangement, which determine the geometry. The common hybridisation are sp (linear), sp^2 (trigonal planar), sp^3 (tetrahedral), sp^3d (trigona bipyramidal), sp^3d^2 (octahedral) and sp^3d^3 (pentagonal bipyramidal). The presence of lone pairs in addition to bond pairs distort the geometry because $\text{lone pair} - \text{lone pair repulsion} > \text{lone pair} - \text{bond repulsion} > \text{bo}$

.

Give an example of a molecule involving sp^3d hybridisation of the central atom and two lone pairs.

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9. Hybridisation helps us to understand the geometry of the molecules. This is because hybridised orbitals are directed in space in some preferred directions to have stable arrangement, which determine the geometry. The common hybridisation are sp (linear), sp^2 (trigonal planar), sp^3 (tetrahedral), sp^3d (trigona bipyramidal), sp^3d^2 (octahedral) and

sp^3d^3 (pentagonal bipyramidal). The presence of lone pairs in addition to bond pairs distort the geometry because lone pair $-$ lone pair repulsion $>$ lone pair $-$ bond repulsion $>$ bo

.

What is the hybridisation and shape of XeF_4 molecule?

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10. Hybridisation helps us to understand the geometry of the molecules. This is because hybridised orbitals are directed in space in some preferred directions to have stable arrangement, which determine the geometry. The common hybridisation are sp (linear), sp^2 (trigonal planar), sp^3 (tetrahedral), sp^3d (trigona bipyramidal), sp^3d^2 (octahedral) and sp^3d^3 (pentagonal bipyramidal). The presence of lone pairs in addition to bond pairs distort the geometry because lone pair $-$ lone pair repulsion $>$ lone pair $-$ bond repulsion $>$ bo

.

Do CH_4, NH_3 and H_2O involve same hybridisation of the central atom?

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Revision Exercises (Objective Questions)(True or False Questions)

1. Ionic compounds are bad conductors of electricity in the solid state.

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2. The shape of SF_6 molecule is octahedral whereas that of IF_7 is square pyramidal.

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3. The bond order of CO molecule is 2.5.`

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4. As $N-F$ bond is more polar than $N-H$ bond, NF_3 molecule has higher dipole moment than NH_3.

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5. The bond angle follows the order:

$NH_4^+ > NH_3 > NH_2^-$

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6. The dipole moment of cis $C_2H_2Cl_2$ isomer is more than that of trans isomer.

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7. N_2^+ has greater bond dissociation enthalpy than N_2 molecule.

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8. Out of MgO and CaO, MgO is harder.

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9. The d - orbital involved in dsp^2 hybridisation si $d_{x^2-y^2}$.

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10. The dipole moment of CH_3F is greater than that of CH_3Cl.

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Revision Exercises (Objective Questions)(Fill in the blanks Questions)

1. During the change : $O_2 \rightarrow O_2^+ + e^-$, bond order changes from .....to .....

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2. Ortho nitrophenol has .....hydrogen bond while p-nitrophenol has .....hydrogen bond.

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3. In SF_4 molecule, S involves .....hybridisation.

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4. The d - orbitals involved in sp^3d^2 hybridisation are .....and .....

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5. The shape of ClF_3 molecule is .....

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6. Out of H_2S, CO_2, BeF_2 and H_2O, the linear molecules are .....

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7. The shape of BrF_5 molecule is .....

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8. The number of lone pairs and bond pairs in XeF_4 molecule are .....and .....

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9. The bond order in O_2^+ species is .....

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10. Out of HF, HCl, HBr and HI, the lowest boiling point is of ..... and highest boiling point is of .....

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Revision Exercises (Objective Questions)(Assertion Reason Questions)

1. Assertion : Ionic compounds tend to be non-volatile

Reasoning : Intermolecular forces in these compounds are weak .

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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2. Assertion : The dipole moment helps to predict whether a molecule is polar or non- polar.

Reason : The dipole moment helps to predict geometry of molecule.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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3. Assertion(A) - BF_3 molecule is planar but NF_3 is pyramidal

Reason(R)-N atom is smaller than B

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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4. Assertion : CO_2 is non - polar while H_2O is polar, though both are triatomic.

Reason : CO_2 is linear while H_2O is angular.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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5. Assertion:- NO_3^- is planar while NH_3 is pyramidal

Reason:- N in NO_3^- is sp^2 and in NH_3 it is sp^3 hybridised with one ione pair.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: A

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6. Assertion : Both BF_3 and PF_5 do not obey octet rule.

Reason : Both are electron deficient molecules.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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7. Assertion : Bond angle in H_2O is less than that in H_2S.

Reason : Electronegativity of O is more than that of S.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: D

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8. Assertion : C_2H_2 molecule is linear.

Reason : In C_2H_2 carbon atoms remain unhybridized.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: C

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9. Assertion : XeF_2 has linear geometry.

Reason : XeF_2 involves sp^3d hybridisation of Xe atom.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: B

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10. Which one is covalent bond ?

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

Answer: B

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Revision Exercises (Objective Questions)(Very Short Answer Questions)

1. Why are the noble gases monoatomic?

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2. Can a non-polar molecule have polar covalent bonds?

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3. Give one example each for a compound with (a) an ionic bond (b) a covalent bond.

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4. Write Lewis dot structure of $HCOOH$.

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5. Which hybrid orbitals are used by Carbon atoms in the following molecules ?

$CH_3 - CH = CH_2$

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6. Calculate the formal charge on each atoms in nitrite ion .

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7. Out of CS_2 and OCS which have higher dipole moment and why?

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8. An element A has the electronic configuration $1s^2 2s^2 2p^6 3s^2$ and another element B has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^5$. What type of bond is formed between A and B? Give its Lewis structure.

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9. Define resonance.

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10. How does the hybridisation of carbon atom in $CH_2 = CH_2$ change when it is when it is hydrogenated to $CH_3 CH_3$?

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11. Give two examples of molecules containing coordinate bond.

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12. What are the shapes of (i) BF_3 and (ii) NH_3 molecules?

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13. Which of the two bonds : ionic or covalent is directional?

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14. Can a $\pi -$ bond be formed without the formation of a $\sigma -$ bond. How many $\sigma -$ and $\pi -$ bonds are formed in acetylene?

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15. Draw Lewis structure of O^{2-} and N^{3-} ions.

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16. Give bond angles in H_2O, CH_4 and SF_6 molecules.

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17. Write the favourable factors for the formation of ionic bond.

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18. Define electric dipole moment. Write its SI unit ?

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19. How many $\sigma -$ and $\pi -$ bonds are present in naphthalene?

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20. Out of NaCl and MgO which has higher lattice energy ?

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21. What do you understand by bond pairs and lone pairs of electrons? Illustrate by giving one example of each type.

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22. Define electronegativity and dipole moment.

Watch Video Solution

23. Give one example each of a tetraatomic molecule which is

(i) Polar

(ii) Non - polar.

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24. Give one example each of a molecule having

(i) 6 bond pairs

(ii) 7 bond pairs around the central atom.

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25. What is the total number of sigma bonds and pi bonds in

$$H_3C - \underset{H}{\underset{|}{C}} = \underset{H}{\underset{|}{C}} - C \equiv C - H$$

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26. What shapes are associated with sp^3d and sp^3d^2 hybrid orbitals?

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27. How is paramagnetic character of a compound related to the number of unpaired electrons?

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28. Which out of H_2^- and H_2^+ is more stable and why?

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29. Which d - orbitals are involved in sp^3d^2 hybridisation in SF_6?

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30. Write the molecular orbital configuration of a molecule having bond order of three.

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31. Which out of O_2^+ and O_2^- is more stable?

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32. Arrange the following molecular species in order of increasing stability :

$N_2, N_2^+, N_2^{2-}, N_2^{2+}$

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33. What is the shape of SF_6 molecule?

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34. Give one example of a molecule involving `sp^(3)d^(2) hybridisation.

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35. Although chlorine has the same electronegativity as nitrogen, it does not form hydrogen bonding. Explain.

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36. Why does formic acid exist as dimer?

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37. KHF_2 exists while $KHCl_2$ does not. Explain.

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38. State the type of hybrid orbitals associated with (i) P in PCl_5 and (ii) S in SF_6.

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39. Which out of O_2^- and O_2^{2-} has higher bond order and why ?

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40. What is the effect of the following ionization processes on the bond order in C_2 and O_2?

(i) $C_2 \rightarrow C_2^+ + e^-$

(ii) $O_2 \rightarrow O_2^+ + e^-$

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41. What is the effect on the interatomic bond length of the following ionization processes?

(i) $N_2 \rightarrow N_2^+ + e^-$

(ii) $C_2 \rightarrow C_2^+ + e^-$

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42. Which one of the following has higher bond order?

N_2, N_2^+ or N_2^-

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43. Draw a diagram showing the formation of bonding and anti - bonding molecular orbitals by LCAO in homonuclear hydrogen molecule.

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44. Out of water and ice which has lesser density?

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45. Do N_2^+ and O_2^+ have same bond order?

Watch Video Solution

46. Define the bond length.

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Revision Exercises (Objective Questions)(Short Answer Questions)

1. Explain the formation of a chemical bond.

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2. Explain the formation of a covalent bond. State two factors which influence the formation of a covalent bond.

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3. Write the favourable factors for the formation of ionic bond.

Watch Video Solution

4. Define octet rule. Write its significance and limitations.

Watch Video Solution

5. What do you understand by a chemical bond? Why do atoms combine to form compounds?

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6. Draw Lewis symbols for the following elements :

$B, Ge, Si, Ar, Ca, K, As, Br.$

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7. Give one example of a compound containing double bond and one containing a triple bond.

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8. Explain that whereas H_2 and F_2 are non - polar, HF is polar.

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9. Draw the orbital representation of the molecules :

HF, H_2O and NH_3.

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10. Write the Lewis dot structures of (a) CCl_4 (b) PH_3 (c) BCl_3. Is the octet roule obeyed in these structures ?

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11. Draw the shapes of the following hybrid orbitals :

sp, sp^2, sp^3

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12. Considering X axis as the internuvlear axis, which out of the following will form a sigma bond

(a) $1s$ and ls (b) ls and $2p_x$

(c) $2p_y$ and $2p_y$ (d) $2p_x$ and $2p_y$

(e) $1s$ and $2s$.`

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13. Give the Lewis dot structures of NH_3, CH_4 and SO_3.

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14. Draw electron dot structures of the following :

(i) OF_2

(ii) C_2H_2

(iii) PCl_3

(iv) H_2O_2.

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15. What is octet rule? List important exceptions to octet rule.

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16. Give the number and types of various bonds in acetylene molecule. Name the type of oerlap responsible for each bond.

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17. Draw dipole moment diagrams showing polarity of individual bonds and resultant dipole of the following :

(i) H_2O

(ii) CO_2

(iii) BeF_2

(iv) BF_3.

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18. Which one is covalent bond ?

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19. Which plot best repersent the potential energy (E) of two hydrogen atoms as they approach one another to form a hydrogen molecule ?

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20. The dipole moment of hydrogen halides decreases form HF to HI. Explain this trend.

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21. Write the formal charges of the atoms in

(i) hydroxide ion

(ii) carbonate ion

(iii) nitrite ion.

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22. Sketch the bond moments and resultant dipole moments in the following molecules :

PCl_3, H_2O, NH_3, NF_3

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23. Write the resonance structures for SO_3,NO_2, and $NO_3^{\ominus}$.

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24. What is polar covalent bond? Explain with example.

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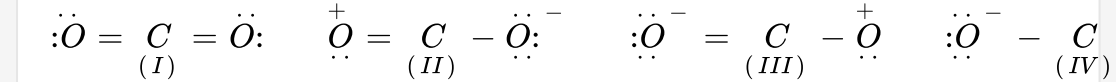
25. Out of the following resonating strictures for CO_2 molecule, which are important for describing the bonding in the molecule and why ?



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26. Which of the two : KCl or Cl_2 has higher boiling point and why?

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27. Presence of a lone pair of electrons distorts the geometry of a covalent molecule. Explain.

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28. Define hyvridisation. Discuss the bonding in acetylene molecule on the basis of hybrdisation.

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29. Write the resonance structures for SO_3,NO_2, and $NO_3^{\ominus}$.

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30. APPLICATION OF DIPOLE MOMENT

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31. Name the two bonds present in oxygen molecule and compare their strengths.

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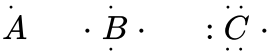
32. Three elements have the following Lewis symbols :



(a) Place the elements in the appropriate group of the periodic table.

(b) Which elements are most likely to form ions? What is the expected charge on the ions?

(c) Write the formulae and Lewis structures of the covalent compounds formed between :

(i) A and B

(ii) A and C.

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33. Distinguish between a sigma and a pi bond.

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34. Define lattice enthalpy. How is it related to the stability of an ionic compound?

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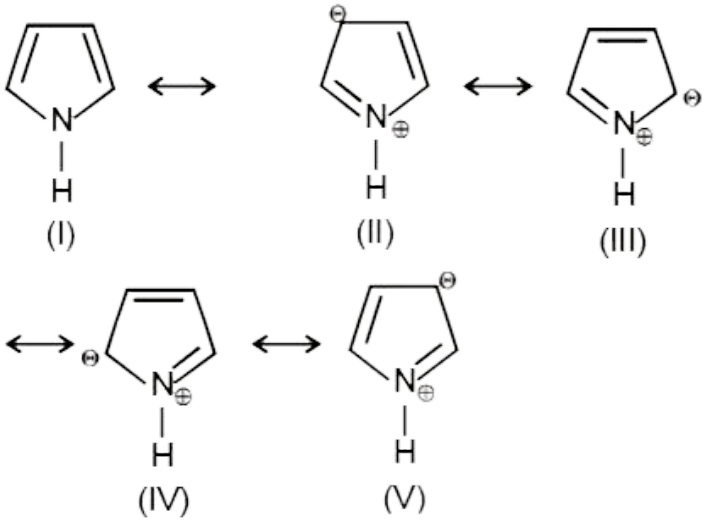
35. Write the stability order of Resonating Structures:



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36. Discuss the shape of CO_2 molecule on the basis of hybridisation.

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37. How do you account for equal bond lengths in ozone molecule?

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38. Define dipole moment. How does this help to predict the geometries of H_2O and CO_2?

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39. Draw diagrams showing the formation of a double bond and a triple bond between carbon atoms in C_2H_4 and C_2H_2 molecules.

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40. Explain the important aspects of resonance with reference to the CO_3^{2-} ion.

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41. Explain with the help of suitable example polar covalent bond.

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42. In each of the following pairs, predict which has higher value of the property mentioned:

$(i) HF, HCl$: Polar character

$(ii) NH_3, H_2O$: Bond angle

$(iii) KCl, KF$: Lattice enthalpy

$(iv) NF_3, NH_3$: Dipole moment

$(v) C_2H_2, C_2H_4$: s - character in the hybridisation of carbon

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43. Explain the term dipole moment. Name two molecules which have dipole moment and two molecules which do not have dipole moment. What is the significance of dipole moment?

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44. Using the concept of hybridisation, explain the shapes of BF_3, C_2H_4 and C_2H_2 molecules.

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45. The electronic configurations of five neutral atoms are given below :

$A: 1s^2 2s^2 2p^6 3s^2$

$B: 1s^2 2s^2 2p^6 3s^1$

$C: 1s^2 2s^2 2p^1$

$D: 1s^2 2s^2 2p^3$

$E: 1s^2 2s^2 2p^6$

Write the empirical formula for the substances containing :

(i) A and D

(ii) B and D

(iii) D and D

(iv) E and E.

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46. Each carbon - oxygen bond is CO_2 molecule is polar and the molecule is no - polar. Explain.

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47. Which out of NH_3 and NF_3 has higher dipole ment and why ?

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48. Draw elecctron dot representation of :

(i) acetylene

(ii) ammonia.

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49. What is dipole moment ? How does it affect the polarity of the molecule ? Which of the following molecules do you expect to be polar?

$CO, CCl_4, H_2O, BF_3, NH_3$ and CO_2

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50. Explain the formation of H_2 molecule on the basis of valance bond theory.

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51. Each carbon - oxygen bond in carbon dioxide molecule is polar but the molecule itself is non - polar. Explain.

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52. CO_2 and H_2O both are triatomic molecules but there is large difference in their dipole moment values. Explain.

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53. Explain the following :

(a) HCl is a covalent compound but it ionises in the solution.

(b) The molecule of $MgCl_2$ is linear whereas that of $SnCl_2$ is angular.

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54. Write the important conditions required for the linear combination of atomic orbitals to form molecular orbitals.

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55. Why is that in the SF_4 molecule, the lone pair of electrons occupies an equatorial position in the overall trigonal pyramidal arrangement in preferencr to an axial position ?

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56. Explain the important aspects of resonance with reference to the CO_3^{2-} ion.

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57. Describe the hydribisation in case of PCl_5. Why are the axial bonds longer as compared to equatorial bonds?

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58. Explain how valence bond theory accounts for

(i) a carbon-carbn double bond (C=C)

(ii) a carbon -carbon triple bond (C=C)

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59. What do you understand by a molecular orbital?

What is the maximum number of electrons that can occupy a molecular orbital?

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60. What do you understand by bonding and antibonding molecular orbitals? Calculate the bond order for O_2^+ and O_2.

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61. CONDITIONS FOR COMBINATIONS OF ATOMIC ORBITALS

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62. Draw molecular orbital energy level diagram for nitrogen molecule.

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63. Using MO diagram and occupancy of electrons in orbitals, arrange the following molecular species in increasing order of their stabilities :

(i) H_2

(ii) H_2^-

(iii) H_2^+

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64. Use the molecular orbital energy level diagram to show that N_2 would be expected to have a triple bond. F_2, a single bond and Ne_2 , no bond.

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65. Is it correct to say that bond order always increases when an electron is lost?

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66. Compare the relative stability of the following species and indicate their magnetic properties:

$O_2, O_2^{\oplus}, O_2^{\ominus}$ (superoxide), O_2^{-2} (peroxoide).

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67. Arrange the following species in order of increasing stability and give reasons: Li_2, Li_2^+, Li_2^-.

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68. How does molecular orbital theory account for the following?

(a) Bond order of N_2 is greater than N_2^+ but the bond order of O_2 is less than that of O_2^+.

(b) Be_2 does not exist.

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69. Sketch the shapes of MOs obtained by the overlap of

(i) two s - orbitals

(ii) end on overlap of two p - orbitals.

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70. What is hybridisation? What type of hybridisation are possible in the following geometries?

(i) Square planar

(ii) Trigonal bipyramidal

(iii) Octahedral.

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71. On the basis of hybridisation, discuss the structures of

(i) PCl_5

(ii) IF_7

(iii) SF_6.

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72. Calculate the bond order of O_2^- and O_2^{2-} ions on the basis of M.O. theory and explain their magnetic properties.

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73. Explain the following :

(i) O_2^- is paramagnetic but O_2^{2-} is not.

(ii) N_2 has higher bond order than NO.

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74. 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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Revision Exercises (Objective Questions)(Short Answer Questions)(Fill in the blanks:)

1. During the process : $O_2 + e^- \rightarrow O_2^-$, the electron in added to the ..... MO .

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2. The bond order in O_2^+ is .....tahn in O_2.

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3. In O_2 has double bond, F_2 has single bond and Ne_2 has no bond.

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Revision Exercises (Objective Questions)(Long Answer Questions)

1. Explain the formation of H_2 molecule on the basis of valance bond theory.

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2. Discuss the orital stuctures of the following molecules on the basis of hybridisation.

$(i) NH_3 (ii) C_2H_2 (iii) CO_2.$

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3. What type of bonding would you expect between the following pairs of elements?

(i). Calcium and Oxygen

(ii). Carbon and Chlorine

(iii). Hydrogen and chlorine

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4. What is electronegativity? How is this useful in understanding the nature of elements?

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5. Discuss the shapes of the following molecules of the basis of VSEPR theory :

(i) CH_4

(ii) PF_5

(iii) NH_3

(iv) H_2O

(v) SF_6.

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6. Select correct statement(s) regarding σ and π bonds :

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7. What is lattice energy?

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8. Discuss the shape of the following molecules using the $VSEPR$ model:

$BeCl_2, BCl_3, SiCl_4, AsF_5, H_2S, PH_3$

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9. What are SI units of dipole moment?

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10. TYPES OF HYBRIDISATION

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11. With the help of molecular orbital theory, show that N_2 molecule has triple bond, O_2 molecule has double bond while F_2 molecule has single bond. Compare their bond strengths.

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12. The EAN of Ni in $\left[Ni(CN)_4\right]^{2-}$ is

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HIGHER ORDER THINKING SKILLS

1. Which is expected to have the highest melting point :

NH_3, $(CH_3)_3N$ or PH_3? Explain why?

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2. Which of the following has higher dipole moment and why?

But -1- ene or But -1- yne

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3. Explain why melting point of $NaCl$ is higher than that of $AlCl_3$.

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4. Silver halides have law solubilities in water as compared to alkali metal halides. Explain.

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5. Which homonuclear diatomic molecule besides O_2 is paramagnetic?

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6. Distinguish between antibonding and nonbonding orbitals.

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7. Anhydrous $AlCl_3$ is covalent but $AlCl_3.6H_2O$ is ionic in nature. How would you account for this?

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8. Cu^+ and Na^+ are of same size but $CuCl$ is insoluble while $NaCl$ is soluble in water. Explain.

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9. The geometry of I_3^- is

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10. The type of bonds present in NH_4Cl are

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11. Which one has high boiling point and why?

Ethyl alcohol or dimethyl ether.

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12. XeF_2 molecule is linear molecule but it is sp^3d hybridized. Why?

Watch Video Solution

13. Bonds presents in $CuSO_4.5H_2O$ is

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14. The following are aresome statement about oxides of VA group element

I) N_2O molecule is linear

II) NO_2 molecule is angular

III) N_2O_5 molecule is angular

The correct combination is

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15. The bond order in O_2^- ion is

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16. Explain, why o-hydroxybenzaldehyde is a liquid at room temperature while p-hydroxybenzaldehyde is a high melting solid?

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17. A gaseous compound of nitrogen and oxygen is paramagnetic in nature. When it is cooled below $0^\circ C$ its molecular mass increases and paramagnetism is lost. The behaviour is reversed on heating. The compound is

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18. Draw three possible geometrical structures of PBr_2Cl_3 and predict which of these have dipole moments.

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19. Bond angle in PH_4^+ is higher than that in PH_3.Why ?

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20. Why does PCl_5 exist as $[PCl_4]^+[PCl_6]^-$ in the crystalline state?

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21. Explain the observations that the bond length in N^+ is 0.02Å larger than in N_2 while the bond length in NO^+ is 0.09Å less than in NO.

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22. IF molecular axis is X then which of the following overlapping will form π bond?

$p_z + p_z, p_x + p_x, p_x, p_y, s + p_z, p_y + p_y$

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OBJECTIVE TYPE QUESTIONS (A. MULTIPLE CHOICE QUESTIONS)

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

A. BF_3

B. PF_5

C. CO_2

D. IF_7

Answer: C

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2. Which of the following has maximum covalent character?

A. LiI

B. LiF

C. $LiCl$

D. $LiBr.$

Answer: A

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3. Which of the following has highest lattice energy

A. LiF

B. NaF

C. KF

D. RbF.

Answer: A

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4. Which of the following molecule has net dipole moment?

A. CCl_4

B. C_2H_2

C. BF_3

D. NH_3.

Answer: D

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5. The percentage ionic character of a bond having 1.275Å its length hand 1.03 D its dipole moment is :

A. $10\ \%$

B. $15\ \%$

C. $16.83\ \%$

D. $18.8\ \%$

Answer: C

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6. The correct order of dipole moment is :

A. $CH_4 < NF_3 < NH_3 < H_2O$

B. $NF_3 < CH_4 < NH_3 < H_2O$

C. $CH_4 < NH_3 < NF_3 < H_2O$

D. $H_3O < NH_3 < NF_3 < CH_4.$

Answer: A

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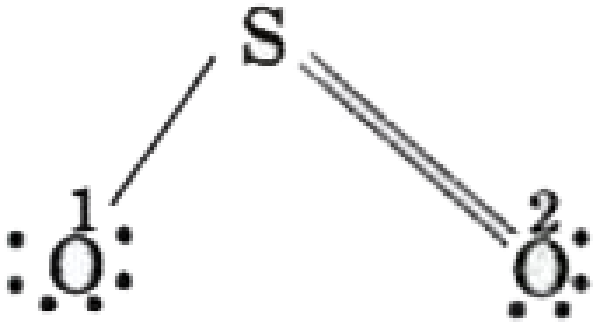
7. Formal charge on two O atoms in



A. $-1, +1$

B. $-1, 0$

C. $0, +1$

D. $-1, -1$

Answer: B

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8. Which of the following ions has the maximum polarising power?

A. Na^{+}

B. Mg^{2+}

C. Ca^{2+}

D. Al^{3+}

Answer: D

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9. Which of the following is not correct resonating structure for carbon dioxide ?

A. $O = C = O$

B. $^{-}O - C \equiv O^{+}$

C. $^{+}O - C \equiv O^{-}$

D. $^{+}O \equiv C - O^{-}$

Answer: C

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10. The bond angles in molecules H_2O, NH_3, CH_4 and CO_2 are in the order :

A. $H_2O > NH_3 > CH_4 > CO_2$

B. $H_2O < NH_3 < CO_2 < CH_4$

C. $H_2O < NH_3 < CH_4 < CO_2$

D. $H_2O > NH_3 < CH_4 > CO_2.$

Answer: C

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11. The hybridisation of C involved in acetylene is :

A. sp^2

B. sp^3

C. sp

D. dsp^2

Answer: C

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12. For which of the following hybridisation the bond angle is maximum ?

A. sp^2

B. sp

C. sp^3

D. dsp^2.

Answer: B

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13. The angle between the covalent bonds is maximum in :

A. CH_4

B. BF_3

C. PF_3

D. NH_3.

Answer: B

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14. The percentage s-character of the hybrid orbitals in methane, ethene and ethyne are respectively

A. 25, 50, 75

B. 25, 33, 75

C. 25, 33, 50

D. 100, 50, 25.

Answer: C

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15. CO_2 is isostructural with

A. $SnCl_2$

B. $ZnCl_2$

C. $HgCl_2$

D. C_2H_4

Answer: C

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16. In an octahedral structure , the pair of d orbitals involved in d^2sp^2 hybridization 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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17. Which of the following has highest bond angle?

A. NO_2^+

B. NO_2

C. NO_2

D. NO_3.

Answer: A

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18. Which of the following molecules does not contain a lone pair of electrons?

A. NH_3

B. PF_5

C. H_2O

D. SF_4

Answer: B

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19. In which of the following, the central atoms has two lone pairs of electrons

A. SF_4

B. BrF_5

C. SO_2

D. XeF_4

Answer: D

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20. What typs of hybridisation is possible in square planar molecules?

A. sp^3d

B. dsp^3

C. dsp^2

D. sp^3d^2.

Answer: C

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21. PCl_5 molecule has the following geometry :

A. Trigonal bipyramidal

B. Octahedral

C. Square planar

D. Planar triangular.

Answer: A

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22. In which of the following molecules are all the bonds not equal ?

A. BF_3

B. AlF_3

C. NF_3

D. ClF_3

Answer: D

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23. Which of the following molecules/ins does not contain unpaired electrons?

A. N_2^+

B. O_2^{2-}

C. O_2

D. B_2

Answer: B

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24. The bond order in O_2^- ion is

A. 1

B. $1\frac{1}{2}$

C. 2

D. $2\frac{1}{2}$

Answer: B

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25. If molecular axis is Z then which of the following overlaping is not possible

A. $2p_z + 2s$

B. $2p_y - 2p_y$

C. $2p_x - 2p_x$

D. $2p_x + 2p_y$

Answer: D

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26. Which of the following is paramagnetic?

A. O_2^-

B. CN^-

C. CO

D. NO^+.

Answer: A

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27. Which one of the following pairs consists of only paramagnetic species

A. O_2, NO

B. O_2^+, O_2^{2-}

C. CO, NO

D. NO, NO^+

Answer: A

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28. The correct order of bond order values among the following

(i) NO^- (ii) NO^+

(iii) NO (iv) NO^{2+}

(v) NO^{2-}

A. $(i) < (iv) < (iii) < (ii) < (v)$

B. $(v) = (ii) < (i) < (iv) < (iii)$

C. $(v) < (i) < (iv) = (iii) < (ii)$

D. $(ii) < (iii) < (iv) < (i) < (iv)$

Answer: C

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29. Which of the following is not paramagnetic?

A. O_2

B. N_2^+

C. B_2

D. O_2^{2-}

Answer: D

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30. The maximum bond strengths is in:

A. O_2^+

B. O_2^-

C. O_2

D. O_2^{2-}

Answer: A

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31. which of the following hydrogen bond is strongest in vapour phase ?

A. $S - H \cdot \cdot \cdot \cdot \cdot O$

B. $O - H \cdot \cdot \cdot \cdot \cdot S$

C. $F - H \cdot \cdot \cdot \cdot \cdot F$

D. $F - H \cdot \cdot \cdot \cdot \cdot O$

Answer: C

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32. strongest hydrogen bonding is shown by

A. H_2O_2 and H_2O

B. $HCOOH$ and CH_3COOH

C. CH_3COOH and CH_3COOCH_3

D. SiH_4 and $SiCl_4$

Answer: B

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33. Which of the following has highest boiling point?

A. NH_3

B. PH_3

C. SbH_3

D. AsH_3

Answer: A

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34. Which of the following has lowest boiling point?

A. HF

B. HCl

C. Hl

D. HBr

Answer: B

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35. Which of the following statement is not true about amorphous solids?

A. Water has more density than ice.

B. Each water molecule is linked to four water molecules tetrahedrally

C. In water, each O atom is bonded to 2 -H atoms by hydrogen bonds.

D. Water has minimum denisity at 277 K.

Answer: D

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OBJECTIVE TYPE QUESTIONS (B. MULTIPLE CHOICE QUESTIONS)

1. In which of the following pairs, the two species are isostructural :

A. BrO_3^- and XeO_3

B. SF_4 and XeF_4

C. SO_3^{2-} and NO_3^-

D. BF_3 and NF_3

Answer: A

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2. The correct order of $C - O$ bond length among CO, CO_3^{2-}, CO_2 is

A. $CO < CO_2 < CO_3^{2-}$

B. $CO_2 < CO_3^{2-} < CO$

C. $CO < CO_3^{2-} < CO_2$

D. $CO_3^{2-} < CO_2 < CO.$

Answer: A

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3. According to MO theory which of thhe following lists makes the nitrogen species in terms of increasing bond order?

A. $N_2^{2-} < N_2^- < N_2$

B. $N_2 < N_2^{2-} < N_2^-$

C. $N_2^- < N_2^{2-} < N_2$

D. $N_2^- < N_2 < N_2^{2-}$

Answer: A

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4. In which of the following molecular/ions BF_2, NO_2^-, NH_2 and H_2O the correct atom is sp^2 hybridized ?

A. NH_2^- and H_2O

B. NO_2^- and H_2O

C. BF_3 and NO_2^-

D. NO_2^- and NH_2^-

Answer: C

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5. In which one of the following species , the central atom has the tuype of hybdridiztion which is not the same as that present in other three?

A. $SbCl_5^{2-}$

B. PCl_5

C. SF_4

D. I_2^-

Answer: A

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6. Which of the following species does not exist under normal condition ?

A. B_2

B. Li_2

C. Be_2^+

D. Be_2

Answer: D

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7. Among the following molecules : SO_2, SF_4, ClF_3, BrF_5 , and XeF_4 , which of the following shapes does not describe any of the molecules mentioned ?

A. Bent

B. Trigonal bipyramidal

C. See saw

D. T - shape

Answer: B

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8. Which of the following has the minimum bond length ?

A. O_2^+

B. O_2^-

C. O_2^{2-}

D. O_2

Answer: A

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9. Which of the two ions from the list given below that have the geometry that is explained by the same hybridisation or orbitals, $NO_2^-, NO_3^-, NH_2^-, NH_4^+, SCN^-$ -

A. NO_2^- and NO_3^-

B. NH_4^+ and NO_3^-

C. SCN^- and NH_2^-

D. NO_2^- and NH_2^-

Answer: A

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10. The pair of species with the same bond order is :

A. O_2^{2-}, B_2

B. O_2^+, NO^+

C. NO, CO

D. N_2, O_2

Answer: A

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11. Which of the following species contains three bond pairs and one lone pair around the central atom

A. H_2O

B. BF_3

C. NH_2^-

D. PCl_3

Answer: D

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12. Which of the following pairs is isostractural (i.e having the same shape and hybridization ?

A. $[BCl_3 \text{ and } BrCl_3]$

B. $[NH_3 \text{ and } NO_3]$

C. $[NF_3 \text{ and } BF_3]$

D. $\left[BF_4^- \text{ and } NH_4^+\right]$

Answer: D

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13. Bond order of 1.5 is shown by:

A. O_2^+

B. O_2^-

C. O_2^{2-}

D. O_2

Answer: B

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14. Which of the following is a polar molecule

A. SiF_4

B. XeF_4

C. BF_3

D. SF_4

Answer: D

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15. Which of the following is paramagnetic?

A. CN^-

B. NO^+

C. CO

D. O_2^-

Answer: D

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16. Which one of the following molecules contains no π - bond ?

A. SO_2

B. NO_2

C. CO_2

D. H_2O

Answer: D

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17. The bond orders for O_2^+ and C_2 respectively are

A. 2.5, 2

B. 3, 2

C. 2, 2.5

D. 2, 3

Answer: A

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18. Which of the following molecules has the maximum dipole moment ?

A. CO_2

B. CH_4

C. NH_3

D. NF_3

Answer: C

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19. Which of the following species has plane tringular shape ?

A. N_3

B. NO_3^-

C. NO_2^-

D. CO_2

Answer: B

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20. Which of the following sets of molecules contains the same number of lone pairs of electrons in the central atom ?

A. SO_2, ClF_3, BrF_3

B. SF_4, NH_3, O_3

C. ClF_3, XeF_2, H_2O

D. H_2O, SF_4, NH_3

Answer: B

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21. Which one of the following does not match with respect to the shape of the molecule?

A. NH_3 – Trigonal pyramidal

B. SF_4 – Tetrahedral

C. H_2S – Tetrahedral

D. XeF_4 – Square planar

Answer: B,C

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22. Find the pair that has the same bond order with diamagnetic and paramagnetic properties respectively.

A. F_2 and O_2

B. N_2 and O_2^{2-}

C. Li_2 and B_2

D. B_2 and O_2

Answer: C

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23. Decreasing order of stability of O_2, O_2^-, O_2^+ and O_2^{2-} is

A. $O_2 > O_2^+ > O_2^{2-} > O_2^-$

B. $O_2^- > O_2^{2-} > O_2^+ > O_2$

C. $O_2^+ > O_2 > O_2^- > O_2^{2-}$

D. $O_2^{2-} > O_2^- > O_2 > O_2^+$

Answer: C

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24. In which of the following pairs, both the species are not isostructural?

A. NH_3, PH_3

B. XeF_4, XeO_4

C. $SiCl_4, PCl_4^+$

D. `diamond, silicon carbide

Answer: B

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25. Which of the following pairs of ions are isoelectronic and isostructural?

A. SO_3^{2-}, NO_3^-

B. ClO_3^-, SO_3^{2-}

C. CO_3^{2-}, SO_3^{2-}

D. ClO_3^-, CO_3^{2-}

Answer: B

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26. The correct bond order in the following species is:

A. $O_2^+ < O_2^- < O_2^{2+}$

B. $O_2^- < O_2^+ < O_2^{2+}$

C. $O_2^{2+} < O_2^+ < O_2^-$

D. $O_2^{2+} < O_2^- < O_2^+$

Answer: B

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27. Maximum bond angle at nitrogen is present in which of the following ?

A. NO_2^+

B. NO_3^-

C. NO_2

D. NO_2^-

Answer: A

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28. Consider the molecules CH_4, NH_3 and H_2O. Which of the given statements is false-

A. The $H-O-H$ bond angle in H_2O is smaller than the $H-N-H$ bond angle in NH_3.

B. The $H-C-N$ bond angle in CH_4 is larger than the $H-N-H$ bond angle in NH_3.

C. The $H-C-H$ bond angle in CH_4 is larger than the $H-C-H$ bond angle in NH_3, and the $H-O-H$ bond angle in H_2O are all greater than 90°.

D. The $H-O-H$ bond angle in H_2O is larger than the $H-C-H$ bond angle in CH_4.

Answer: D

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29. Predict the correct order among the following-

A.

$$\text{bond} \ -\text{bond pair} > \text{lone pair} - \text{bond pair} > \text{lone pair} - \text{lone pair}$$

B.

$$\text{lone pair} - \text{bond pair} > \text{bond pair} - \text{bond pair} > \text{lone pair} - \text{lone pai}$$

C.

$\text{lone pair} - \text{lone pair} > \text{lone pair} - \text{bond pair} > \text{bond pair} - \text{bond pair}$

D.

$\text{lone pair} - \text{lone pair} > \text{bond pair} - \text{bond pair} > \text{lone pair} - \text{bond pair}$

Answer: C

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30. Which one of the following compounds shows the presence of intramolecular hydrogen bond ?

A. H_2O_2

B. HCN

C. Cellulose

D. Concentrated acetic acid

Answer: C

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31. The correct geometry and hybridisation for XeF_4 are

A. octahedral, sp^3d^2

B. trigonal bipyramidal sp^3d

C. planar triangle, sp^3d^3

D. planar trianglar, sp^3d^3

Answer: D

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32. The hybridization of atomic orbitals of nitrogen is NO_2^+, NO_3^-, and NH_4^+ respectively are

A. sp, sp^3 and sp^2

B. sp^2, sp^3 and sp^3

C. sp, sp^2 and sp^3

D. sp^2, sp and sp^3

Answer: C

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33. Which of the following pairs of compound is isoelectronic and isostructure ?

A. TeI_2, XeF_2

B. IBr_2^-, XeF_2

C. IF_2, XeF_2

D. $BeCl_2$, XeF_2

Answer: B

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34. The species, having bonds angle of 120° is

A. ClF_3

B. NCl_3

C. BCl_3

D. PH_3

Answer: C

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35. Which of the following pairs of species have the same bond order

A. O_2, NO^+

B. CN^-, CO

C. N_2, O_2^-

D. CO, NO

Answer: B

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36. Among $CaH_2, BeH_2, BaH_2,$ the order of ionic character is

A. $BeH_2 < CaH_2 < BaH_3$

B. $CaH_2 < BeH_2 < BaH_2$

C. $BeH_2 < BaH_2 < CaH_2$

D. $BaH_2 < BeH_2 < CaH_2$

Answer: A

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37. Consider the following species

CN^-, CN^-, NO and CN`.

Which one of these will hqave the highest bond order ?

A. NO

B. CN^-

C. CN^+

D. CN

Answer: B

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38. In the structure of ClF_3, the number of lone pairs of electrons on central atom Cl is-

A. one

B. two

C. four

D. three

Answer: B

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39. Identify the incorrect statement related to PCl_5 from the follwing

A. PCl_5 molecule is non - reactive.

B. Three equatorial $P-Cl$ bonds make an angle of 120° with each other.

C. Two axial $P-Cl$ bonds make an angle of 180° with each other.

D. Axial $P-Cl$ bonds are longer than equatorial $P-Cl$ bonds.

Answer: A

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40. Which of the following diatomic molecular species has only π bonds according to Molecular orbital Theory

A. Be_2

B. O_2

C. N_2

D. C_2

Answer: D

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OBJECTIVE TYPE QUESTIONS (B. MULTIPLE CHOICE QUESTIONS) (JEE (MAIN) & OTHER STATE BOARDS FOR ENGINEERING ENTRANCE)

1. The types of hybridisation on the five carbon atoms from left to right in the molecule $CH_3 - CH = C = CH - CH_3$ are

A. $sp^3, sp^2, sp^2, sp^2, sp^3$

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

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

D. sp^3, sp, sp, sp^2, sp^3

Answer: C

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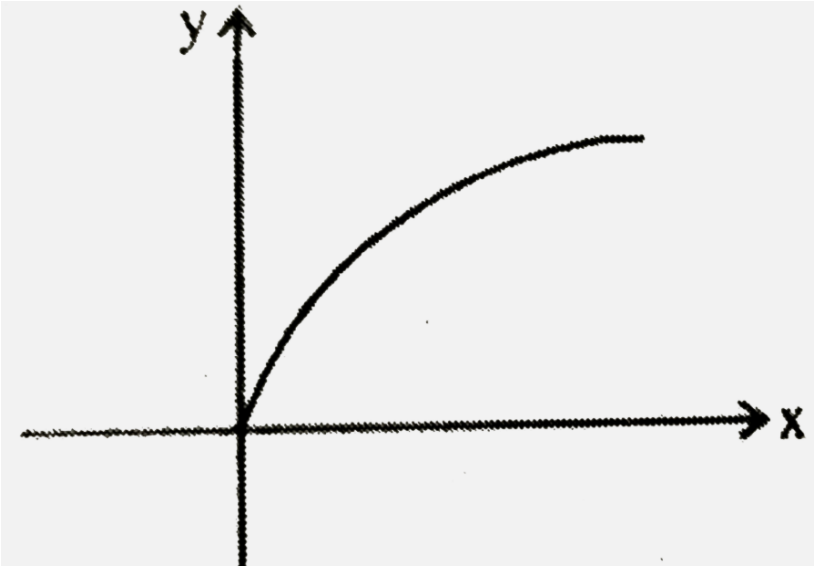
2. 

A. 1.5 D

B. 2.25 D

C. 1 D

D. 3 D

Answer: A

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3. How many hydrogen-bonded water molecule(s) are associated in $CuSO_4.5H_2O$?

A. 1

B. 2

C. 3

D. 4

Answer: A

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4. Which one of the following conversions involve change in both hybridisation and shape?

A. $CH_4 \rightarrow C_2H_6$

B. $NH_2 \rightarrow NH_4^+$

C. $BF_3 \rightarrow BF_4^-$

D. $H_2O \rightarrow H_3O^+$

Answer: C

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5. N_2 and O_2 are converted into monocations, N_2^+ and O_2^+ respectively. Which of the following is wrong?

A. In N_2^+ the $N - N$ bond is weakened

B. In O_2^+, the bond order increases

C. In O_2^+, paramagnetism decreases

D. N_2^+ become diamagnetic

Answer: D

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6. The structure of IF_7 is

A. square pyramid

B. trigonal bipyramid

C. octahedral

D. pentagonal bipyramid

Answer: D

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7. Likely bond angles of SF_4 molecule are :

A. $89^\circ, 117^\circ$

B. $120^\circ, 180^\circ$

C. $45^\circ, 118^\circ$

D. $117^\circ, 92^\circ$

Answer: A

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8. Which of the following has maximum number of lone pairs associated with Xe?

A. XeF_4

B. XeF_6

C. XeF_2

D. XeO_3

Answer: C

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9. The number and type of bonds between two carbon atoms in calcium carbide are

A. one sigma, one pi

B. two sigma, one pi

C. two sigma, two pi

D. one sigma, two pi

Answer: D

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10. The state of hybridization of the central atom and the number of lone pairs over the central atom in $POCl_3$ are

A. $sp, 0$

B. $sp^2, 0$

C. $sp^3, 0$

D. $dsp^2, 1$

Answer: C

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11. The paramagnetic behaviour of B_2 is due to the presence of

A. 2 unpaired electrons in $\pi_b MO$

B. 2 unpaired electrons in $\pi^* MO$

C. 2 unpaired electrons in $\sigma^* MO$

D. 2 unpaired electrons $\sigma_b MO$

Answer: A

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12. Which of the following compounds shows ionic, covalent and co-ordinate bonds as well ?

A. $NaOH$

B. $NaCl$

C. $NaCN$

D. $NaNC$

Answer: D

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13. In which of the following pairs, the two species are not isostructural?

A. PCl_4^+ and $SiCl_4$

B. PF_5 and BrF_5

C. AlF_6^{3-} and SF_6

D. CO_3^{2-} and NO_3^-

Answer: B

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14. The correct order of bond angle of NO_2^+, NO_2 and NO_2^- is

A. $NO_2^+ < NO_2 < NO_2^-$

B. $NO_2^- < NO_2 < NO_2^+$

C. $NO_2^+ < NO_2^- < NO_2$

D. $NO_2 < NO_2^+ < NO_2^-$

Answer: B

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15. Molecular shape of SF_4, CF_4 and XeF_4 are

A. the same, with 1, 2 and 1

B. the same, with 1, 0 and 1

C. different, with 0, 1 and 2

D. different, with 1, 0 and 2

Answer: D

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16. Allyl cyanide has

A. 9 sigma bonds, 4 pi bonds and no lone pair

B. 9 sigma bonds, 3 pi bonds and one lone pair

C. 8 sigma bonds, 5 pi bonds and one lone pair

D. 8 sigma bonds, 3 pi bonds and two lone pairs

Answer: B

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17. In which of the following pairs of molecules/ions, both the species are not likely to exist ?

A. H_2^-, He_2^{2+}

B. H_2^+, He_2^{2-}

C. H_2^-, He_2^{2-}

D. H_2^{2+}, He_2

Answer: D

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18. Stability of the species Li_2, Li_2^- and Li_2^+ increases in the order of

A. $Li_2^- < Li_2 < Li_2^+$

B. $Li_2 < Li_2^+ < Li_2^-$

C. $Li_2^- < Li_2^+ < Li_2$

D. $Li_2 < Li_2^- < Li_2^+$

Answer: C

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19. The structure of XeF_6 is

A. octahedron

B. trigonal bipyramid

C. pentagonal bipyramid

D. tetragonal bipyramid.

Answer: C

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20. Molecular formulae and shapes of some molecules are given below.

Choose the incorrect match.

Formula	–	Shape
$(a) NH_3$	–	Trigonal pyramidal
$(b) SF_4$	–	Tetrahedral
$(c) ClF_3$	–	T-shaped
$(d) PCl_5$	–	Trigonal bipyramidal
$(e) BF_3$	–	Trigonal planar

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21. Correct order of bond length is

A. $CO, CO_2, HCO_2^-, CO_3^{2-}$

B. $CO_2, HCO_2^-, CO, CO_3^{2-}$

C. $CO_3^{2-}, HCO_2^-, CO_2, CO$

D. $CO, CO_3^{2-}, CO_2, HCO_2^-$

Answer: C

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22. Which one of the following properties is not shown by NO ? .

A. Its bond orderis 2.5.

B. It is diamagnetic in gaseous state.

C. It is a neutral oxide.

D. It combines with oxygen to form nitrogen dioxide.

Answer: B

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23. The number of lone pairs of electrons on central atom of H_2O, $SnCl_2$, PCl_3 and XeF_2 respectively are :

A. 2, 1, 1, 3

B. 2,2,1,3

C. 3,1,1,2

D. 2, 1, 2, 3

Answer: A

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24. The correct order of $O-O$ bond length in O_2, H_2O_2 and O_3 is

A. $O_2 > O_3 > H_2O_2$

B. $H_2O_2 > O_3 > O_2$

C. $O_3 > O_2 > H_2O_2$

D. $O_3 > H_2O_2 > O_2$

Answer: B

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25. Identify the T - shaped molecule in the following :

A. BF_3

B. NH_2

C. NF_3

D. ClF_3

Answer: D

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26. The increassing order of bond order of O_2, O_2^+, O_2^- and O_(2)^(--)` is :

A. $O_2^+, O_2, O_2^-, O_2^{2-}$

B. $O_2^{2-}, O_2^-, O_2^+, O_2$

C. $O_2, O_2^+, O_2^-, O_2^{2-}$

D. $O_2^{2-}, O_2^-, O_2, O_2^+$

Answer: D

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27. The species in which the N-atom is in a state of sp hybridisation is

A. NO_2^+

B. NO_2^-

C. NO_3^-

D. NO_2

Answer: A

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28. The ground state magnetic property of B_2 and C_2 molecules will be

A. B_2 paramagnetic and C_2 diamagnetic

B. B_2 diamagnetic and C_2 paramagnetic

C. both are diamagnetic

D.

Answer: A

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29. Which of the following pairs have identical bond order?

A. CN^- and NO^+

B. CN^- and O_2^-

C. CN^- and CN^+

D. NO^+ and O_2^-

Answer: A

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30. Which of the following species is not paramagnetic?

A. NO

B. CO

C. O_2

D. B_2

Answer: B

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31. What will be the shape of the compound MB_4L_2? Here B is bond pair and L is lone pair.

A. Square planar

B. Octahedral

C. Square pyramid

D. Tetrahedral

Answer: A

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32. What is the hybridisation and geometry of the given species? The species are XeF_2 and ICl_2^-

A. sp^3d and trigonal bipyramidal

B. sp^3d^2 and square planar

C. sp^3d and linear

D. sp^3 and irregular tetrahedron

Answer: C

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33. Which of the following has the strongest H - bond?

A. $O-H---O$

B. `S-H---S

C. $F-H---F$

D. $N-H---N$

Answer: C

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34. The intramolecular hydrogen bond is present in

A. phenol

B. o - nitrophenol

C. p - nitrophenol

D. p - cresol

Answer: B

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35. According to molecular orbital theory, which of the following will not be a viable molecule?

A. He_2^{2+}

B. He^{2+}

C. H_2^-

D. H_2^{2-}

Answer: D

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36. Which of the following compounds contain(s) no covalent bond(s)?

$KCl, PH_3, O_2, B_2H_6, H_2SO_4$

A. KCl, B_2H_6, PH_3

B. KCl, H_2SO_{34}

C. KCl

D. KCl, B_2H_6

Answer: C

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37. Total number of lone pair of electrons in 3 I_3^- ion is

A. 3

B. 6

C. 9

D. 12

Answer: C

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38. According to molecular orbital theory, which of the following is true with respect to $LI_2 + \text{and} Li_2 - ?$

A. Both are unstable

B. Li^{2+} is unstable and Li_2^- is stable

C. Li_2^+ is stable and Li_2^- is unstable

D. Both are stable

Answer: D

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39. In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic ?

A. $N_2 \rightarrow N_2^+$

B. $NO \rightarrow NO^+$

C. $O_2 \rightarrow O_2^{2-}$

D. $O_2 \rightarrow O_2^+$

Answer: B

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40. Two pi and half sigma bonds are present in :

A. N_2^+

B. N_2

C. O_2^+

D. O_2

Answer: A

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41. NO^+ has bond order

A. 2

B. 2.5

C. 3

D. 3.5

Answer: C

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42. The shape of ClO_3^- is

A. linear

B. triangular planar

C. pyramidal

D. square planar

Answer: C

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43. The two carbon atoms in calcium carbide are held by which of following bonds ?

A. ionic bonds

B. two sigma bonds

C. two sigma and one coordinate bond

D. two sigma and two π bonds

Answer: D

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44. Which of the following posses net dipole moment ?

A. SO_2

B. BF_3

C. $BeCl_2$

D. CO_2

Answer: A

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45. Which of the following pair contains 2 lone pairs of electrons on the central atom?

A. I_2, H_2O

B. H_2O, NF_3

C. XeF_4, NH_3

D. SO_4^{2-}, H_2S

Answer: A

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46. According to molecular orbital theory, which of the following is true with respect to $LI_2 +$ and$Li_2 -$?

A. Both are unstable

B. Li_2^+ is unstable and Li_2^- is stable

C. Li_2^+ is stable and Li_2^- is unstable

D. Both are stable

Answer: D

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47. Two pi and half sigma bonds are present in :

A. N_2^+

B. N_2

C. O_2^+

D. O_2

Answer: A

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48. Among the following, the molecule expected to be stabilized by anion formation is : C_2, O_2, NO, F_2

A. NO

B. C_2

C. F_2

D. O_2

Answer: B

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49. During the change of O_2 to O_2^-, the incoming electron goes to the orbital:

A. $\sigma^* 2p_z$

B. $\pi 2p_y$

C. $\pi^* 2p_x$

D. $\pi 2p_x$

Answer: C

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50. Among the following species, the diamagnetic molecule is:

A. O_2

B. NO

C. B_2

D. CO

Answer: D

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51. Among the following molecules/ions, C_2^{2-}, N_2^{2-}, O_2^{2-}, O_2

Which one is diamagnetic and has the shortest bond length?

A. C_2^{2-}

B. N_2^{2-}

C. O_2

D. O_2^{2-}

Answer: A

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52. In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic ?

A. $N_2 \rightarrow N_2^+$

B. $NO \rightarrow NO^+$

C. $O_2 \rightarrow O_2^{2-}$

D. $O_2 \rightarrow O_2^+$

Answer: B

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53. The ion that has sp^3d^2 hybridization for the central atom, is :

A. $[ICl_2]^-$

B. $[IF_6]^-$

C. $[ICl_4]^-$

D. $[BrF_2]^-$

Answer: C

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OBJECTIVE TYPE QUESTIONS (B. MULTIPLE CHOICE QUESTIONS) (JEE (ADVANCED) FOR IIT ENTRANCE)

1. The molecular shapes of SF_4, CF_4 and XeF_4 are :

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: D

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2. The correct order of hybridisation of the central atom in the following species NH_3, $[PtCl_4]^{2-}$, PCl_5 and BCl_3 is

(At. No. Pt = 78)

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

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

C. dsp^3, sp^2, sp^3, sdp^3

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

Answer: B

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3. Which of the following are isoelectronic and isostructural ?

$NO_3^-, CO_3^{2-}, ClO_3^-, SO_3$

A. NO_3^-, CO_3^{2-}

B. SO_3, NO_3^-

C. ClO_3^-, CO_3^{2-}

D. CO_3^{2-}, SO_3

Answer: A

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4. Total number of lone pair of electrons in $XeOF_4$ is :

A. 0

B. 1

C. 2

D. 3

Answer: B

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5. Which species has the maximum number of lone pair of electrons on the central atom ? .

A. ClO_3^-

B. XeF_4

C. SF_4

D. $[I_3]^-$

Answer: D

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6. The correct stability order of the following resonance structures is

$(I) H_2C = \overset{+}{N} = \overset{-}{N} \quad (II) H_2\overset{+}{C} - N = \overset{-}{N}$

$(III) H_2\overset{-}{C} - \overset{+}{N} = N \quad (IV) H_2\overset{-}{C} - N = \overset{+}{N}$

A. $I > II > IV > III$

B. $I > III > II > IV$

C. $II > I > III > IV$

D. $III > I > IV > II$

Answer: B

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7. Assuming that Hund's rule is violated the bond order and magnetic nature of the diatomic molecle B_2 is

A. 1 and diamagnetic

B. 0 and diamagnetic

C. 1 and paramagnetic

D. 0 and paramagnetic

Answer: C

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8. The species having pyramidal shape is

A. SO_3

B. BrF_3

C. SiO_3^{2-}

D. OSF_2

Answer: D

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9. The shapes of XeO_2F_2 molecule is

A. Trigonal bipyramidal

B. square planar

C. tetrahedral

D. see - saw

Answer: D

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OBJECTIVE TYPE QUESTIONS (C. MULTIPLE CHOICE QUESTIONS)

1. Paramagnetic species are

A. O_2^-

B. N_2

C. C_2

D. F_2

Answer: A::C

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2. The linear structure is possessed by

A. $SnCl_2$

B. CS_2

C. NO_2^+

D. SF_2

Answer: B::C

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3. Diamangetic species are

A. N_2

B. O_2

C. B_2

D. O_2^{2-}

Answer: A::D

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4. In which of the following pairs, the shapes of the two molecules/ions is same?

A. H_2O, SF_2

B. NH_3, SO_2

C. PF_5, $SbCl_5$

D. XeF_4, SF_4

Answer: A::C

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5. In which of the following pairs of molecules/ ions, the central atoms have sp^2-hybridization ?

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6. In which of the following, the geometry is not correctly given?

A. PH_3: Trigonal pyramidal

B. SiH_4: Tetrahedral

C. ClF_3: Trigonal planar

D. SF_4: Square planar

Answer: C::D

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7. CO_2 is isostructural with

A. $SnCl_2$

B. SF_2

C. $HgCl_2$

D. C_2H_2

Answer: C::D

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8. Hydrogen bonding plays a central role in which of the following phenomena?

A. Ice floats in water.

B. Higher Lewis basicity of primary amines than tertiary amines in aqueous solutions.

C. Formic acid is more acidic than acetic acid.

D. Dimerisation of acetic acid in benzene.

Answer: A::B::D

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9. The compound(s) with two lone pairs of electron on the central atom is (are)

A. BrF_5

B. ClF_3

C. XeF_4

D. SF_4

Answer: B::C

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10. According to molecular orbital theory,

A. C_2^{2-} is expected to be diamagnetic

B. O_2^{2+} is expected to have a longer bond length than O_2

C. N_2^+ and N_2^- have the same bond order

D. He_2^+ has the same energy as two isolated He atom.

Answer: A::C

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11. Which statements are correct for the peroxide ion ?

(1) It has five completely filled anti - bonding molecular orbitals

(2) It is diamagnetic

(3) It has bond order one

(4) It is isoelectronic with neon

A. It has five completely filled anti - bonding molecular orbitals.

B. It is diamagnetic.

C. IT has bond order one.

D. It is isoelectronic with neon.

Answer: B::C

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12. Each of the following options contains a set of four molecules. Identify the option(s) where all four molecules possess permanent dipole moment at room temperature.

A. $NO_2, NH_3, POCl_3, . CH_3Cl$

B. BF_3, O_3, SF_6, XeF_6

C. $BeCl_2, CO_2, BCl_3, CHCl_3$

D. $SO_2, C_6H_5Cl, H_2Se, BrF_5$

Answer: A::D

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OBJECTIVE TYPE QUESTIONS (D. MULTIPLE CHOICE QUESTIONS)

1. Most of the polyatomic molecules except a few such as CO_2 and CS_2 are linear or angular with a bond angle generally somewhat greater than 90° A bond angle is defined as the angle between the direction of two covalent bonds Since the atoms in molecules are in constant motion with respect to each other they are not expected to have a fixed value of bond angle Repulsion between non-bonded atoms alone does not provide an adequate explanation Hybridisation of bonding orbitals an adequate explanation Hybridisation of bonding orbitals also plays a very important role in detrmining the value of bond angle It has been observed that in hybridisation as the s-character of hybrid orbital increases the bond angle increases

Which of the following hybridisation may have more than one type of bond angle ? .

A. The hybridised orbitals are always equivalent in energy and shape.

B. sp hybridised orbitals has more s - character than sp^2 hybridised orbital.

C. Promotion of electron is essential condition prior to hybridisation.

D. The hybridized orbitals are directed in space in some preferred directions to have minimum repulsion between electron pairs.

Answer: C

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2. NO_2^+ is called

A. SF_2

B. H_3O^+

C. XeF_2

D. CO_3^{2-}

Answer: C

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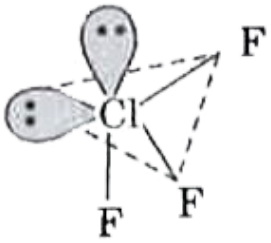
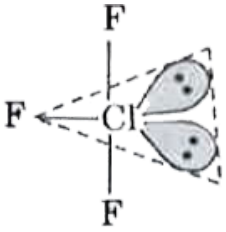
3. In order to explain the characteristic geometrical shapes of polyatomic molecules, Pauling introduced the concept of hybridisation. The orbitals undergoing hybridisation should have nearly same energy. There are various types of hybridisations involving s, p and d - type of orbitals. The type of hybridisation gives the characteristic shape of the molecular or ion.

Which of the following has correct placement of lone pairs and bond pairs?

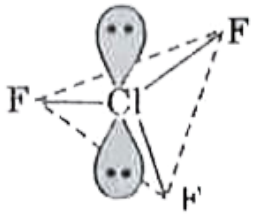
A.



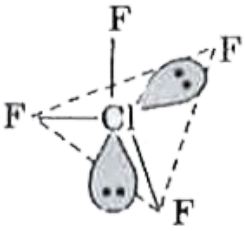
B.



C.



D.



Answer: B

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4. In order to explain the characteristic geometrical shapes of polyatomic molecules, Pauling introduced the concept of hybridisation. The orbitals undergoing hybridisation should have nearly same energy. There are various types of hybridisations involving s, p and d - type of orbitals. The type of hybridisation gives the characteristic shape of the molecular or ion.

Which molecule does not have the same type of hybridisation as P has in PF_5?

A. ClF_3

B. SF_4

C. XeF_4

D. XeF_2

Answer: C

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5. In order to explain the characteristic geometrical shapes of polyatomic molecules, Pauling introduced the concept of hybridisation. The orbitals undergoing hybridisation should have nearly same energy. There are various types of hybridisations involving s, p and d - type of orbitals. The type of hybridisation gives the characteristic shape of the molecular or ion.

Which of the following molecule/ion does not have same number of lone pairs?

A. SF_4

B. PH_3

C. ClO_3^-

D. XeF_2

Answer: D

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6. Molecular orbital theory as developed by Hund and Mulliken concerns with the formation of molecular orbitals formed by linear combination of atomic orbitals. The electrons are present in these molecular orbitals. The molecular orbitals are filled. The molecular orbital configuration helps us to calculate bond order which gives information about the number of bonds present between atoms. The bond order is related to bond length and bond strength.

Which of the following combination does ot give σ MO (assume Z - axis as internuclear axis)

A. $2p_x + 2p_x$

B. $2p_z + 2s$

C. $2s + 2s$

D. $2p_z + 2p_z$

Answer: A

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7. Molecular orbital theory as developed by Hund and Mulliken concerns with the formation of molecular orbitals formed by linear combination of atomic orbitals. The electrons are present in these molecular orbitals. The molecular orbitals are filled. The molecular orbital configuration helps us to calculate bond order which gives information about the number of bonds present between atoms. The bond order is related to bond length and bond strength.

Which one of the following does not have single electron in a bonding molecular orbital?

A. CN

B. B_2

C. NO

D. N_2^+

Answer: C

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8. Molecular orbital theory,bond order of molecules

A. $\sigma^{*}2s$

B. $\sigma 2pz$

C. $\pi 2px$

D. $\sigma 2s$

Answer: B

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9. Molecular orbital theory as developed by Hund and Mulliken concerns with the formation of molecular orbitals formed by linear combination of atomic orbitals. The electrons are present in these molecular orbitals. The molecular orbitals are filled. The molecular orbital configuration helps us to calculate bond order which gives information about the number of bonds present between atoms. The bond order is related to bond length

and bond strength.

Which of the following is expected to have largest bond length?

A. O_2

B. O_2^+

C. O_2^-

D. O_2^{2-}

Answer: D

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10. Molecular orbital theory as developed by Hund and Mulliken concerns with the formation of molecular orbitals formed by linear combination of atomic orbitals. The electrons are present in these molecular orbitals. The molecular orbitals are filled. The molecular orbital configuration helps us to calculate bond order which gives information about the number of bonds present between atoms. The bond order is related to bond length and bond strength.

Which of the following will have maximum number of electrons in antibonding MOs?

A. N_2^+

B. O_2^+

C. F_2

D. Be_2

Answer: C

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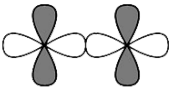
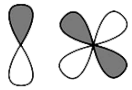
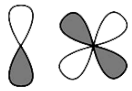
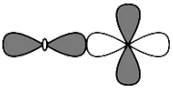
OBJECTIVE TYPE QUESTIONS (D. MULTIPLE CHOICE QUESTIONS)(Matching Type Question)

1. Match the orbital overlap figure in List I with the description given in List II and select the correct answer using the code given below the lists.

Column I		Column II	
(p)		(1)	p – d π -antibonding
(q)		(2)	d – d σ -bonding
(r)		(3)	p – d π -bonding
(s)		(4)	d – d σ -antibonding

A. $\begin{matrix} P & Q & R & S \\ 2 & 1 & 3 & 4 \end{matrix}$

B. $\begin{matrix} P & Q & R & S \\ 4 & 3 & 2 & 1 \end{matrix}$

C. $\begin{matrix} P & Q & R & S \\ 2 & 3 & 1 & 4 \end{matrix}$

D. $\begin{matrix} P & Q & R & S \\ 4 & 1 & 3 & 2 \end{matrix}$

Answer: C

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2. Match the interhalogen compounds of column I with the geometry in column II and assign the correct code

Column I	Column II
(a) XX'	(i) T-shape
(b) XX_2'	(ii) Pentagonal bipyramidal
(c) XX_5'	(iii) Linear
(d) XX_7'	(iv) Square-pyramidal
	(v) Tetrahedral

A. (P) (Q) (R) (S)
(iii) (i) (iv) (ii)

B. (P) (Q) (R) (S)
(v) (iv) (iii) (ii)

C. (P) (Q) (R) (S)
(iv) (iii) (ii) (i)

D. (P) (Q) (R) (S)
(iii) (iv) (i) (ii)

Answer: A

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OBJECTIVE TYPE QUESTIONS (D. MULTIPLE CHOICE QUESTIONS)(Matrix Match Type Question)

1. Match the molecule in Column I with the shape in Column II

Column I	Column II
(A) SF_4	(p) Pyramidal
(B) ClF_3	(q) Square planar
(C) XeF_4	(r) Sea saw
(D) NH_3	(s) T-shaped

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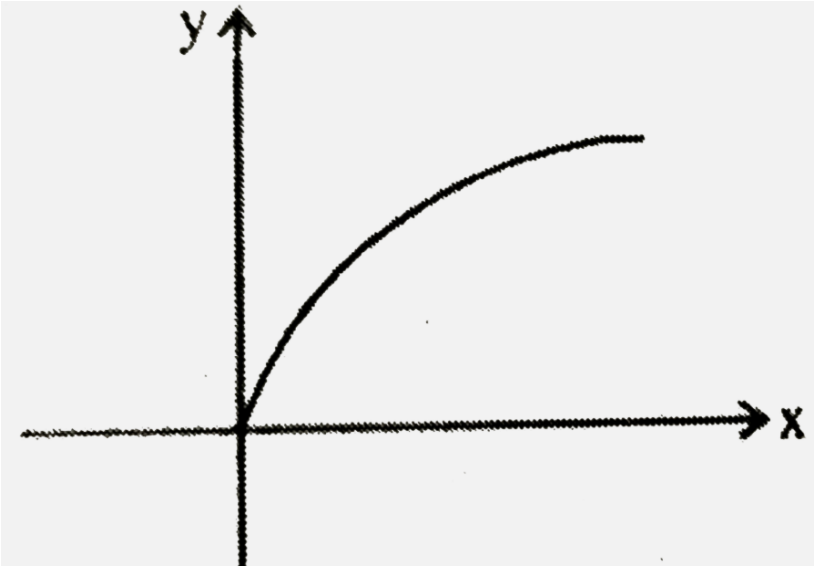
2.



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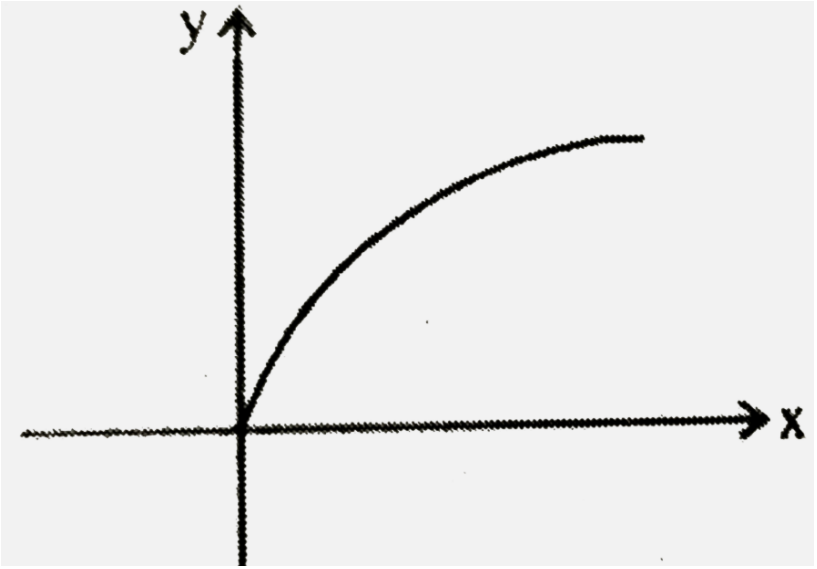
3. 

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4. Match the molecule in Column I with the characteristic in Column II

Column I	Column II
(A) B_2	(p) paramagnetic
(B) N_2	(q) undergoes oxidation
(C) O_2^-	(r) undergoes reduction
(D) O_2	(s) bond order ≥ 2
	(t) mixing of s and p orbitals

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5. Match the species in Column I with bond order in Column II.

Column I	Column II
(A) NO	(*p*) 1.5
(B) CO	(*q*) 2.0
(C) O_2^-	(*r*) 2.5
(D) O_2	(*s*) 3.0

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6. Match the items given in Column I with examples given in Column II.

Column I	Column II
(A) Hydrogen bond	(*p*) C
(B) Resonance	(*q*) LiF
(C) Ionic solid	(*r*) HF
(D) Covalent solid	(*s*) O_3

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OBJECTIVE TYPE QUESTIONS (D. MULTIPLE CHOICE QUESTIONS)(Integer Type Questions)

1. The number of molecules or ions having bond order 2.5 among $O_2^+, CN, NO, N_2^+, CO^+, NO^+, O_2^-, CN^-, N_2,$ is

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2. Total number of molecular orbitals occupying one or two electrons in O_2^+ is

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3. Total number of coordinate bonds present in $CuSO_4.5H_2O$ is

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4. Total number of electrons present in πMOs in B_2 molecule is

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5. The number of molecules having more than one lone pair among the following :

$XeF_4, ClF_3, NH_3, SF_4, XeF_2, BrF_5, H_2O$

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6. Number of molecules having dipole moment among : $BF_3, H_2O, NH_3, H_2S, CO_2$, trans - 1, 2 - dichloroethene, CH_3Cl, CCl_4 HI` is

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7. Find the total number of polar molecules

$SF_4, PCl_5, PCl_3F_2, SF_6, XeF_2, NO_2^+, BF_2Cl, BF_3, PF_3Cl_2$

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8. $COCl_2$ is a poisonous gas. The formal charge on O atom is

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9. The number of 90° bond angles present in SF_4 molecules is

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10. Total number of lone pairs present in the structure of HNO_3 is

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11. Based on VSEPR theory, the number of 90 degree F-Br-F angles in BrF_5, is

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12. A list of species having the formula of XZ_4 is given below $XeF_4, SF_4, SiF_4, BF_4^-, BrF_4^-, [Cu(NH_3)4]^{2+}, [FeCl_4]^{2-}, [CoCl_4]^{2-}$

and $[PtCl_4]^{2-}$

Defining shape on the basis of the locatiion of X and Z atoms, the total number of species having a square planar shape is

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13. Among the triatomic molecules/ions $BeCl_2, N_3^-, N_2O, NO_2^+, O_3, SCl_2, lCl_2^-, l_3^-$ and XeF_2, the total number of linear molecules (s)/ion(s) where the hybridisation of the central atom does not have contribution from the d- orbitals (s) is [atomic number of $S = 16, Cl = 17, I = 53$ and $Xe = 54$]

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14. Among $H_2, He_2^+, Li_2, Be_2, B_2, C_2, N_2, O_2^-$ and F_2, the number of diamagnetic species is

(Atomic numbers: $H = 1, He = 2, Li = 3, Be = 4, B = 5, C = 6, N = 7, O = 8, F = 9$)

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15. The sum of the number of lone pair of electrons on each central atom in the following species is

$[TeBr_6]^{2-}$, $[BrF_2]^{2+}$, SNF_3, and $[XeF_3]^-$

(Atomic number : N = 7, F = 9, S = 16, Br = 35, Te = 52, Xe = 54)

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UNIT PRACTICE TEST

1. Assertion : Bond length of O_2 is more than that of O_2^+.

Reason : Bond order of O_2^+ is more than that of O_2.

A. Assertion and reason both are correct statements and reason is correct explanation for assertion.

B. Assertion and reason both are correct statements but reason is not correct explanation for assertion.

C. Assertion is correct statement but reason is wrong statement.

D. Assertion is wrong statement but reason is correct statement.

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2. The bond angle in H_2O molecule is less than that of NH_3 molecule because_____.

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3. Which one of the following pairs of species have the same bond order ?

A. O_2^- and CN^-

B. NO^+ and CN^-

C. CN^- and CN^+

D. NO^+ and CN^+

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4. The hybridization of atomic orbitals of nitrogen is NO_2^+, NO_3^-, and NH_4^+ respectively are

A. sp^3, sp^2 and sp respectively

B. sp, sp^3 and sp^2 respectively

C. sp^2, sp^2 and sp^3 respectively

D. sp, sp^2 and sp^3 respectively

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5. The incorrectly matched pair among the following is :

Molecule	Shape
$(a) XeF_4$	Square planar
$(b) ClF_3$	T shaped
$(c) BrF_5$	Trigonal bipyramidal
$(d) XeF_2$	Linear

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6. Is there any change in hybridisation of the B and N atom as a result of the following reaction?

$BF_3 + NH_3 \rightarrow F_3B.NH_3$

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7. Which of the two will have dipole moment?

cis or trans $-C_2H_2Cl(2)$

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8. Which has higher dipole moment & why: NH_3, NF_3 ?

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9. Do ortho- nitrophenol and para - nitrophenol have hydrogen bonding in their molecules? Explain which of the two has higher boiling point?

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10. Giving one example explain the shapes of following molecules :

(i) Molecule containing one lone pair and four bond pairs.

(ii) Molecule containing two lone pairs and three bond pairs.

(iii) Molecule containing two lone pairs and two bond pairs.

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11. Explain the following :

(i) Ionic compounds have high melting and boiling points.

(ii) Ice floats over water.

(iii) BeH_2 molecule has zero dipole moment although although the $Be-H$ bonds are polar.

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12. Discuss the shapes of following molecules using VSEPR model :

(i) $SiCl_4$ (ii) PH_3 (iii) $BeCl_2$

Which of these is/are polar molecules.

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13. (a) What is resonance ? Write resonance structures of carbon doxide molecule.

(b) Using the concept of hybridisation explain the shapes of

(i) C_2H_4 and (ii) C_2H_2 molecules.

(c) State the type of hybrid orbitals associated with

(i) P in PF_5 and

(ii) S in SF_6

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