CHEMISTRY

BOOKS - PRADEEP CHEMISTRY (HINGLISH)

CHEMICAL BONDING AND MOLECULAR STRUCTURE

SAMPLE PROBLEM

1. Write the Lewis dot structure of CO molecule .

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2. Write the Lewis dot structure of the nitrite ion $\left(NO_2^{\Theta}\right)$.

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3. Draw the Lewis structure of HCN.

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4. Write the Lewis dot structure of CO_3^{2-} ion .

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5. Calculate formal charge on each O-atom of O_3 molecule.

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6. Calculate the formal charge on

(i) $Cl \text{ in } HClO_4$

(ii) $S \text{ in } HSO_4^-$

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7. Write the formal charges on atoms in (i) and carbonate ion (ii) nitrite ion.

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8. In a moleculte A - B, electronegativities of atom A and B are 2.0 and 4.0 respectively. Calculate the percent ionic character of A- B bond using (i) Pauling equation (ii) Hannay and

Smith equation.

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9. Calculate the percent ionic character of HCl. Given that the observed dipole moment is 1.03 D and bond length of HCl is 1.275 .

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10. The dipole moment of LiH is 1.964×10^{-29} Cm and the interatomic distance

between Li and H in the molecule is 1.596Å . Calualate the persent ionic character of the molecule .

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11. Calculate the fractional charge on each atom in HBr molecule. Given that

Dipole moment of BHr = 0 . 78 D, Bond distance of HBr = $1.41\ \text{Å}$. Electronic charge , e = 4.8×10^{-10} esu

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PROBLEM

1. Explain the sturcture of CO_2 molecule in terms of reasonance,

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

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3. Draw the most common five resonating structures of benzene. What are their names ?

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EXAMPLE

1. Cyanogen $(CN)_2$, is called pseudohalogen because if has some properties similer to halogens

Its structures consisits of two CN groups linked toghether. These two CN group linked together. These two CN groups may be linked either through

carbon or through nitrogen,i.e., we may have

c- N- N - C or N - C- C - N `

which of these is correct and why ?

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2. On the basis of VSEPR theory, predict the shapes of the following :

$(i) CIF_3 (ii) BrF_5 (iii) NH_2^- (iv) H_3O^+$

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TEST YOUR GRIP (MULTIPLE CHOICE QUESTIONS I)

1. The electronic configuration of two elements X and Y are given below:

$X = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ and $Y = 1s^2 2s^2 2p^6 3s^2 3p^5$ The formula of the ionic compound can be formed between these elements is

A. XY

B. XY_2

C. X_2Y

D. XY_3

Answer: B

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2. Which of the following contains both covalent and ionic bond?

A. $\mathbb{C}l_4$

B. $CaCl_2$

C. NH_4Cl

D. H_2O

Answer: C

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3. Soperoctet molecule is

A. CiF_3

B. NH_3

C. PCl_3

D. CO_2

Answer: C

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4. In OF_2, the number of bond pairs and lone pairs of electrons are respectively,

A. $2, 0$

B. $2, 8$

C. $2, 10$

D. $2, 9$

Answer: B

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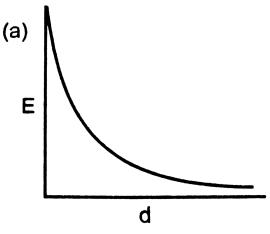
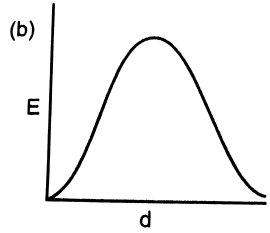
5. When two hydrogen atoms approach each other to form H_2 molecule, the potential energy

diagram obtained is : (d = interatomic distance)

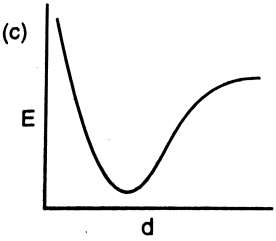
A.



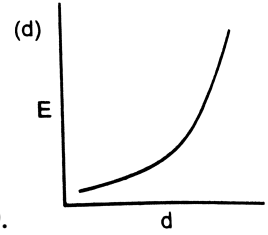
B.



C.



D.



Answer: C

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6. The number of σ and π- bonds in allyl isocyanide are

A. $9\sigma, 3\pi$

B. $9\sigma, 9\pi$

C. $3\sigma, 4\pi$

D. $5\sigma, 7\pi$

Answer: A

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7. Which contains both polar and non-polar bonds ? .

A. NH_4Cl

B. HCN

C. H_2O_2

D. CH_4

Answer: C

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8. Which one of the following has the highest dipole moment ?

A. NH_3

B. PH_3

C. SbH_3

D. AsH_3

Answer: A

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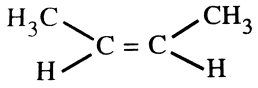
9. Which of the following hydrocarbons has the lowest dipole moment ?

A. 

B. $CH_3 - C \equiv CCH_3$

C. $CH_2CH_2C \equiv CH$

D. $CH_2 \equiv CH - C \equiv CH$

Answer: B

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10. A neutral molecule XF_3 has a zero diple moment. The element X is most likely :

A. chlorine

B. boron

C. nitrogen

D. bromine

Answer: B

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11. Polarizing power Cd^{2+} on the anions is stronger then that of Ca^{2+} ion. This is because

A. atomic number of Cd is greater than that of Ca

B. atomic mass of Cd is greater than that Ca

C. size of Cd^{2+} ion is larger than that of Ca^{2+} ions

D. Ca^{2+} ions has noble gas configuration white Cd^{2+} ion has pseudo noble gas configuration with

18 electrons in its outer shell

Answer: D

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12. In which of the following the central atoms does not use sp^3 hybrid orbitals in its bonding

A. BeF_3^-

B. OH_3^-

C. NH_2^-

D. NH_3

Answer: A

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13. In an octahedral structure , the pair of d orbitals involved in d^2sp^2 hybridization is

A. $d_{x^2-y^2}, d_{z^2}$

B. $d_{xz}, d_{x^2-y^2}$

C. d_{z^2}, d_{xz}

D. d_{xy}, d_{yz}

Answer: A

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14. The correct order regarding the electronegativity of hybrid orbitals of carbon is ?

A. $sp < sp^2 > sp^3$

B. $sp < sp^2 < sp^3$

C. $sp > sp^2 > sp^2$

D. $sp > sp^2 > sp^3$

Answer: D

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15. The bond angle formed by different hybrid orbitals are in the order

A. $sp^2 > sp^3 > sp^3$

B. $sp^3 > sp^2 > sp$

C. $sp > gp^3 > sp^2$

D. $sp > sp^2 > sp^3$

Answer: D

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16. The structure of IF_7 is

A. Trigonal bipyramid

B. Octahedral

C. Pentagonal bipyramid

D. Square pyramid

Answer: C

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17. Which one of the following molecules has the smallest bond angle ?

A. NH_3

B. PH_3

C. H_2S

D. H_2Se

Answer: D

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18. Molecular shape 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. the same with 0,1 and 2 lone pairs of electrons respectively

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

Answer: D

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19. In BrF_3 molecule, the lone pairs occupy requatorial position to minize

A. lone pair - bond pair repulsion only

B. bond pari - bond pair repulsion only

C. lone pair - lone pair repulsion and lone pair-bond pair repulsion

D. lone pair - lone pair repulsion only

Answer: D

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20. Which of the following molecular orbitals has two nodal planes ?

A. σ_{2s}

B. $\pi 2_{p_y}$

C. $\pi^* 2p_y$

D. $\sigma^* 2p_x$

Answer: C

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

A. Li_2

B. Be_2^+

C. Be_2

D. B_2

Answer: C

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22. Choose the paramagnetic oxide in the following

A. Na_2O

B. MgO

C. BeO

D. KO_2

Answer: D

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

A. O_2

B. O_2^+

C. O_2^-

D. O_2^{2-}

Answer: B

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24. In which of the following , the double bond consists of both pi bonds

A. O_2

B. C_2

C. Be_2

D. S_2.

Answer: B

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25. The correct statement with regard to H_2^+ and H_2^- is

A. both H_2^+ and H_2^- do not exist

B. H_2^- is more stable than H_2^+

C. H_2^+ is more stable than H_2^-

D. both H_2^+ and H_2^- are equally stable

Answer: C

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26. The bond order of the N-O bonds in NO_3^- ion is

A. 0.33

B. 1.00

C. 1.33

D. 1.50

Answer: C

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27. Which of the following molecule forms linear polymeric structure due to H-bonding ?

A. HCl

B. HF

C. H_2O

D. NH_3

Answer: D

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28. Which of the following is arranged in the increasing order of enthalpy of vaporization?

A. $NH_3. PH_3. AsH_3$

B. AsH_3, PH_3, NH_3

C. $NH_3. AsH_3, Ph_3$

D. PH_3, AsH_3, NH_3

Answer: D

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29. KF combination with HF to form KHF_2. The compound contains the species

A. $K_{+}.\ F^{-}$ and H^{+}

B. K^{+}, F^{-} and HF

C. K^{+} and $[HF_2]^{-}$

D. $[KHF]^{+}$ and F_2 .

Answer: C

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30. Intramolecular hydrogen bonding is present in

A. water

B. o-nitrophenol

C. p-nitrophenol

D. methyl amine

Answer: B

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31. Which of the following hydrogen halide is liquid at room temperature ?

A. HF

B. HCl

C. HBr

D. HI

Answer: A

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TEST YOUR GRIP (FILL IN THE BLANKS II)

1. When electrons are contributed by one atom but shared by both the atoms so as to complete their octets, the bond formed is called

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2. For the formation of an ionic bond between two atoms, one atom should have ..... And the other atom should have .....

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3. The energy relesed when gaseous positive and negtive ions combine together to form an ionic bond is called .....

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4. Write the Lewis dot structure of CO_3^{2-} ion .

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5. $AlCl_3$ is ..... Compound whereas PCl_5 is ..... compound in terms of octer rule.

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6. The shape of the molecule containing 3 bond pairs and one lone pair around the central atom is .....

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7. The energy released when gaseous hydrogen atoms combine together to form one of hydrogen

molecules is ..... $KJmol^{-1}$.

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8. When atomic orbitals overlap head-on , the bond formed is ..... Whereas when they overlap laterally , the bond formed is .....

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9. For the formation of ionic bond between two atoms, the electronegativity difference between them should be greater than or equal to

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10. The CGS unit of dipole moment is ..... Whereas its SI unit is .....

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11. The dipole moment of LiH is 1.964×10^{-29} Cm and the interatomic distance

between Li and H in the molecule is 1.596Å . Calualate the persent ionic character of the molecule .

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12. The shape of acetylene molecule is .....

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13. The dipole moment of H_2O molecule is ..... Whereas that of SF_4 is .....

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14. The difference of energy between the actual structure of molecule and that of the most stable

contributing structure is called.....

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15. Taking Z-axis as the intermolecular axis , when two $2p_x$ orbitals of two atoms/ions overlap, the

molecular orbitals formed are ..... and .....

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16. The bond order of N_2, N_2^+, N_2^- and N_2^{2-} respectively are ....., ... ,..... and ..... .

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17. The bond order of NO_3^- ion is ..... and its shape is .....

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

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19. The bond order of CO molecule is ..... whereas that of CO^+ ion is .....

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20. Out of σ_{2s}, π_{2p_x}, $\pi^*_{2p_z}$

the gerde molecular orbital (s) is (are) ..... Whereas

ungerde molecular orbital (s) is (are) .....

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CONCEPTUAL QUESTIONS

1. Write the Lewis dot symbols and predict the valencies you expect for the following elements :

Nitrogen , Fluorine and Neon

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2. Why an ionic bond is formed between two elements having large difference in their electrongativity ?

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3. Is CaF_2 linear or bent or neither of the two ? Justify .

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

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5. Draw the Lewis structures of the following molecules and ions and ions and tell in which case/cases the octet

rule is violated CO_2, SO_2, $BeCl_2$, NH_3, $AlCl_3$, PCl_5, CO_3^{2-}

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6. On the basis of VSEPR theory, predict the shapes of the following molecules molecules /ions ?

$(i) SiF_4 (ii) NH_2^- (iii) NH_4^+ (iv) C_2H_2 (v) H_3O^+ (vi) F_2O (vii) PCl_3 (viii) PF$

.

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7. Arrange the following in the order of property indicated for each set:

NO_2, NO_2^+, NO_2^- (decreasing bond angle)

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8. 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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9. Explain how VB theory differs from Lewis concept.

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10. Why two hydrogen atoms combine to form H_2 but two helium atoms do not combine to form He_2 ?

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11. What is the total number of sigma and pi bonds in the following molecules ? (a) $C_2H_3Cl (b) CH_2Cl_2$

$(c) H_3C - \overset{H}{\overset{|}{C}} = \overset{H}{\overset{|}{C}} - C - H$

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12. What order or C-H bond lengths do you expect in C_2H_6, C_2H_4 and C_2H_2 and why ?

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13. Which bond do you expect to be stronger in each of the following cases and why ?

(i) $H-H, Cl-Cl (ii) O_2, N_2 (iii) F-F, Cl-Cl$

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14. Arrange the following single bonds in order of bond energy giving reasons :

$C-C, N-N, O-O, F-F$

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15. Explain why dipole moment of hydrogen halides decreases from HF to HI

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16. Respresent diagrammatically the bond moments and the resultant dipole moment in

$(i) SO_2$ (ii) cis trans forms of $C_2H_2Cl_2$

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

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18. Why reaction between $NaCl$ and $AgNO_3$ is very fast but reaction between H_2 and Cl_2 is slow ?

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19. Draw the shapes of the following hybrid orbitals :

sp, sp^2, sp^3

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20. Name the type of hybridisation of each C-atom in a molecule of (i) propylene (propene) (ii) propyne.

How many σ and π-bonds are present in each case ?

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21. Out of p - orbital and sp-hybrid orbital which has greater directions character and why ?

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22. What angles are associated with the following orbitals ?

sp, sp^2 and sp^3

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23. Which d-orbital is involved in sp^3d hydridisation and why ?

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24. Which d-orbital is involved in dsp^2 hybridisation why ?

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25. What is the hybrid state of $BeCl_2$? What will be the change in the hybrid state of $BeCl_2$ in the solid state ?

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26. Arrange the following in order of decreasing bond angles

$(i) CH_4, NH_3, H_2O, BF_3, C_2H_2$ $(ii) NH_3, NH_2^-, NH_4^+$

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27. Write the structure of an anion which is isostructural with BF_3 and the structure of a cation which

is Isostural with CH_4

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28. Why axis bonds of PCl_5 are longer than equatorial bonds ?

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29. Name the different type of bonds present in NH_4Cl after drawing its structure.

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30. Write two resonance structure of N_2O that satisfy the octet rule.

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31. Which of the following species have same shape/same bond order ?

N_3^- , NO_2^- , CO_2, O_3

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32. Taking Z-axis as the internuclear axis, explain why $2p_x$ or $2p_y$ orbital does not combine with 2s

obtial to form molecular orbtals ?

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33. Compara the relative stablilties of O_2^- and N_2^- and comment on their magnetic (paramagetic or diamagnetic) behaviour.

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34. (a) How bond energy veries from N_2^- to N_2^+ and why ?

(b) On the basis of molecular orbital theory what is similartiy between

(i) F_2, O_2^- (ii) CO, N_2, NO^+ ?

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35. N_2 has higher order than NO. Explain .

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36. Ethanol has higher boiling point diethyl ether or ethyl amine. Why ?

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37. Why water has maximum density at 277 K ?

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38. How many H-bonds are formed by each H_2O molecule and how many water moleculas are attached

to each water molecule and in what diraction ?

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39. Though Cl has nearly same electronegativeity as N, yet there is no H-bonding is HCl . Why ?

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40. Explain why HF is less viscous than H_2O .

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41. From each of the following pairs, select the molecule with higher value of the property mentioned against each pair :

NH_3, PH_3: bond angle

$(ii) NF_3$, NH_3 : dipole moment

(iii) MgO, CaO: hardness

(iv) HCl, HBr : ionic character

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42. Account for the following :

The experimentally determined N_F bond length in NF_3 is greater than the sum of the sigle covalent radii of N and F.

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NCERT Questions And Exercises With Answers

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^{-}

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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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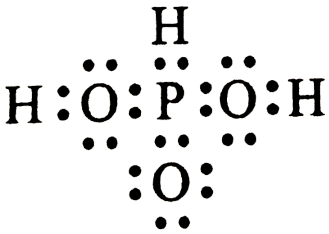
12. H_3PO_3 can be represented by the structures 1 and 2 shown below . Can these two structrue be

taken as the canonical forms of the resonance hybrid of H_3PO_3? If not ,given reason for the same



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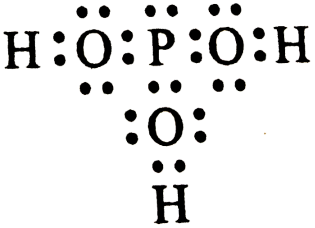

(2)

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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. Write the significance/applications 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 following molecules in order ionic character of their bonds

$LiF, K_2O, N_2, SO_2, ClF_3$

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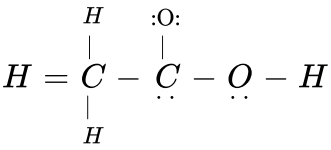
20. The skeletal structure of CH_3COOH as shown below is correct , but some of the bonds are shown

incorrectly . Write the correct Lewis structure for a acetic acid.



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21. Apart from tetrahedral geometry, another possible geometry for CH_4 is square planar with four

H atoms at the corners of the square and the C atom as 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 ment 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. What is the change in hybridization (if any) of the Al atom in the following reaction.

$AlCl_3 + Cl^- \rightarrow AlCl_4^-$

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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 ? $(a)s$ and $1s(b)1s$ and $2p_x(c)2p_y$ and $2p_y$ (d) 1s and 2s`.

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30. Which hybrid orbitals are usel 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.

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

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

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

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36. Write the significance of a plus ans 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 $N_2, O_2, O_2^{\oplus}$ and $O_2^{\ominus}$.

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NCERT EXAMPLAR PROBLEMS (MULTIPLE CHOICE QUESTIONS -I)

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

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

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

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. The types of hybrid orbitals of nitrogen in NO_2^+, NO_3^- and NH_4^+ respectively are expected to be :

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: B

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4. 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. $HF > H_2O > NH_3$

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 PO_4^{3-} ion, the formal charge on the oxygen atom of P-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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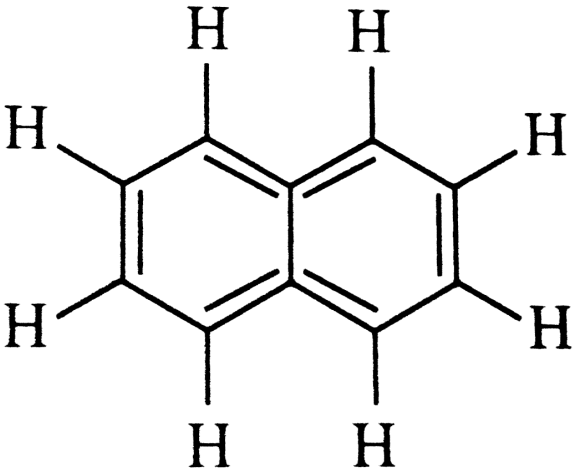
8. Number of π bonds and σ bonds in the following

structer is



A. 6, 19

B. 4, 20

C. 5, 19

D. 5 , 20

Answer: C

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9. Which molecule/ion out of the following 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 substance will

hydrogen bond be strongest ?

A. HCl

B. H_2O

C. HI

D. H_2S

Answer: B

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12. If the electron configuration of an element is $1s^2, 2s^2, 2p^6, 3s^2, 3p^2, 3d^2, 4s^2$, the 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. Which of the following angle corresponds to sp hydridisation ?

A. 90°

B. 120°

C. 180°

D. 109°

Answer: B

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14. The electronic configurations of three elements,

A,B are C are given below. Answer the

questions 14 to 17 on the basis of these

configurations .

A	$1s^2$	$2s^2$	$2p^6$		
B	$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^3$
C	$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^5$

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 configurations of three elements,

A,B are C are given below. Answer the

questions 14 to 17 on the basis of these

configurations .

A	$1s^2$	$2s^2$	$2p^6$		
B	$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^3$
C	$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^5$

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

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

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

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

Answer: A

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19. Which of the following statement is not correct from the view point of molecular orbital theory?

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 to homonuclear diatomic molecular belonging to the second period

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

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

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 outer most 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::B

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22. Amongst the following elements whose electronic configuration are given below, the one having the highest ionisation enthalpy is

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

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

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

D. $[Ar]3d^{10} 4s^2 4p^3$

Answer: A::D

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NCERT EXAMPLAR PROBLEMS (MULTIPLE CHOICE QUESTIONS -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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NCERT EXAMPLAR PROBLEMS (MULTIPLE CHOICE QUESTIONS -1)

1. Which of the following attain the linear structure ?

A. $BeCl_2$

B. NCO^+

C. NO_2

D. CS_2

Answer: C::D

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2. CO is isoelectronic with

A. NO^+

B. N_2

C. $SnCl_2$

D. NO_2^-

Answer: C::D

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

A. CO_2

B. CCl_4

C. O_3

D. NO_2^-

Answer: A::D

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

A. The hybridisation of central atom is sp^3

B. Its resonance structrue has cone C-O single

bond and two C= O double bonds

C. The average formal charge on each oxygen atom in 0 . 67 units

D. All C-O bond length are equal .

Answer: C::D

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5. Dimagnetic species are those which contain no unpaired electrons. Which among the followig are diamagnetic ?

A. N_2

B. N_2^{2-}

C. O_2

D. O_2^{2-}

Answer: A::D

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6. 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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7. Which of the following statements are not correct ?

A. NaCl being an ionic compound is a good conductor of elecricity 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 square planar geometry o f XeF_4.

Answer: A::B

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NCERT EXAMPLAR PROBLEMS (SHORT ANSWER 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 molecular 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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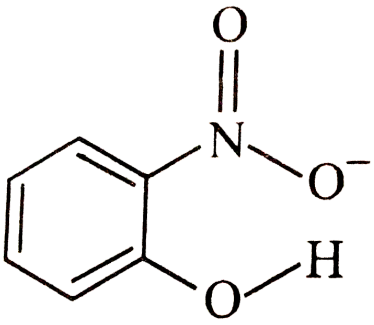
4. Structrues of moleculars of two compounds are shown on the side .

(a) Which of the two compounds will have intermolecular

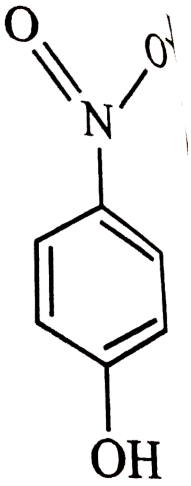
hydrogen bonding and which compounds is expected to show intermolecular hydrogen bonding ?

(b) The melting point of a compound depends on , among other things, the extent of hydrogen bonding . On this basis explain Which one of the two compounds will show higher melting point.

(c) Solubility of compounds in water depedns on power to form hydrogen bonds with water. Which one of the two compounds will form hydrogen bond with water easily and be more soluble in it .



(I)



(II)

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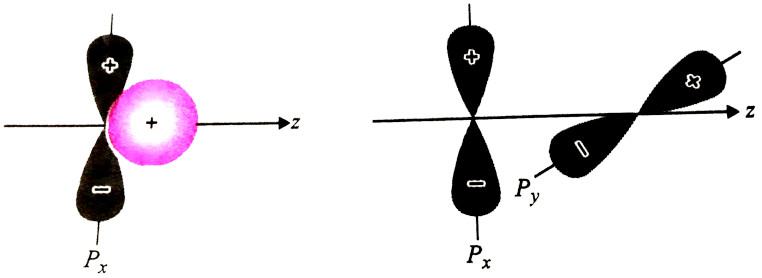
5. Why does type of overlap given in the following figure not result in bond formation ?



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

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7. In both water and dimethyl ether $\left(CH_3 - \ddot{O} - CH_3\right)$, oxygen atoms is central atom, and has the same hybridisation, 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) Etyne 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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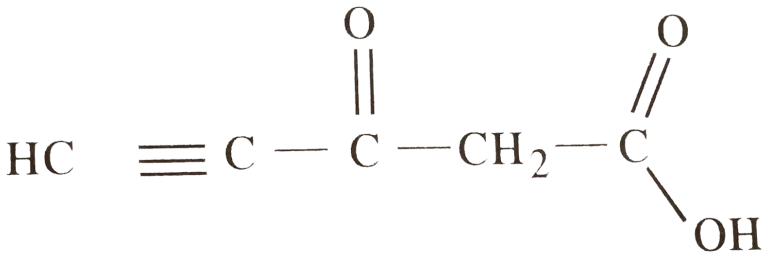
15. Predict the hybridisation of each carbon in the molecule of organic compound given below. Also indicate the total number of sigma and pi bonds in this molecule.



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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?

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NCERT EXAMPLAR 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
A.	H_3O^+	1.	Linear
B.	$HC \equiv CH$	2.	Angular
C.	ClO_2^-	3.	Tetrahedral
D.	NH_4^+	4.	Trigonal bipyramidal
		5.	Pyramidal

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

Column I	Column II
$(i) NO$	(a) 1.5
$(ii) CO$	(b) 2.0
$(iii) O_2^-$	(c) 2.5
$(iv) O_2$	(d) 3.0

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

	Column I	Column II
A.	Tetrahedral	1. sp^2
B.	Trigonal	2. sp
C.	Linear	3. sp^3

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NCERT EXAMPLAR 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.

A. A and R both are correct, and R is the correct ecplanation of A.

B. A and R both are correct, But R is not the correct ecplanation of A .

C. A is true but R is false .

D. A and R both are false.

Answer: A

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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.

A. A and R both are correct, and R is the correct ecplanation of A.

B. A and R both are correct, But R is not the correct ecplanation of A .

C. A is true but R is false .

D. A and R both are false.

Answer: A

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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.

A. A and R both are correct, and R is the correct ecplanation of A.

B. A and R both are correct, But R is not the correct ecplanation of A .

C. A is true but R is false .

D. A and R both are false.

Answer: D

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NCERT EXAMPLAR 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_6 The axial bonds are longer as compared to equatorial 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 EXAMPLAR PROBLEMS (MULTIPLE CHOICE QUESTIONS BASED ON THE GIVEN COMPREHENSION)

1. Which of the following statements is correct ?

A. In the formation of dioxygen form 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 orbitals will not be same as total number of antibonding orbitals in dioxygen.

D. Number of filled bonding orbitals will be same as number of filled antibonding orbitals

Answer: a

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

A. $\sigma^* 1s$

B. $\sigma^* 2p_z$

C. $\pi 2p_x$

D. $\pi^* 2p_y$

Answer: D

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3. 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. 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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ADDITIONAL QUESTIONS (VERY SHORT ANSWER QUESTIONS)

1. Define octet rule.

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2. In terms of ionization enthalpy and electron gain enthaply , what type of atoms combine to form an

ionic compound ?

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3. What is coordination number of Na^+ and Cl^- ion in Nacl ?

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4. Write down the Lewis structures of : (i) $CO_2 (ii) CN^-$

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5. Identify the compound/comounds in the following in which S does not obey the octet rule.

SO_2, SF_2, SF_4, SF_6

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6. On the basis of VESPR theory predict the shape of H_3O^+ ion.

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7. On the basis of VSEPR theory, explain why ozone is a bent molecule and not a linear mulecular ?

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8. How does velence bond theory, explain the existence of H_2 but non-existence of He_2?

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9. What orbitals can overlap to form a σ-bond and which orbitals can overlap to form a π-bond?

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10. Why free rotation about a π-bond is not possible ?

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11. Arrange in order of increasing bond strengths : F_2, N_2, O_2, Cl_2

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12. Arrange the molecules H_2, O_2, F_2 and N_2 in order of increasing bond lengths.

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13. Which of the following has maximum bond angle ? H_2O, CO_2, NH_3, CH_4.

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14. 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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15. Predict the dipole moment of a molecule of the type AX_4 with square planar arrangement of X atoms

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16. What are SI units of dipole moment?

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17. Which of the following molecule/moleculas will have zero dipole moment ?

$CO_2, H_2OCCl_4, CHCl_3, BF_3, BeF_2, NH_3.$

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18. Why covalent molecules show isomerism but ionic compound do not ?

Watch Video Solution

19. What is the hybridisation of the central atom in (i) $H_3O^+ (ii) XeF_2 (iii) XeF_4$? What are their shapes ?

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20. Name one compound each involving sp^3, sp^2 and sp hybridisation.

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21. Name the shapes of the following molecules : CH_4, $C_2H_2mCO_2$

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22. What type of hybridisation is involved in SF_6 ?

Watch Video Solution

23. Write the state of hybridisation of boron in BF_3.

Watch Video Solution

24. Give the structure of sulphur tetrafluoride .

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25. BH_4^- and NH_4^+ are isolobal . Explain.

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

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27. Give the hybridisation and shape of (i) $NO_3^- ion (ii) CO_3^{2-}$ ion.

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28. Draw the structure of H_2SO_4 . What is hybridisation of S-atom in it ?

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29. Out of the following, select the compounds containing ionic, covalent and coordinate bonds.

$CaCl_2, C_2H_6, MgO, HCI, \overset{\oplus}{N}H_4, O_3$

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30. What is valence boned approach for the formation of covalent bond and a coordinate bond ?

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

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32. Out of bonding and antibonding m.o.'s, which one has lower energy and which one has higher stablility ?

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33. What happens to the probability of finding the electron in the m.o.'s after the combination of two

atomic orbitals ?

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34. How is bond order related to the stability of a molecule ?

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35. How is bond order related to bond length of a molecular ?

Watch Video Solution

36. Which type of atomic orbitals can overlap to from molecular orbitals ?

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37. Define the term 'bond order' and find bond order of O_2.

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

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39. Why N_2 is more stable than O_2 ? Explain on the basis of molecular orbital theory .

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40. The bond order in He_2^+ ions is :

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41. Write which one out of O_2^+ and O_2^{2-} is more stable on the basis of bond order calculations .

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

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

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44. Arrange the following molecular species in increasing order of stability . N_2, N_2^+ , N_2^- , N_2^{2-}

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45. How is bonding molecular orbital of hydrogen different from the antibonding molecular orbital ?

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46. Define bonding molecular orbital.

Watch Video Solution

47. Define antibonding molecular orbitals .

Watch Video Solution

48. How will bond order in N_2 and O_2 be influenced in the following ionization process ?

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

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49. What is magnetic character of anion of KO_2?

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50. How many nodal planes are present in $\pi(2p_x)$ and $\pi^*(2p_x)$ molecular orbitals ?

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51. What are the conditions which must be satisfied for H-bonding to take place in a molecule.

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52. Arrange the following as stated.

"Increasing strength of hydrogen bonding $(X - H - X)$

O, S, F, Cl, N

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53. Represent hydrogen bonding between two molecular of (i) acetic acid

(CH_3COOH) (ii) acetamide

(CH_3CONH_2).

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54. Why is H_2O a liquid and H_2S a gas ?

Watch Video Solution

55. Why HF has higher boiling point than HCl ?

Watch Video Solution

56. Why ethyl alcohol is competely miscible with water ?

Watch Video Solution

57. You are given the electronic configuration of five neutral atoms - AB, B, C, D and E

$A-1s^2 2s^2 2p^6 3s^2, B-1s^2, 2s^2 2p^6 3s^1, C-1s^2 2s^2 2p^1, D-1s^2 2s^2 2p^5, E-$

Write the empirical formula for the substance containing (i) A and D (ii) B and D (iii) only D

(iv) only E ?

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ADDITIONAL QUESTIONS (SHORT ANSWER QUESTIONS)

1. What do you understand by a chemical bond ?

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2. Briefly explain Kossel-Lewis approach of chemical bonding

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3. Why are the noble chemical reactants ?

Watch Video Solution

4. Explain the term electrovalency.

Watch Video Solution

5. What is an electrovalent bond (or ionic bond) ? Explain its formation witht two suitable example

Watch Video Solution

6. An element A conbines with element B . An atom of A contains two electrons in its outermost shell

whereas that of B has six electrons iin its outermost shell. Tow electrons are transferred from the atom A to

the atom B

(a) What is the nature of bond between A and B ? (b) What is the electronic structure of AB ?

(c) What is the electrovalency of a and that of B ?

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7. Briefly explain the factors which influence the formation of ionic compounds .

Watch Video Solution

8. Define Lattice energy . On what factors does it depend ? How does it help to predict the stability of the

ionic compound formed ?

Watch Video Solution

9. What are the important characteristice of ionic compounds ?

Watch Video Solution

10. $NaCl$ is a better conductorof elelctricity in a molten condition than in the solid state . Explain

Watch Video Solution

11. Given reason for the following :

(i) Ionic compounds are soluble in water whereas covalent compounds are mostly insoluble in water

(ii) Ionic compounds have higher melting points than the covalent compounds .

(iii) NaCl solution gives a white ppt with $AgNO_3$ solution but CCl_4 or choroform does not.

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12. What is meant by a covalent bond ? Explain with three suitable examples . What are the conditions for the formation of this type of bond ?

Watch Video Solution

13. Explain the term covalency .

Watch Video Solution

Watch Video Solution

14. What are Lewis structures ? Wrtie the Lewis structures of $H_2, F_2, H_2O, NH_3, C_2H_4$ and C_2H_2

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15. How is the formal charge on an atom in molecule/ion calculated ? Explain taking the example of ozone molecule.

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16. Illustrate the indadequacy of octet rule with two suitable examples. Give the Lewis structure of these

molecules.

Watch Video Solution

17. predict the shapes of the following molecules using the valence shell electron pair repulsion modal.

$(i) BeCl_2 (ii) (SiF_4 (iii) BF_3 (iv) NH_3 (v) H_2O.$

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18. What happens when two hydrogen atoms approach each other ?

Watch Video Solution

19. Briefly discuss the orbital concept of covalent bond formation taking suitable examples .

Watch Video Solution

20. What is valence bond approach of covalent bond ? Given two examples to illustrate it .

Watch Video Solution

21. Differentiate between σ and π bond .

Watch Video Solution

22. Explain how the strength of a bond is related to (i) extent of overlapping (ii) shape of the orbital.

Watch Video Solution

23. What are sigma and pi bonds ? Explain the different ways of their formation diagrammatically. Which one

of them is stronger and why ?

Watch Video Solution

24. Arrange the following according to bond length giving reasons :

(i) $H-F, H-Cl, H-Br, H-I$(ii) C - C , C= C, C = C (iii) C - H bond length in CH_4, C_2H_4 and C_2H_2

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25. Define the term Electronegativily. Explain it with one suitalbe example . How does it help in predicting

whether a covalent bond is polar or non-polar ? Explain each case with one example .

Watch Video Solution

26. what do you understand by partial ionic character of covalent bonds ?

Watch Video Solution

27. Define Dipole moment . Draw dipole diagrams of H_2O and BF_3 .

Watch Video Solution

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

Watch Video Solution

29. 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?

Watch Video Solution

30. Give reason for the following : (i) In solution, reactions of covalent compounds are show but those of ionic

compounds are fast (ii) Covalent compounds show isomerism but ionic compound do not.

Watch Video Solution

31. What type of hybridisation is associated with the central when the atoms attached to it form

(a) an equilateral triangle (b) a regular tetrahedron ?

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32. Explain why carbon has a valency of four and not two and why are the four C-H bonds in methane identical .

Watch Video Solution

33. Making use of the concept of hybridisation, predict the shape of C_2H_2 molecule .

Watch Video Solution

34. Draw shapes of H_2O and C_2H_4 .

Watch Video Solution

35. Draw well labelled orbital diagrams for the following molecules :

(i) $BeF_2(ii)BF_3(iii)NH_3(v)C_2H_6$.

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36. Explain the shapes of SF_4 and CIF_3

Watch Video Solution

37. Why PCl_5 dissociates to give PCl_3 and Cl_2?

Watch Video Solution

38. Why the equatiorial and axial bond lengths of PCl_5 are not equl ?

Watch Video Solution

39. Which hybridization is presumed for P in PF_3 and S in SF_6 ? Give reasons for your answer .

Watch Video Solution

40. What is a coordinate bond ? Explain with two suitable example . How is it different from a covalent bond ?

Watch Video Solution

41. What is resonance ? Define Resonance energy .

Watch Video Solution

42. Draw the resonating structures of CO_2 ?

Watch Video Solution

43. Sketch the shapes of molecular orbitals formed by the overlap of

(i) two s-orbitals , (ii) End on overlap of two p-orbitals . (iii) Side on overlap of two p-orbitals .

Name the orbitals formed in each case .

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44. What do you understand by a molecular orbitals (m.o.) ? What is the maximum number of electrons that

can occupy a molecular orbitals ? How many m.o.'s of H_2O originate from the hydrogen 1s atomic orbitals ?

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45. What is meant by bonding and antibonding molecular orbitals ? Give the number of electrons which occupy the bonding orbitals in H_2^+, H_2 and He_2.

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46. What are the condition for combination of atomic orbitals ? Which species out of H_2, H_2^+ and H_2^- are paramagnetic and why ?

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47. 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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48. What is meant by bond order ? Calculate the bond order of He_2^+, O_2 and N_2 molecules .

Watch Video Solution

49. Calculate the bond order for H_2^+ ion. Is this ion expected to be paramagnetic of diamagnetic and why ?

Watch Video Solution

50. Arrange the following molecular species in increasing order of satbility (giving bond orders) :-

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

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51. Explain why the bond in H_2^+ is longer than that in H_2.

Watch Video Solution

52. Give the molecular orbitals energy diagram for oxygen molecule and account for its paramagnetic property.

Watch Video Solution

53. Distinguish two aspects of bonding and antibonding orbitals .

Watch Video Solution

54. 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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55. What information does M.O. theory provide for O_2, O_2^+, O_2^- and O_2^{2-} molecular species with regard to

(i) Dissociation energy (ii) Bond length ?

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56. What is bond order? Discuss its significance.

Watch Video Solution

57. On the basis of M.O. theory , show that Ne_2 does not exist .

Watch Video Solution

58. Draw MO Energy leval diagram for nitrogen molecule and find its bond order and magnetic behaviour.

Watch Video Solution

59. Account for the following : (i) Water is a liquid while H_2S is a gas .

(ii) NH_3 has higher boiling point than PH_3

(iii) Boiling point of HF is lower than that of water .

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60. Explain why ordinarily H_2S is a gas while H_2O a liquid even through both S and O are elements of the

same group in the periodic table and S has a higher atomic mass.

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61. What requirement should a molecule fulfil for the formation of a hydrogen bond ?

Watch Video Solution

62. Explain the following observations :

(i) CO_2 and SO_2 are not isostructural. (ii) O_2^- is paramagnetic but O_2^{2-} is not .

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ADDITIONAL QUESTIONS (LONG ANSWER QUESTIONS)

1. What do you mean by a chemical bond ? How do atoms combine ? How many types of bonds are there ?

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2. What are essential conditions for the formation of an ionic bond ? Explaiin the formation of an ionic bond

between an atom of Na and Cl .

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3. Describe various characteristics of electrovalent compounds .

Watch Video Solution

4. What are sigma and pi bond ? Explain the different ways of their formation diagrammatically . Which one of term is stronger and why ?

Watch Video Solution

5. Explain the term bond length , bond energy and bond angle .

Watch Video Solution

6. Define dipole moment . Discuss its important applications .

Watch Video Solution

7. List various characteristics of covalent compounds . Differentiate between electrovalent and covalent compounds .

Watch Video Solution

8. Define the term 'hybridisation'. Using the concept of hybridisation , explain the shapes of PCl_5 and SF_6 molecules .

Watch Video Solution

9. On the basis of hybridization , explain the shape of iodine deptafluoride and sulphur tetrafluoride .

Watch Video Solution

10. What is Resonance ? Explain with a suitable example . Difine Resonance energy.

Watch Video Solution

11. How is the moleculer orbital different from an atomic orbital ? Given the number of electrons which occupy

the bonding molecular orbitals in H_2^+ and H_2 .

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12. write the molecular orbital configurations of the species : $(a)N_2(b)N_2^+(c)N_2^-(d)N_2^{2-}$

(ii) Calculate their bond orders (ii) Predict their paramagnetic behaviour

(iii) Which of these shows highest paramagnetism ?

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13. what are the main points of similarity and difference between valence bond theory and molecular orbital theory .

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ANALYTICAL QUESTIONS AND PROBLEMS WITH ANSWERS/SOLUTIONS (Questions)

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

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ANALYTICAL QUESTIONS AND PROBLEMS WITH ANSWERS/SOLUTIONS

1. Out of MgO and CaO, which one is more hard and why ?

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2. Why is solubility of $MgCl_2$ much greater than that of MgF_2 ?

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

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

Watch Video Solution

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

Watch Video Solution

6. 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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7. Which is more polar and why, CO_2 or N_2O?

Watch Video Solution

8. Why AlF_3 is a high melting solid wheareas SiF_4 is a gas ?

Watch Video Solution

9. Why NF_3 pyramidal but BF_3 is triangular planar ?

Watch Video Solution

10. 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 ?

Watch Video Solution

11. Why bond angle in H_2O is nearly 104.5° but that in H_2S , it is nearly 90° ?

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

Watch Video Solution

13. Can we have a diatomic molecule with its ground state moleculer orbitals full with electrons ? Give a reason for your answer .

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14. Out of H and H_2 , the latter has higher first ionization energy while out of O and O_2 , the former has higher first ionization energy . Explain why .

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15. Given reason for the following :

H_2^+ and H_2^- ions have the same bond order but H_2^+ ions are more stable than H_2^- .

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

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17. When we move from HF to HCl , the boiling point sharply but on moving further to HBr and HI the boiling point increases . Why ? Or Out of HF, HCl , HBr and HI which has boiling point and why ?

Watch Video Solution

18. Out of o-nitrophenod and p-nitrophenol, which has higher boiling point and why ?

Watch Video Solution

19. Why glucose, fructose, sucrose etc. are soluble in water through they are covalent compounds ?

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20. Using the VSEPR theory, identify the type of hybridisation and draw the structure of OF_2.What are the oxidation states of O and F?

Watch Video Solution

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

But -1- ene or But -1- yne

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

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23. Using VSEPR thory, draw the molecular structures of OSF_4 and XeF_4 indicating the lacation of

lone pair(s) of electrons and hybridisation of central atoms .

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24. Which of the following species has the shortest bond length ?

NO, NO^+, NO^{2+}, NO^-

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25. Sodium metal vaporises on heating and the vapour will have diatomic molecular of sodium (Na_2). What type of bonding is presetn in these moleculas ? Justify your answer .

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26. Arrange the following in order of (i) increasing N-O bond length (ii) increasing bond angles

NO_2^+ , NO_2^- , NO_3^- Give reasons .

Watch Video Solution

27. Explain the shape of I_3^- ion .

Watch Video Solution

28. Which of the following have identical bond order?

(I) CN^-

(II)O_2^-

(III)NO^+

(IV) CN^+

Watch Video Solution

29. Arrange the following compounds in the icreasing order of bond length of O-O bond O_2, $O_2[AsF_6]$, KO_2 and peroxide ion. Explain on the basis of ground state electronic configuration of dioxygen in these molecules.

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30. Indicate the type of bonds present in NH_4NO_5 and state the mode of hybridisation of two N atom in it .

Watch Video Solution

31. Draw the Lewis structures of the species : CN^-, I_3^-, C_3O_2 (carbon suboxide), HN_3 (hydrazonic acid).

Watch Video Solution

32. Why PCl_5 exists but NCl_5 does not ?

Watch Video Solution

33. Name and represent the type of bonds present in $CuSO_4.5H_2O$.

Watch Video Solution

34. In each of the following pairs of compounds, which one is more covalent and why ?

(i) $AgCl, AgI$

(ii) $BeCl_2, MgCl_2$

(iii) $SnCl_2, SnCl_4$

(iv) CuO, CuS

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35. Give reason for the following :

The molecule of $MgCl_2$ is linear while that of stannous chloride is angular.

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36. Explain why bond angle of NH_3 is greater than NF_3 while bond angle of PH_3 is less than that of PF_3,

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37. When 2s orbital overlaps with $2p_x$ or $2p_y$ orbital (assuming Z -axis as the internuclear axis) threr is a partical overlap and they do not form any MO Explain why ? .

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38. What would be the electronic configuration of HeH^- molecular ion ? Calculate its bond order and comment on its stability .

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39. H_2, Li_2 and B_2 all have the same bond order , viz, 1. Thun why they have different stabilities ? Arrange them in order of stability.

Watch Video Solution

40. Arrange the given dicarbon species in order of their bond lengths giving reasons L C_2, C_2^-, C_2^{2-} .

Watch Video Solution

41. Explain giving reasons whether BH_4^- and H_3O^+ will have same or different geometry .

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42. In both water and diethyl ether, the central atom viz. O-atoms has same hybridisation . Then why have they different bond angles ? Which one has greater bond angle ?

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43. BCl_3 is planar but anhydrous $AlCl_3$ is tetrahedral . Explain .

Watch Video Solution

44. Calculate the percentage of p-character in the orbitals forming P-P bonds in P_4 molecule.

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45. Explain whether H^+ ions will have greater mobility in ice or liquid water .

Watch Video Solution

ANALYTICAL QUESTIONS AND PROBLEMS WITH ANSWERS/SOLUTIONS (PROBLEMS)

1. The dipole momnet of KCI is $3.336 \times 10^{-29} Cm$ which indicates that it is a highly polar molecules. The inter atomic distance between $K^{\oplus}$ and CI^{Θ} in this molecules is 2.6×10^{-10} m Calculate the dipole moment of KCI molecule if there were opposite charges of one fundamental unit located at each nucleus Calculate the ionic character percentage of KCI

.

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2. Anhydrous $AlCl_3$ is covalent. From the date given below, predict whether it would remain covalent or become ionic in aqueous solution. (Ionisation energy for Al is $1537 kJmol^{-1}$)

$\Delta_{\text{hydration}} f \text{ or } Al^{3+} = -4665 kJmol^{-1}$

$\Delta_{\text{hydration}} f \text{ or } Cl^{\Theta} = -381 kJmol^{-1}.$

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3. The observed value of dipole moment of H_2O molecule is found to be 1 .84 D. Calculate the $H-O-H$ bond angle in H_2O molecule , given that the bond moment of O-H bond is 1.5 D.

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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (I. MULTIPLE CHOICE QUESTIONS WITH ONE CORRECT ANSWER))

1. It is believed that atoms combine with each other such that the outermost shell acquires a stable configuration of 8 electrons. If stability were attained with 6 electrons rather than 8. What would be the formula of the stable fluoride ion.

A. F^-

B. F^+

C. F^{2+}

D. F^{3+}

Answer: B

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2. In which of the following compounds does not central atom obey the octet rule ?

A. XeF_4

B. $XeOF_2$

C. SCl_2

D. $AlCl_3$

Answer: C

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3. Based on lattice energy and other considerations which one of the following alkali metal chlorides is expected to have the highest melting point

A. LiCl

B. NaCl

C. KCl

D. RbCl

Answer: B

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4. 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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5. In which of the following the central atom has two lone pairs of electrons ?

A. SF_4

B. BrF_5

C. SO_2

D. XeF_4

Answer: D

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6. 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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7. 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_4

C. KCl

D. KCl, B_2, H_2

Answer: C

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8. Which of the following has a regular geometry

A. $CHCl_3$

B. PCl_3

C. XeF_6

D. SF_4

Answer: A

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9. Predict the correct order of repulsions among the following :

A. bond pair-bond pair $>$ lone pair-bond pair $>$

lone pair -lone pair

B. lone pair-bond pari $>$ bond pair-bond pair $>$

lone pair-lone pair

C. lone pair -lone pair $>$ lone pair-bond pair $>$

bond pair-bond pair

D. lone pair-lone pair $>$ bond pair-bond pair $>$

lone pair-bond pair

Answer: C

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

A. 3

B. 6

C. 9

D. 12

Answer: D

Watch Video Solution

11. The strength of the covalent bond in H_2, F_2 and

HF is in the order

A. $H - H > F - F > H - F$

B. $H - F > F - F > H - H$

C. $H - F > H - H > F - F$

D. $F - F > H - F > F - F$

Answer: C

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

A. one sigma , one pi

B. one sigma , two pi

C. two sigma, one pi

D.

Answer: B

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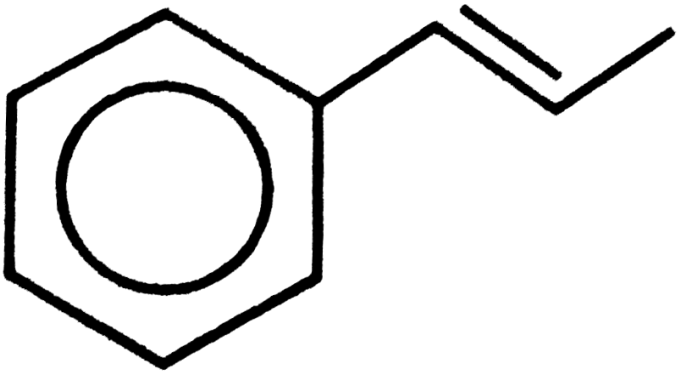
13. How many bonds are there in



A. $14\sigma, 8\pi$

B. $18\sigma, 8\pi$

C. $19\sigma, 4\pi$

D. $14\sigma, 2\pi$

Answer: C

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14. In $\left[Ag(CN)_2\right]^-$, the number of π bonds is

A. 2

B. 3

C. 4

D. 6

Answer: C

Watch Video Solution

15. Which of the following species contains equal number of pi and pi bonds ?

A. $(CN)_2$

B. $CH_2(CN)_2$

C. HCO_3^-

D. XeO_4

Answer: D

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16. The covalent bond length is the shortest in which of the following bonds

A. C-O

B. C-C

C. $C \equiv N$

D. $O - H$

Answer: D

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17. v_100_subject_string_diff_newFlow

A. $50\ \%$

B. $72.24\ \%$

C. $55.3\ \%$

D. $43\ \%$

Answer: B

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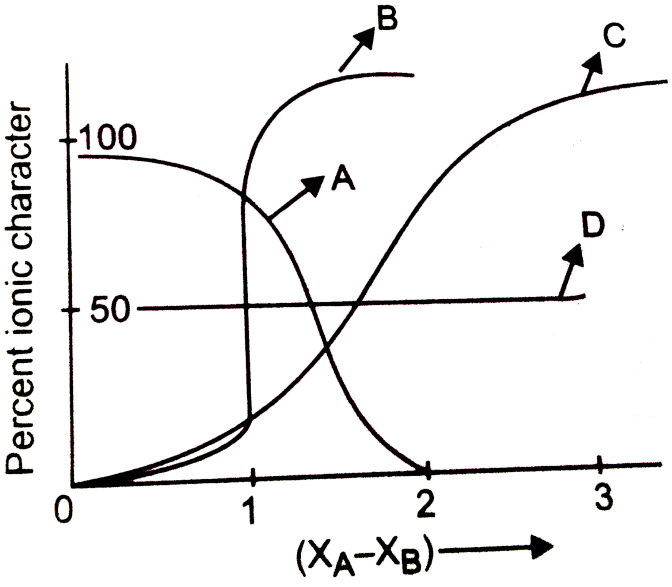
18. For AB bond if percent ionic character is plotted against electronegativity difference $(X_A - X_B)$, the shape of the curve would look like



A. A

B. B

C. C

D. D

Answer: C

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19. Arrange the following compounds in order of increasing dipole moment, Ethylbenzene (I), m-dichlorobenzene (II), o-dichlorobenzene (III), p-dichlorobenzene (IV)

A. $I < IV < II < III$

B. $IV < I < II < III$

C. $IV < IIII < II$

D. $IV < II < I < III$

Answer: B

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20. Among the following, the molecule with the highest dipole moment is :

A. $\mathbb{C}l_4$

B. NH_3

C. H_2O

D. $CHCl_3$

Answer: C

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21. Which one of the following arrangements of molecules is correct on the basic of their dipole moments?

A. $BF_3 > NF_3NH_3$

B. $NF_3 > BF_3 > NH_3$

C. $NH_3 = NF_3 > BF_3$

D. $NH_3 > NF_3 > BF_3$

Answer: D

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22. Among the following, the molecule with the highest dipole moment is

:

A. CH_3Cl

B. CH_2Cl_2

C. $CHCl_2$

D. $\mathbb{C}l_4$

Answer: A

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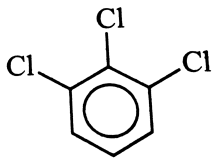
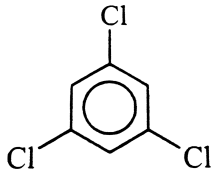
23. Which of the following has maximum dipole moment?

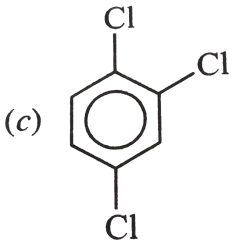
A. (a)



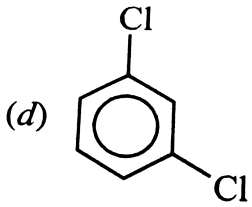
B. (b)



C. (c)



D. (d)



Answer: A

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24. Which are non-polar molecules?

$I.\ NCl_3$ $II.\ SO_3$ $III.\ PCl_5$

The correct option is :

A. I only

B. II only

C. I and II only

D. II and III only

Answer: C

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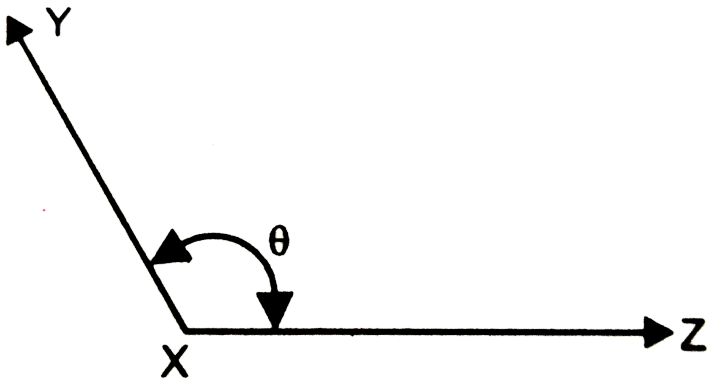
25. Which bond angle θ would result in the maximum dipole moment for the triatomic molecule, XY_2 shown below ?



A. 90°

B. 120°

C. 150°

D. 180°

Answer: A

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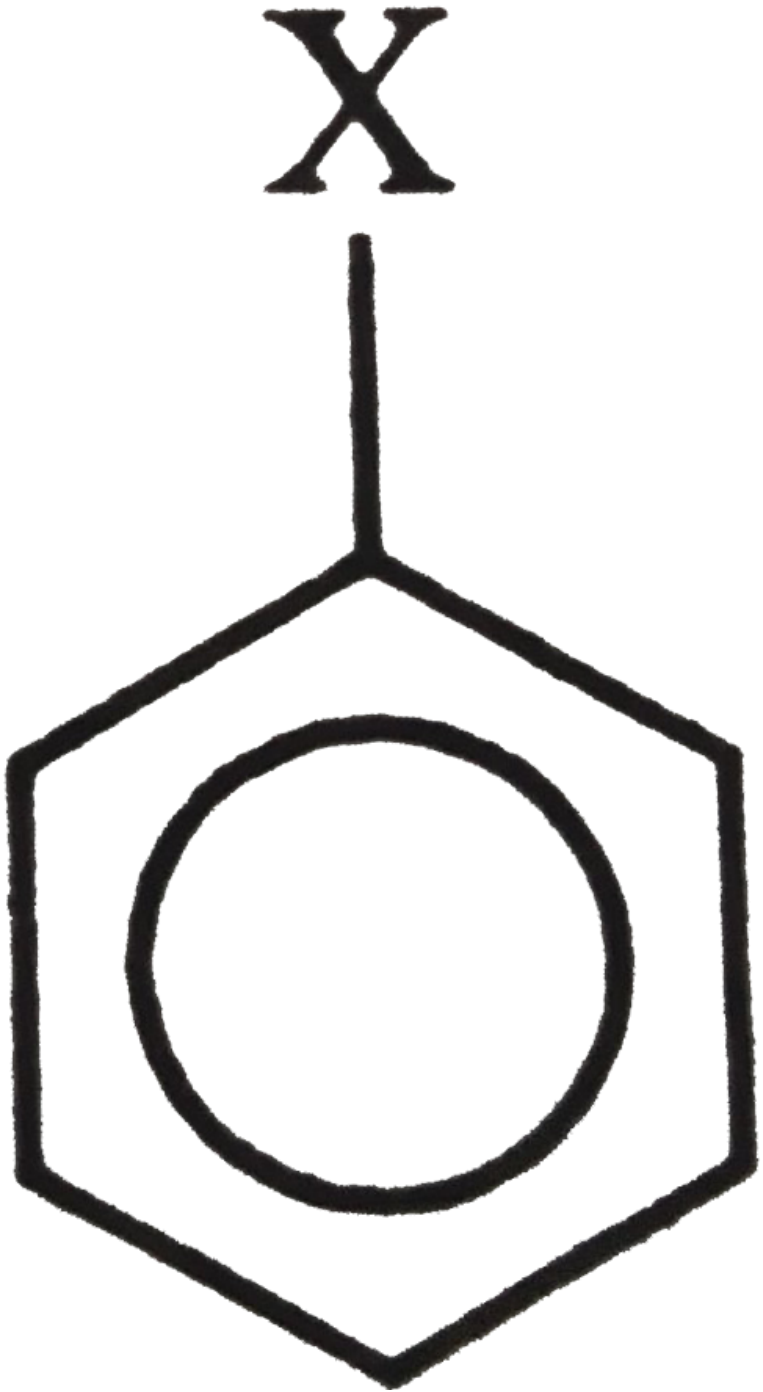
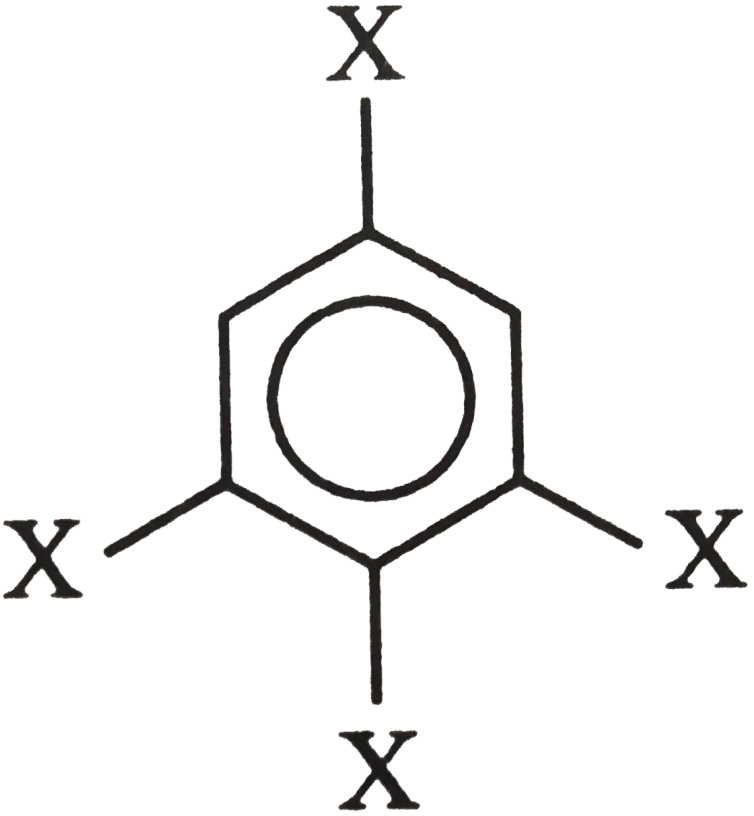
26. The dipole moment of



The dipole moment of



A. $1.5D$

B. $2.25D$

C. 1 D

D. 3 D

Answer: A

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27. The correct order of increasing polarising power of the cations in the following $AlCl_3$, $MgCl_3$, $NaCl$ is

A. $AlCl_3 < MgCl_2 < NaCl$

B. $MgCl_2 < NaCl < AlCl_3$

C. $NaCl < MgCl_2 < AlCl_3$

D. $NaCl < AlCl_3 < MgCl_2$

Answer: C

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28. The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic species, K^+, Ca^{2+}, Mg^{2+}, Ba^{2+}?

A. $Ca^{2+} < Mg^{2+} < Be^{2+} < K^{+}$

B. $Mg^{2+} < Be^{2+} < K^{+} < Ca^{2+}$

C. $Be^{2+} < K^{+} < Ca^{2+} < Mg^{2+}$

D. $K^{+} < Ca^{2+} < Mg^{2+} < Be^{2+}$

Answer: D

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29. Which of the following is a polar molecule ?

A. BfF_3

B. SF_4

C. SiF_4

D. XeF_4

Answer: B

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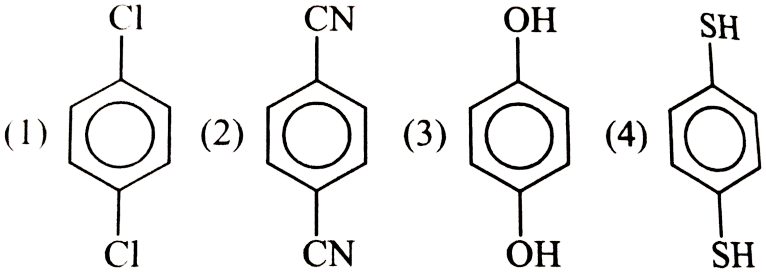
30. For which of the following molecules, significant

$\mu \neq o$?



A. 3 and 4

B. Only 1

C. 1 and 2

D. 4 only

Answer: A

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31. Some ether is added to anb aqueous soluetion of a mixtrue of $LiCl, NaCl$ and $AlCl_3$. Which will be extracted into ether ?

A. $LiCl, NaCl$

B. $LiCl, AlCl_3$

C. $NaCl, AlCl_3$

D. $LiCl, NaCl, AlCl_3$

Answer: B

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32. Among the following species, identify the isostuctural pairs

$NF_3. NO_3^-, BF_3, H_3O, HN_3$

A. $\left[NF_3, NO_3^-\right]$ and $\left[BF_3, H_3^+O\right]$

B. $[NF_3, NH_3]$ and $\left[NO_3^-, BF_3\right]$

C. $\left[NF_3, H_3^+o\right]$ and $\left[NO_3^-, BF_3\right]$

D. $\left[NF_3, H_3^+O\right]$ and $[HN_3, BF_3]$

Answer: C

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

A. SO_3^{2-}, NO_3^{9-}

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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34. The type of hybrid orbitals used by chlorine atom in ClO_3^- is

A. sp^3

B. sp^2

C. sp

D. none of these .

Answer: A

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35. Which one of the following compounds has sp^2 hybridisation ? .

A. CO_2

B. SO_2

C. N_2O

D. CO.

Answer: B

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

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

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

C. sp^2, sp and sp^3 respectively

D. sp^2, sp^3 and sp^3 respectively.

Answer: B

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37. 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^2, sp^2, sp^3, dsp^3

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

Answer: B

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38. The shapes of SF_4 and XeF_2 respectively are

A. trigonal bipyramidal and trigonal bipyramidal

B. see-saw and linear

C. T-shape and linear

D. squrae planar and trigonal bipyramidal

Answer: B

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39. The pair having similar geometry is

A. PCl_3, NH_4^+

B. $BeCl_2$, H_2O

C. CH_4, $\mathbb{C}l_4$

D. IF_5, PF_5

Answer: C

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40. The maximum number of 90° angles between bond pair-bond pair of electrons is observed in

A. dsp^3 hybridisation

B. sp^3d hybridisation

C. dsp^2 hybridisation

D. sp^3d^2 hybridisation

Answer: D

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41. The ion with maximum number of lone pairs on the central atom is-

A. ClO_3^-

B. XeF_4

C. SF_4

D. I_3^-

Answer: D

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42. Consider the following molecules or ions :

(i) $CH_2Cl_2 (ii) NH_4^+ (iii) SO_4^{2-} (iv) ClO_4^- (v) NH_3$

sp^3 hybridisation is involved in the formation of

A. (i), (ii), (v) only

B. (i) , (ii) only s

C. (ii) only

D. (i), (ii), (iii), (iv) and (v)`

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43. The hybridization of oxygen atom in H_2O_2 is

A. sp^3d

B. sp

C. sp^2

D. sp^3

Answer: D

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44. SF_2, SF_4 and SF_6 have the hybridisation at sulphur atom respectively as .

A. sp^2, sp^3, sp^3, d^2

B. sp^3, sp^3, sp^3d^2

C. sp^3, sp^3, d, sp^3d^2

D. sp^3, spd^2, d^2sp^3

Answer: C

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45. The percentage of p-character in SF_6 are

A. 120°, $20\ \%$

B. 90°, $33\ \%$

C. 109°, $25\ \%$

D. 90°, $25\ \%$

Answer: B

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46. The percentage of p character of hybrid orbitals in graphite and diamond are respectively

A. 33 and 25

B. 50 and 75

C. 67 and 75

D. 33 and 75

Answer: C

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47. The d-orbital involved in the hybridization in PCl_3 molecule is

A. $3d_{x^2-y^2}$

B. $3d_{z^2}$

C. $3dxy$

D. $4d_{x^2-y^2}$

Answer: B

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48. In which one of the following species the central atom has the type of hybridization which is not the same as that present in the other three ?

A. PCl_5

B. SF_4

C. I_3^-

D. $SbCl_5^{2-}$

Answer: D

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49. Some of the properties of the two species, NO_3^- and H_3O^+ are described below.Which one of them is correct?

A. Dissimilar in hybridization for the central atom with different strcutures

B. Isostructural with same hybridization for the central atom

C. Isostructural with different hybridization for the central atom

D. Similar in hybridization for the central atom with different structures

Answer: A

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

A. $CH_4 \rightarrow C_2H_6$

B. $NH_3 \rightarrow NH_4^+$

C. $BF_3 \rightarrow BF_4^-$

D. $H_2O \rightarrow H_3O$

Answer: C

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51. Which of the two lons from the list given have the geometry that is explained by the same hybridization of orbitals $NO_2^-, NO_3^-, NH_2^- NH_4^+ SCN^-$?

A. NO_4^+ and NH_2^-

B. NO_2^- and NO_3^-

C. NH_4^+ and NO_3^-

D. SCN^- and NH_2^-

Answer: B

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52. The correct sequence of decrease in the bond angles of the following hydrides is

A. $NH_3 > PH_3 > AsH_3 > SbH_3$

B. $NH_3 > AsH_3 > PH_3 > SbH_3$

C. $SbH_3 > AsH_3 > PH_3 > NH_3$

D. $PH_3 > NH_3 > AsH_3 > SbH_3$

Answer: A

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53. The nodal plane in the π-bond of ethene is located in:

A. the molecular plane

B. a plane parallel to the molecular plane

C. a plane perpendicular to the molecular plane

which bisects the carbon-carbon σ-bond at

right angle.

D. a plane perpendicular to the molecular plane

which contains the carbon-carbon σ-bond

Answer: A

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54. Shape of O_2F_2 is similar to that of

A. C_2F_2

B. H_2O_2

C. $H_{2\square}F_2$

D. C_2H_2

Answer: B

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55. The ONO bond angle is maximum in

A. NO_3^-

B. NO_2^-

C. NO_2

D. NO_2^+

Answer: D

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56. In I_3^- , Lewis base is

A. I_2

B. I_2^-

C. I_2^+

D. I^-

Answer: D

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

A. AIF_3

B. NF_3

C. CIF_3

D. BF_3

Answer: C

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58. Which of the following species has a linear shape ?

A. NO_2^+

B. O_3

C. NO_2^-

D. SO_2

Answer: A

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59. If I_2 is dissolved in aqueous KI, the intense yellow species I_3 is formed. The structure of I_3^- ion is

A. Square pyramidal

B. Trigonal bipyramidal

C. Octahedral

D. Pentagonal biypramid

Answer: B

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60. In which pair of species, both species do have similar geometry

A. CO_2, SO_2

B. NH_3, BH_3

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

D. SO_4^{2-} and CIO_4^-

Answer: D

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61. The incorrectly matched pair, among the following is

A.

Molecule	Shape
BrF_5	Trigonal bipyramidal

B.

Molecule	Shape
SF_4	See saw

C.

Molecule	Shape
CIF_3	T-shape

D.

Molecule	Shape
NH_4^+	Tetrahedral

Answer: A

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62. Two types of FXF angles are present in which of the following molecule (X = S, Xe, C)

A. SF_4

B. XeF_4

C. SF_6

D. CF_4

Answer: A

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63. Out of N_2O, SO_2, I_3^+, I_3^-, H_2O, NO_2^- and N_3^-

the linear species are

A. NO_2^-, I_3^+, H_2O

B. N_2O, I_3^-, N_3^-

C. N_2O, I_3^-, N_3^-

D. N^{3-}, I_3^+, SO_2

Answer: C

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64. Which of the following species is non-linear ?

A. ICI_2^-

B. I_3^-

C. N_3^-

D. CIO_2^-

Answer: D

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65. 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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66. The correct order of increasing bond angles in the following species is

A. $ClO_2^- < Cl_2O < ClO_2$

B. $Cl_2O < ClO_2 < ClO_2^-$

C. $ClO_2 < Cl_2O < ClO_2^-$

D. $Cl_2O < ClO_2^- < ClO_2$

Answer: A

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67. Among the following molecules : SO_2, SF_4, CIF_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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68. XeF_2 is isostructural with

A. TeF_2

B. ICI_2^-

C. $SbCl_3$

D. $BaCl_2$

Answer: B

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69. 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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70. Consider the molecules CH_4, NH_3 and H_2O which of the given statement is false ?

A. The H-O-H bond angle in H_2O is smallar

than H-N-H bond anlge in NH_3

B. The H-C-H 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, the H-N-H

bond angle in NH_3 and $H-O-H$ bond angle

in H_2O are all greater than 90°

D. The H-O-H bond angle in H_2O is larger than

H-C-H bond angle in CH_4

Answer: D

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71. The species having bond angle of 120° is

A. PH_3

B. ClF_3

C. NCl_3

D. BCl_3

Answer: D

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

A. $BeCl_2, XeF_2$

B. Tel_2, XeF_2

C. Ibr_2^-, XeF_2

D. IF_3, XeF_2

Answer: C

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73. Which one of the following contains ionic , covalent and coordinate bonds ?

A. $NaOH$

B. NaCl

C. NaCN

D. NaNC

Answer: D

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74. Which of the following has $p\pi - d\pi$ bonding ?

A. NO_3^-

B. SO_3^{2-}

C. BO_3^{3-}

D. CO_3^{2-}

Answer: B

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75. 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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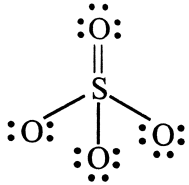
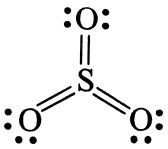
76. Which of the following is a the most preferred and hence of the lower energy for SO_3?

A. 

B. 

C. (c) 

D. (d) 

Answer: D

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77. Consider the statements :

I . Bond length in $N_2^+ is 0.002Å$ greater than in N_2

II. Bond length in $NO^+ is 0.09Å$ less than in NO

III. O_2^{2-} has shorter bond length than O_2

which of the following statements are ture ?

A. I and II

B. II and III

C. I, II and III

D. I and III

Answer: A

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

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

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

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

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

Answer: D

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79. In which of the following ionixation processes , the bond order has increased and the magnetic behaviour has changed ?

A. $N_2 \rightarrow N_2^+$

B. $C_2 \rightarrow C_2^+$

C. $NO \rightarrow NO^+$

D. $O_2 \rightarrow O_2^+$

Answer: C

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80. The species having bond order different from that in CO is

A. NO^-

B. NO^+

C. CN^-

D. N_2

Answer: A

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

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

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

(v) NO^{2-}

A. $A < D < C < B < E$

B. $D = B < A < E \leq C$

C. $E < A < D = C < B$

D. $B < C < D < A < E$

Answer: C

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82. 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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83. The magnetic moment of KO_2 at room temperature is --------- BM.

A. 1.41

B. 1.73

C. 2.23

D. 2.64

Answer: B

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84. 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: D

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

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

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

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

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

Answer: D

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86. Four diatomic species are listed below in different sequences. Which of these represents the correct order of their increasing bond order?

A. $O_2^- < NO < C_2^{2-} < He_2^+$

B. $No < C_2^{2-} < O_2^- < He_2^+$

C. $C_2^{2-} < He_2^+ < NO < O_2^-$

D. $He_2^+ < O_2^- < NO < C_2^{2-}$

Answer: D

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87. Which one of the following pairs of species have the same bond order ?

A. O_2^- and CN^-

B. NO^+, CN^+

C. CN^- and NO^+

D. CN^- and CN^+

Answer: C

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88. 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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89. Consider the following species

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

Which one of these will hqave the highest bond order ?

A. CN^+

B. CN^-

C. NO

D. CN

Answer: B

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90. During change of $NO^+ \rightarrow NO$, the electron is added to

A. σ orbital

B. π orbital

C. σ^* orbital

D. π^* orbital

Answer: D

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91. The common featrues among the species CN^-, CO and CO^+ are

A. Bond order three and isoelectronic

B. Bond order three and weak-field ligands

C. Bond order two and π – acceptor

D. Isoelectronic and weak-field ligands

Answer: A

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92. Which is the correct statement about σ and π molecular orbitals? Statements are

(i) π bonding orbitals are ungerade

π antibonding orbitals are ungerade

(iii) σ antibonding orbitals are gerade

A. 1 only

B. 2 and 3 only

C. 3 only

D. 2 only

Answer: A

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

A. 1 and diagagnetic

B. 0 and diamagnetic

C. 1 and paramagnetic

D. 0 and paramagnetic

Answer: A

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94. 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. (iii) and (iv)

B. (i) , (ii) and (v)

C. (ii) and (iii)

D. (i) and (v)

Answer: C

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95. The pairs of species of oxygen and their magnetic behaviour are noted below. Which of the following presents the correct description ?

A. O_2^-, O_2^2 - Bone diamagnetic

B. O^+, O_2^2 - Both paramagnetic

C. O_2^+, O_2 - Both paramagnetic

D. O, O_2^{2-} - Both paramagnetic

Answer: C

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96. Which one of the following is not correct with respect to bond length of the species?

A. $C_2 > C_2^{2-}$

B. $B_2^+ > B_2$

C. $Li_2^+ > Li_2$

D. $O_2 > O_2^-$

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97. Which of the following species has lowest ionisation potential?

A. O

B. O_2

C. O_2^+

D. O_2^-

Answer: D

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98. Arrange the following ions in the order of decreasing $X - O$ bond length where X is the central atom:

A. $ClO_4^-, SO_4^{2-}, PO_4^{3-}, SiO_4^{4-}$

B. $SiO_4^{4-}, PO_4^{3-}, SO_4^{2-}, ClO_4^-$

C. $SiO_4^{4-}, PO_4^{3-}, ClO_4^-, SO_4^{2-}$

D. $SiO_4^{2-}, SO_4^{2-}, PO_4^{3-}, ClO_4^-$

Answer: B

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99. The correct order in which the O-O bond length increases in the following is

A. $O_3 < H_2O_2 < O_2$

B. $O_2 < O_3 < H_2O_2$

C. $O_2 < H_2O_2 < O_3$

D. $H_2O_2 < O_2 < O_3$

Answer: B

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

A. H_2^-, H_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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101. 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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102. 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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103. Which of the following is paramagnetic?

A. CO

B. O_2^-

C. CN^-

D. NO^+

Answer: B

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104. Assuming $2s - 2p$ mixing is not operative, the paramagnetic species among the following is

A. Be_2

B. B_2

C. C_2

D. N_2

Answer: C

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105. The maximum possible number of hydrogen bonds a water molecule can form is

A. 1

B. 2

C. 3

D. 4

Answer: D

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106. Which of the following hydrogen halide is most volatile?

A. HF

B. HCl

C. HBr

D. HI.

Answer: B

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107. 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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108. Ortho -nitrophenol is less soluble in water than p-and $m-$ nitrophenols because

A. Melting point of o-Nitrophenol is lower than

those of m- and p-isomers

B. o-Nitrophenol is more volatile is steam than m-and p-isomers .

C. o-Nitrophenol shown Intramolecular H-bonding

D. o-Nitrophenol shows Intermolecular H-bonding

Answer: C

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109. The hydrogen bond is shortest in

A. $S-H- - - - S$

B. $N-H- - - - O$

C. $S-H- - - - - - O$

D. $F-H- - - - F$

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110. Which one of the following statement is correct ?

A. Melting point of and boiling point of HI are greater than those of HF

B. Boiling point of HI is less than that of HF but melting point of HI is greater than that of HF

C. Boiling point of HI is greater than that of HF but melting point of HI is less than that of HF

D. Melting point and boiling point of HI are less than that of HF

Answer: B

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111. The variation of the boiling points of the hydrogen halides is in the order $HF > HI > HBr > HCl.$

What explains the higher boiling point of hydrogen fluoride?

A. There is strong hydrogen bonding between HF molecules

B. The bond energy of HF molecules is greater

than in other hydrogen halides

C. The effect of nuclear shielding is much reduced

in fluorine which polarises the HF molecule

D. The electronegativity of flurine is much

higher than for other elements in the group .

Answer: A

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112. 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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113. Among $KO_2, KAlO_2, CaO_2$ and NO_2^+, unpaired electrons is present in :

A. NO_2^+ and BaO_2

B. KO_2 and AlO_2^-

C. KO_2 only

D. BaO_2 only

Answer: C

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114. Hybridisation of Al in $AlCl_3$ (monomeric from ltbgt above $800^\circ C$) and Al_2Cl_6 (dimeric form below 400° C) respectively are

A. sp^2, sp^3

B. sp^2, sp^2

C. sp^3, sp^3

D. sp^2, dsp^2

Answer: A

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115. Which one of the following statements about carbon monoxide is correct ?

A. It has two lone pairs of electrons on oxygen atom

B. Carbon atom in it is sp hybridized

C. In formaing metal carbonyls, oxygen is attached

to the metal atom

D. It has large value of diple moment

Answer: B

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116. In Which of the following molecule would you expect the introgen to nitrogen bond to be longest ?

A. N_2O

B. N_2O_4

C. N_2H_4

D. N_2

Answer: B

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117. The bond dissociation energy of $B-F$ in BF_3 is $646\,\text{kJ mol}^{-1}$ whereas that of $C-F$ in CF_4 is $515\,\text{kJ mol}^{-1}$. The correct reason for higher $B-F$ bond dissociation energy as compared to that of $C-F$ is

A. smallar size of B-atom as compared to that of C-atom

B. stronger σ-bond between B and F in BF_3as compared to that between C and F in CF_4

C. significant $p\pi-p\pi$ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4

D. lower degree of $p\pi - p\pi$ interaction between B and F in BF_3 than between C and F in CF_4

Answer: C

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118. Which one of the following statements about water is false ?

A. Watr is oxidized to oxygen during photo-synthesis

B. Water can act both as an acid and as a base

C. There is extensive intramolecular hydrogen bonding in the condensed phase

D. Ice formed by heavy water sinks in normal water

Answer: C

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119. Among the following ,which one is the wrong statement

A. PH_5 and $BiCl_5$ do not exist

B. $p\pi - d\pi$ bonds are present in SO_2

C. SeF_4 and CH_4 have same shape

D. I_3^- has bent geometry .

Answer: C

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120. Which of the following species is not paramagnetic ?

A. O_2

B. B_2

C. NO

D. CO

Answer: D

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121. Which one of the following pairs of species have the same bond order ?

A. CO, NO

B. O_2, NO^+

C. CN^-, NO^+

D. N_2, O_2^-

Answer: C

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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (II. MULTIPLE CHOICE QUESTINS (WITH ONE OR MORE THAN ONE CORRECT ANSWER))

1. Which of the following statements are not correct ?

A. $NaCl(s)$ being an ionic compound , is a good conductor of electricity

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

C. Hybrid orbitals form stronger bonds the p-orbitals.

D. VSEPR theory connot explain the equare planar geometry of XeF_4

Answer: A::B::D

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2. Paramagnetic species are

A. O_2^+

B. O_2^-

C. N_2^+

D. N_2^-

Answer: A::B::C::D

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

A. The C-O bond order is 1.33

B. The formal charge on each oxygen atom is

0.67 units

C. It has two C-O single bonds and one C=O

double bond

D. The hybridization of central atom is sp^3

Answer: A::B

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4. Dipole moment is possessed by (one or more)

A. 1,4 -Dichlorobenzene

B. cis 1, 2-Dichloroethene

C. trans-1, 2-Dichloroethene

D. trans-2, 3-Dichloro-2-pentene

Answer: B::D

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5. Which of the following species have same shape/same bond order ?

N_3^-, NO_2^-, CO_2, O_3

A. (i) and (ii)

B. (iii) and (iv)

C. (i) and (iii)

D. (ii) and (iv)

Answer: A::B

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6. CO_2 is isostructural with

A. $HgCl_2$

B. $SnCl_2$

C. C_2H_2

D. NO_2

Answer: A::C

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7. The linear struture is assumed by :

A. $SnCl_2$

B. NCO^-

C. NO_2^+

D. CS_2

Answer: B::C::D

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8. Which one of the following molecules is expected to exhibit diamagnetic behaviour?

(i) N_2 (ii) O_2

(iii) S_2 (iv) C_2

A. S_2

B. C_2

C. N_2

D. O_2

Answer: B::C

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9. The correct statement(s) about O_3 is/are

A. O-O bond length are equal

B. Thermal decomposition of O_3 is endothermic

C. O_3 is diamgentic in nature

D. O_3 has a bent structure

Answer: A::C::D

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10. 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 solution

C. Formic acid is more acidic than acetic acid

D. Dimerisation of acetic acid in benzene

Answer: A::B::D

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11. The compound (s) with two lone pairs of electrons

on the central atom is (are)

A. BrF_5

B. CIF_3

C. XeF_4

D. Sf_4

Answer: B::C

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12. According to molecular orbital theory,

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

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

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

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

Answer: A::C

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

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

B. CIO_3^-, CO_3^{2-}

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

D. CIO_3^-, SO_3^{2-}

Answer: A::D

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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (III. MULTIPLE CHOICE QUESTIONS (Based on the given Passage/Comprehension))

1. The study of diple moment of a molecule is useful to explain the shape of a molecule and also to predict a The net dipole moment of a polyatomic molecule is the resltant of the different bond moments present in that molecule . The values are generalluy expressed in Debye or in the S.I. units in terms of Coulomb meter (C m) 1 Debye is equivalent to

A. 3.33×10^{-30} C m

B. 1.602×10^{-27} C m

C. 10^{-20} C m

D. 3.33×10^{-12} C m

Answer: A

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2. The study of diple

moment of a molecule is useful to explain the

shape of a molecule and also to predict a

The net dipole moment of a polyatomic

molecule is the resltant of the different bond

moments present in that molecule . The values

are generalluy expressed in Debye or in the S.I.

units in terms of Coulomb meter (C m)

Which our of the following will have maximum

dipole moment ?

A. NF_3

B. NCl_3

C. NBr_3

D. NH_3

Answer: D

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3. The study of diple

moment of a molecule is useful to explain the

shape of a molecule and also to predict a

The net dipole moment of a polyatomic

molecule is the resltant of the different bond

moments present in that molecule . The values

are generalluy expressed in Debye or in the S.I.

units in terms of Coulomb meter (C m)

A covalent molecule , X-Y is found to have a

dipole moment of 1.5×10^{-29} C m and a bond

length of 150 pm . The per cent ionic character of the bond will be

A. $50\ \%$

B. $62.5\ \%$

C. $75\ \%$

D. $90\ \%$

Answer: B

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4. Atomic orbitals of bonded atoms combine to form molecular orbitals. The number of molecular orbitals formed is equal to the number of atomic orbitals taking part in the bond formation. When two atomic orbitals combine, two molecular orbitals are formed one of which has lower energy than the combining orbitals and is called bonding Molecular Orbital (MO). Whereas the other having higher energy than the two combining atomic orbitals is called Anti Bonding Molecular orbitals (ABMO) The two combining atomic orbitals must have comparable energies and should be properly oriented to allow considerable overlapping. If the overlapping is end to end along internuclear axis, the molecular orbital is called sigma and if the overlapping is lateral 1.e., sidewise the molecular orbital is called pie. Just like atomic orbitals, the molecular orbitals also have varying energy levels. Filling of electrons in molecular orbitals takes place following the same rules as followed for filing of atomic orbitals. The order of filling may not be same for all the molecules or their ions. Bond order is a useful parameter for comparing

the various characteristics of molecules.

The bond order (BO) in B_2 molecule is

A.

B.

C.

D.

Answer: C

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

A. σ_{1s}^*

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

C. π_{2p_x}

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

Answer: D

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

with electrons following the same rules as

followed for filling of atomic orbitals .

However, the order of filling in not the same

for of the most important parameter to

compare a number of their characteristics

H_2, Li_2, B_2 each has bond order equal to 1 . The

order of their stability is

A. $H_2 = Li_2 = B_2$

B. $H_2 > Li_2 > B_2$

C. $H_2 > B_2 > Li_2$

D. $B_2 > Li_2 > H_2$

Answer: C

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7. In whihc of the following pair the moelcular orbitals are gerade or ungerade ?

A. σ_{2s}, π_{2p_x}

B. $\sigma^*_{2s}, \pi^*_{2p_x}$

C. $\sigma^*_{2s}, \pi_{2p_x}$

D. $\pi_{2p_x}, \pi^*_{2p_x}$

Answer: C

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8. Whihc of the following statements is correct ?

A. In the formation of dioxygen form 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 orbitals will not be same as total number of antibonding orbitals in dioxygen.

D. Number of filled bonding orbitals will be same as number of filled antibonding orbitals

Answer: A

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

A. $\sigma^* 1s$

B. $\sigma^* 2p_z$

C. π_{2p_x}

D. $\pi^* \_ 2p_Y$

Answer: D

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10. 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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11. 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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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (IV. MATCHING TYPE QUESTIONS)

1. Match the entries of column I with appropriate of column II and choose the correct option

out of the four option (a), (b),(c), (d) given at the end of each question

Column I (*Ion*)		Column II (*Shape*)	
(A)	ICl_2^-	(*p*)	V-shape
(B)	NH_2^-	(*q*)	Linear
(C)	NH_4^+	(*r*)	Tetrahedral
(D)	$[PtCl_4]^{2-}$	(*s*)	Square planar

A. A - r, B-s, C-q, D-p

B. A - q, B-p, C-r, D-s

C. A - q, B-p, C-r, D-s

D. A - s, B-p, C-q, D-r

Answer: B

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2. Match the entries of column I with appropriate of column II and choose the correct option

out of the four option (a), (b),(c), (d) given at the end of each question

Column I		Column II	
(A)	sp^2	(p)	ICl_4^-
(B)	dsp^2	(q)	$TeCl_4$
(C)	sp^3d	(r)	$SnCl_2$
(D)	sp^3d^2	(s)	$[Ni(CN)_4]^{2-}$

A. A-r, B-s, C-q, D-p

B. A-r, B-p, C-q, D-s

C. A-p, B-r, C-q, D-s

D. A-q, B-s, C-r, D-p

Answer: A

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3. Match the entries of column I with appropriate of column II and choose the correct option

out of the four option (a), (b),(c), (d) given at the end of each question

Column I (Molecule/Ion)		Column II (Bond order)	
(A)	NO	(p)	1·5
(B)	CO	(q)	2
(C)	BN	(r)	2·5
(D)	CN^-	(s)	3

A. A-r, B-s, C-q, D-p

B. A-s, B-s, C-p, D-q

C. A-r, B-r, C-p, D-s

D. A-r, B-s, C-q, D-s

Answer: D

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4. Match the entries of column I with appropriate of column II and choose the correct option

out of the four option (a), (b),(c), (d) given at the end of each question

A. A-p, B-s, C-r, D-q, E-t

B. A-q, B-s, C-p, D-r, E-u

C. A-r, B-s, C-p, D-q, E-u

D. A-r , B-s, C-p, D-q, E-t

Answer: D

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5. Match the entries of column I with appropriate of column II and choose the correct option

out of the four option (a), (b),(c), (d) given at the end of each question

A. A-r, B-q , C-t, D-s, E-p

B. A-t, B-r, C-q, D-s, E-p

C. A-p, B-s, C-t, D-q, E-r

D. A-p, B-q, C-r, D-s, E-t

Answer: B

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6. Match the entries of column I with appropriate of column II and choose the correct option

out of the four option (a), (b),(c), (d) given at the end of each question

A. $\begin{matrix} P & Q & R & S \\ 2 & 1 & 3 & 4 \end{matrix}$

B. $\begin{matrix} P & Q & R & S \\ 4 & 3 & 1 & 2 \end{matrix}$

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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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (V MATRIX-MATCH TYPE QUESTIONS)

1. Match the entries of column I with appropriate of column II and choose the correct option

out of the four option (a), (b),(c), (d) given at the end of each question

	Column I (Compound)		Column II (Type of bonds present)
(A)	CaC_2	(p)	Ionic
(B)	$SnCl_2$	(q)	Covalnet
(C)	$\left[CrCl_2(H_2O)_4\right]Cl.2H_2O$	(r)	Coordinate
(D)	$CuSO_4.5H_2O$	(s)	Hydrogen

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2.

	Column I(Molecular orbital)		Column II (Nodal planes present
(A)	σ_{2s}	(p)	0
(B)	σ_{2p_z}	(q)	1
(C)	$\pi^*_{2p_x}$	(r)	2
(D)	$\pi^*_{2p_y}$	(s)	Gerade

(Take Z-axis as the internuclear axis)

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3.

	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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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (VI. INTEGER TYPE QUESTIONS)

1. In Al_2Cl_6 each Al atoms is linked to how many Cl atoms ?

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2. Total number of lone pairs present in the structure of HNO_3 is

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3. Total number of electron pairs (both lone and bond pairs) around central atom of XeF_4 is

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4. Total number of molecular orbitals occupying one or two electrons in O_2^+ is

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5. The number of 90° bond angles present in SF_4 molecules is

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6. Total number of σ-bond present in the molecula of propyne is

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7. Total number of coordinate bonds present in $CuSO_4.5H_2O$ is

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8. Number of H_2 molecules attached to each H_2O molecule through hydrogen bonding is

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9. The number of water molecule(s) directly bonded to the metal centre in $CuSO_4.5H_2O$ is-

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10. Based on VSEPR theory, the number of 90 degree F-Br-F angles in BrF_5, is

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11. 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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12. The total number of lone pair of electrons in N_2O_3 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. 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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15. 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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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (VII. NUMERICAL VALUE TYPE QUESTIONS (IN DECIMAL NOTATION))

1. Calculate the electronegativity of fluorine from following data :

$E_{H-H} = 104.2$ kcal mol^{-1}

$E_{F-F} = 36.6$ kcal mol^{-1}

$E_{H-F} = 134.6$ kcal mol^{-1}

Electronegativity of H is 2.05.

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COMPETITION FOCUS JEE (Main and Advanced)/ MEDICAL ENTRANCE SPECIAL (VIII. ASSERTION-REASON TYPE QUESTIONS TYPE I)

1. Statement-1 . $LiCl$ is covalent whereas NaCl is ionic.

Statement-2. Greater the size of the cation, greater is its polarising power.

A. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is not a correct explanation for Statement-1.

C. Statement-1 is True , Statement-2 is False .

D. Statement-1 is False, Statement-2 is True.

Answer: c

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2. Assertion : H_2 molecule is more stable than $He-H$ molecule .

Reason : The antibonding electron in $He-H$ molecule decreases the bond order thereby the stability.

A. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is not a correct explanation for Statement-1.

C. Statement-1 is True , Statement-2 is False .

D. Statement-1 is False, Statement-2 is True.

Answer: b

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3. Assertion Both NO_3^{Θ} and CO_3^{2-} ions are triangular planar

Reasoning Hybridisation of central atom in both NO_3^{Θ} and CO_3^{2-} is sp^2 .

A. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is not a correct explanation for Statement-1.

C. Statement-1 is True , Statement-2 is False .

D. Statement-1 is False, Statement-2 is True.

Answer: a

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4. Statement 1: BF_3 moleculeis planar while NF_3 is pyramidal.

Statement 2: N atom is smaller in size as compared ot B atom.

A. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is not a correct explanation for Statement-1.

C. Statement-1 is True , Statement-2 is False .

D. Statement-1 is False, Statement-2 is True.

Answer: b

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5. Statement 1: o-nitrophenol has higher boilling point than p-nitrophenol.

Statement 2: Intermolecular hydrogen bonding is present in p-nitrophenol and intrmolecular hydrogen bonding in o-nitrophenol.

A. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is not a correct explanation for Statement-1.

C. Statement-1 is True , Statement-2 is False .

D. Statement-1 is False, Statement-2 is True.

Answer: d

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6. Statement-1. The boiling point of NH_3 lies between that of SbH_3 and BiH_3

Statement -2. PH_3 has much lower boiling than NH_3 but it increases from PH_3 to AsH_3 to SbH_3 toBiH_3 due to increase in van dar Waals forces

A. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is a correct explanation for Statement-1.

B. Statement-1 is Ture , Statement-2 is Ture , Statement-2 is not a correct explanation for Statement-1.

C. Statement-1 is True , Statement-2 is False .

D. Statement-1 is False, Statement-2 is True.

Answer: d

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7. Assertion . Nitrogen shown a valency of 3 as well as 5.

Reason. Lewis symbol of nitrogen is $: \dot{\underset{\cdot}{N}} \cdot$

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: a

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8. Assertion . Ionic compounds tend to be non-volatile.

Reason . Ionic compounds are solid

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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9. $Assertion$. Water is specially effective in screeniing the electrostatic interactions between the dissolved ions

$Reason$. The electrostatic forces between two charged ions are inversely proportional to the dielectic constant of the solvent .

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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10. Assertion (A): SF_6 molecule is unstable.

Reason (R): A stable molecule must have 8 electrons around the central atom. i.e. octet rule should be satisfied.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: d

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11. Assertion . The bond anlge of PBr_3 is greater than that of PH_3 but bond angle of NBr_3 is less than that of NH_3.

Reason .Electronegativity of phosphorus atom is less than that of nitrogen .

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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12. Assertion : H-S-H bond angle in H_2S is closer to 90° but H-O-H bond angle in H_2O is 104.5°

Reason: lp-lp repulsion is stronger in H_2S than in H_2O

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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13. Assertion . When two hydrogen atoms approach each other to form a covalent bond , nearly $435.8KJmol^{-1}$ of energy is released .

Reason . When two atoms approach eachother to form a covalent bond between them, potential energy of the system is released .

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: c

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14. Assertion (A): Pi bond is never formed alone. It is formed along with a sigma bond

Reason (R): Pi bond is formed by sideway overlap of p- orbitals only.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: c

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15. Assertion : The atoms in a covalent molecule are said to share electrons, yet some covalent molecule are polar.

Reason :In a polar covalent molecule , the shared electron spend more time on the average near one of the atoms .

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: c

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16. Assertion : Boiling points of cis-isomers are higher than trans - isomers.

Reason : Dipole moments of cis - isomers are higher than trans - isomers.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: a

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17. 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. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: a

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18. Asseration: $SeCl_4$, does not havea tetrahedral structure.

Reason: Se in $SeCl_4$ has two lone pairs.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: c

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19. Assertion: N_3^- is a weaker base than NH_2^-

Reason: The lone pair of electrons on N atom in N_3^- is in a sp^2-orbital while inNH_2^- it is in an sp^(3)`-orbital.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: a

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

Reason(R)-N atom is smaller than B

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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21. Assertion . The resonance hybrid is more stable than any of the contributing structure .

Reason . The contributing structures contain the same number of umpaired elelctrons and have the real existance.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: c

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22. Assertion Both $\pi(2P_x)$ and $\pi^*(2P_x) MO's$ have one nodal plane each

Reasoning All $MO's$ formed by side way overlapping of $2p$ orbitals have one nodal plane .

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: d

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23. Assertion H_2, Li_2, B_2 each has a bond order of 1 and hence are equally stable

Reasoning Stability of molecule//ion depends only on bond order .

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: d

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24. Assertion : Bond order can assume any value number including zero.

Reason :Higher the bond order ,shorter is bond length and greater is bond energy.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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25. Assertion B_2 molecule is diamagnetic

Reasoning The highest occupied molecular orbital is of sigma type .

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: d

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26. (A) Molecular nitrogen is less reactive than molecular oxygen.

(R) The bond length of N_2 is shorter than that of oxygen.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: a

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27. Assertion : H_2 molecule is more stable than $He - H$ molecule .

Reason : The antibonding electron in $He - H$ molecule decreases the bond order thereby the stability.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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28. Assertion. The HF_2^- ion exists in the solid state and also in liquid state but not in aqueous solution.

Reason. The magnitude of hydrogen bonds in between HF-HF molecule is weaker than that in between HF and H_2O molecules.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: a

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29. Assertion Both o-hydroxy benzaldehyde and p-hydroxy benzaldehyde have

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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30. Assertion (A) H_2O is the only hydride of group - 16 which is liquid at ordinary temperature.

Reason (R) In ice , each oxygen atom is surrounded by two covalent bonds and two hydrogen bonding.

A. If both assertion and reason are correct, and reason is the correct explanation of the assertion.

B. If both assertion and reason are correct , but reason is not the correct explanation of the assertion.

C. If assertion is correct, but reason is incorrect .

D. If both assertion and reason are incorrect.

Answer: b

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ADVANCED PROBLEMS

1. The space model which is obtained by joining the points representing various bonded atoms gives the shape of the molecule. The geometry of the molecule is definite relative arrangement of the bonded atoms in a molecule. The shape and geometry of a molecule is explained by valence shell electron pair repulsion theory given by Gillespie and Nyholm.

Select the correct code for the following repulsion orders, according to VSEPR theory :

(I) lone pair -lone pair $>$ lone pair-bond pair

(II) lone pair-bond pair $>$ bond pair -bond pair

(III) lone pair -lone pair $>$ bond pair-bond pair

(IV) lone pair - bond pair $>$ lone pair-lone pair

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2. What type of structure is possessed by H_2O_2 molecule ? Draw it and label the varous bond angles

and bond length . Comment on the dipole moment of H_2O_2 molecule .

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3. You are given the following species

$C_2^+, O_2^{2+}, Be_2, C_2, O_2^{2-}, C_2^-$

Arrange them in order of increasing bond strength giving reason.

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4. You are given the following species :

$PH_3, P_2H_6^{2+}, P_2H_5^+$ and PH_4^+

Which of these has least covalent P-H character and why ?

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5. Choose the correct answer in each of the following and explain with reason

(i)$NaCl, KCl, MgCl_2, CaCl_2$ - most ionic

(ii) $Ba \to Ba^{2+} -, Be \to Be^{2+}, Cs \to Cs^+, Li^+$ - maximum ionization energy

(iii) $AlCl_3, All_3, MgI_2, NaI$ - most covalent

(iv) RbF, CsF, NaF, KF - highest lattice energy

(v) Li^-, Be^-, B^-, C^- - least stable species

(vi) $ClO_3, XeF_4, SF_4, I_3^-$ - maximum number of lone pairs of electrons on central atom

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6. Estimate the lattice energy of $CaCO_3$ if $r_{ca^2+} = 114 \pm$ and r_(CO_3^(2-)) =185 p m`.

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7. The $H - O - H$ bond angle in the water molecule is 105° , the$H - O$ bond distance being 0.94Å, The dipole moment for the moelcule is $1.85D$. Calculate the charge on the oxygen atom .

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8. Bond angle between two hybrid orbitals is 105° Percentage of s-orbital character of hybrid orbital is between

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9. The molecule electronic configuration of oxygen molecule is.

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10. Four elements A, B, C and D form a series of compounds having the formulae AB, B_2, CB_3, DB_2 and DB_3. If the jumbled up atomic numbers of A, B, C and D are 13, 19 , 26 and 35 , What are the ordered atomic numbers of A, B C and C ?

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11. (a) In a polar solvenbt ,PCl_5 undergoes an ionization reaction as follows : $2PCl_5 \Leftrightarrow PCl_4^+ + PCl_6^-$ Wht will be the geometrical shape of

each

species present In the equalilbrium maxture ?

(b) Why does PCl_5 exist as $[PCl_4]^+[PCl_6]^-$?

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Problem For Practice

1. The observed dipole mement of a molecule AB is 1.45 D and its bond length is $1.\ 654\text{Å}$. Calculate the precentage of ionic character in the bond

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2. Calculate the ratio of partial positive charge on H-atom in HCl to that in HI from the following date :

Dipole moment of HCl = 1.03 D , Bond length = 127 pm. Dipole moment of HI = 0 .38 d,

Bond length - 161 pm

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Curiosity Questions

1. Why can sugar (sucrose) melts on heating but common salt (sodium chloride) does not melt so easily ?

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2. Generally solids sink into water but ice floats on water. Explain why ?

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