JEE Main Previous Year Solved Questions on Chemical Bonding

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

(1) Significant pπ - pπ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4.

(2) Lower degree of pπ – pπ interaction between B and F in BF_3 than that

between C and F in CF_4

(3) Smaller size of B-atom as compared to that of C-atom

(4) Stronger bond between B and F in BF_3 as compared to that between C and F in CF_4.

Solution:

Because of pπ - pπ back bonding in BF_3 molecule, all B-F bonds have partial double bond character.

Hence option (1) is the answer.

2. Among the following species which two have a trigonal bipyramidal shape?

(1) NI_3 (2) I_3^- (3) SO_3^{2-} (4) NO_3^-

(1) II and III

(2) III and IV

(3) I and IV

(4) I and III

Solution:

Let us find the hybridization (H) and shape of given species.

(1) For NI_3, H = ½ (5+3) = 8/2 = 4 → sp^3 hybridized state. It is trigonal pyramidal in shape.

(2) For I_3^-, H = ½ (7+2+1) = 10/2 = 5 → sp^3d hybridized state. It is linear in shape.

(3) For SO_3^{2-}, H = ½ (6+2) = 8/2 = 4 → sp^3 hybridized state. It is trigonal pyramidal in shape.

(4) For NO_3^-, H = ½ (5+1) = 6/2 = 3 → sp^2 hybridized state. It is trigonal planar in shape.

Hence option (4) is the answer.

3. Using MO theory, predict which of the following species has the shortest bond length?

(1) O_2^-

(2) O_2^{2-}

(3) O_2^{2+}

(4) O_2^+

Solution:

Chemical species	O_2^-	O_2^{2-}	O_2^{2+}	O_2^+
Bond order	1.5	1	3	2.5

Therefore bond length order $O_2^{2-} > O_2^- > O_2^+ > O_2^{2+}$

Hence option (3) is the answer.

4. Among the following, the species having the smallest bond is :

(1) NO

(2) NO^+

(3) O_2

(4) NO^-

Solution:

The bond order of given molecules are:

NO = 2.5, NO^+ = 3, O_2 = 2, NO^- = 2

Larger the bond order, the smaller the bond length.

NO^+ has the largest bond order 3.

Therefore, it will have the smallest bond.

Hence option (2) is the answer.

5. The hybridisation of orbitals of N atom in NO_3^-, NO_2^+, NH_4^+ are respectively:

(1) sp^2, sp^3, sp

(2) sp, sp^3, sp^2

(3) sp, sp^2, sp^3

(4) sp^2, sp, sp^3

Solution:

In NO_3, the central N atom has 3 bonding domains and zero lone pairs of electrons.

In NO_2, the central N atom has 2 bonding domains and zero lone pairs of electrons.

In NH_4, the central N atom has 4 bonding domains and zero lone pairs of electrons.

The Hybridization of N atom in NO_3^-, NO_2^+, NH_4^+ are sp^2, sp, sp^3 respectively.

Hence option (4) is the answer.

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

(1) RbCl

(2) LiCl

(3) KCl

(4) NaCl

Solution:

NaCl has the highest melting point.

Hence option (4) is the answer.

7. The structure of IF_7 is :

(1) octahedral

(2) pentagonal bipyramid

(3) square pyramid

(4) trigonal bipyramid

Solution:

For IF_7, hybridisation - sp^3d^3. The shape is pentagonal bipyramidal.

Hence option (2) is the answer.

8. Which of the following has the square planar structure :

(1) NH_4^+

(2) CCl_4

(3) XeF_4

(4) BF_4^-

Solution:

Hybridization of XeF_4 sp^3d^2

It has a square planar shape.

Hence option (3) is the answer.

9. Among the following the maximum covalent character is shown by the compound :

(1) $AlCl_3$

(2) $MgCl_2$

(3) $FeCl_2$

(4) $SnCl_2$

Solution:

Al^{+3} is having the highest polarizing power than other compounds having greater covalent character.

Hence option (1) is the answer.

10. The compound of Xenon with zero dipole moment is :

(1) XeO_3

(2) XeO_2

(3) XeF_4

(4) $XeOF_4$

Solution:

XeF_4 has dipole moment zero.

Hence option (3) is the answer.

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

(1) XeO_3

(2) XeF_4

(3) XeF_6

(4) XeF_2

Solution:

XeO_3 has 1 lone pair of electrons. XeF_4 has 2 lone pairs of electrons. XeF_6 has 1 lone pair of electrons. XeF_2 has 3 lone pairs of electrons. XeF_2 has a maximum number of lone pairs of electrons.

Hence option (4) is the answer.

12. Among the following the molecule with the lowest dipole moment is :

(1) $CHCl_3$

(2) CH_2Cl_2

(3) CCl_4

(4) CH_3Cl

Solution:

The order of the dipole moment is $CCl_4 < CHCl_3 < CH_2Cl_2 < CH_3Cl$. So CCl_4 has the lowest dipole moment.

Hence option (3) is the answer.

13. The number of types of bonds between two carbon atoms in calcium carbide is

(1) One sigma, two pi

(2) One sigma, one pi

(3) Two sigma, one pi

(4) Two sigma, two pi

Solution:

$CaC_2 \rightarrow Ca^{+2} + C_2^{2-}$

$^{-}C \equiv C^{-}$

Number of sigma bond is 1 and number of pi bond is 2.

Hence option (1) is the answer.

14. The formation of molecular complex BF_3 - NH_3 results in a change in the hybridisation of boron

(1) From sp^3 to sp^3d

(2) From sp^2 to dsp^2

(3) From sp^3 to sp^2

(4) From sp^2 to sp^3

Solution:

In BF_3, Boron atom has 3 bond pairs of electrons and 0 lone pairs of electrons. It is sp^2 hybridized. In $F_3B \leftarrow NH_3$, Boron atom has 4 bond pairs of electrons and 0 lone pairs of electrons. It is sp^3 hybridized. So the formation of molecular complex results in a change in the hybridization of boron from sp^2 to sp^3.

Hence option (4) is the answer.

15. The molecule having the smallest bond angle is :

(1) PCl_3

(2) NCl_3

(3) $AsCl_3$

(4) $SbCl_3$

Solution:

Bond angle order $NCl_3 > PCl_3 > AsCl_3 > SbCl_3$.

Hence option (4) is the answer.

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

(1) AlF_6^{3-} and SF_6

(2) CO_3^{2-} and NO_3^-

(3) PCl_4^+ and $SiCl_4$

(4) PF_5 and BrF_5

Solution:

PF_5 has a trigonal bipyramidal shape. BrF_5 has a square pyramidal shape.

Hence option (4) is the answer.

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

(1) C_2

(2) N_2

(3) O_2

(4) S_2

Solution:

C_2 and N_2 have no unpaired electrons. So they exhibit diamagnetic behaviour.

18. Which of the following is the wrong statement?

(1) ONCl and ONO^- are not isoelectronic

(2) O_3 molecule is bent

(3) Ozone is violet-black in solid-state

(4) Ozone is diamagnetic gas

Solution:

In the given options all are correct statements.

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

(1) $Li_2 < Li_2^+ < Li_2^-$

(2) $Li_2^- < Li_2^+ < Li_2$

(3) $Li_2 < Li_2 < Li_2^+$

(4) $Li_2^- < Li_2 < Li_2^+$

Solution:

The bond order of Li_2 is 1. The bond order of Li_2^+ is 0.5. The bond order of Li_2^- is 0.5. Stability will depend on the bond order. Li_2^+ is more stable than Li_2^- because the higher interelectronic repulsion in Li_2^- makes it the least stable. So the order is $Li_2 > Li_2^+ > Li_2^-$.

Hence option (2) is the answer.

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

(1) H_2^+, He_2^{2-}

(2) H_2^-, He_2^{2-}

(3) H_2^{2+}, He_2

(4) H_2^-, He_2^{2+}

Solution:

The bond order of H_2^{2+} and He_2 is zero. So these molecules do not exist.

Hence option (3) is the answer.

21. Bond distance in HF is 9.17×10^{-11}m. Dipole moment of HF is 6.104×10^{-30} Cm. The per cent ionic character in HF will be : (electron charge = 1.60×10^{-19} C)

(1) 61.0%

(2) 38.0%

(3) 35.5%

(4) 41.5%

Solution:

Given Bond distance = 9.17×10^{-11}m.

Dipole moment = 6.104×10^{-30} Cm

% iconic character = $6.104 \times 10^{-30} \times 100 / (1.60 \times 10^{-19} \times 9.17 \times 10^{-11})$

= 41.5%

Hence option (4) is the answer.

22. In which of the following ionization processes the bond energy has increased and also the magnetic behaviour has changed from paramagnetic to diamagnetic?

(1) $NO \rightarrow NO^+$

(2) $O_2 \rightarrow O_2^+$

(3) $N_2 \rightarrow N_2^+$

(4) $C_2 \rightarrow C_2^+$

Solution:

During the ionisation of NO → NO^+, the bond order changes from 2.5 to 3. Also magnetic character changes from paramagnetic to diamagnetic.

During the ionisation of O_2 → O_2^+, the bond order increases from 2 to 2.5 and the magnetic character changes from paramagnetic to diamagnetic.

During the ionisation of N_2 → N_2^+, the bond order decreases from 3 to 2.5 and the magnetic behaviour changes from diamagnetic to paramagnetic.

During the ionisation of C_2→ C_2^+, the bond order decreases from 2 to 1.5 and the magnetic behaviour changes from diamagnetic to paramagnetic.

Hence option (1) is the answer.

23. Which one of the following molecules is paramagnetic?

(1) NO

(2) O_3

(3) N_2

(4) CO

Solution:

NO has an unpaired electron. So it is paramagnetic in nature.

Hence option (1) is the answer.

24. The catenation tendency of C, Si and Ge is in the order Ge < Si < C. The bond energies (in kJ $mol^{-1} of C — C, Si —Si and Ge—Ge bonds are respectively :

(1) 348, 260, 297

(2) 348, 297, 260

(3) 297, 348, 260

(4) 260, 297, 348

Solution:

Bond energy order is C - C > Si - Si > Ge - Ge.

Hence option (2) is the answer.

25. Oxidation state of sulphur in anions SO_3^{2-}, $S_2O_4^{2-}$ and $S_2O_6^{2-}$ increases in the orders

(1) $S_2O_6^{2-} < S_2O_4^{2-} < SO_3^{2-}$

(2) $SO_3^{2-} < S_2O_4^{2-} < S_2O_6^{2-}$

(3) $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-}$

(4) $S_2O_4^{2-} < S_2O_6^{2-} < SO_3^{2-}$

Solution:

The oxidation state of sulphur in SO_3^{2-} is +4. The Oxidation state of sulphur in $S_2O_4^{2-}$ is +3 and in $S_2O_6^{2-}$ is +5. So the order is $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-}$

Hence option (3) is the answer.

26. In which of the following species is the underlined carbon having sp^3 hybridisation?

(1) CH_3COOH

(2) CH_3CH_2OH

(3) CH_3COCH_3

(4) $CH_2{=}CH{-}CH_3$

Solution:

Only in CH_3CH_2OH, carbon has sp^3 hybridisation.

In other molecules, the carbon atom has multiple bonds,

Hence option (2) is the answer.

27. In which of the following sets, all the given species are isostructural?

(1) BF_3, NF_3, PF_3, AlF_3

(2) PCl_3, $AlCl_3$, BCl_3, $SbCl_3$

(3) BF_4^-, CCl_4, NH_4^+, PCl_4^+

(4) CO_2, NO_2, ClO_2, SiO_2

Solution:

BF_4^-, CCl_4, NH_4^+,PCl_4^+ are tetrahedral.

Hence option (3) is the answer.

28. In XeF_2, XeF_4, XeF_6 the number of lone pairs of Xe are respectively

(1) 2, 3, 1

(2) 1, 2, 3

(3) 4, 1, 2

(4) 3, 2, 1

Solution:

XeF_2 has 3 lone pairs of electrons. XeF_4 has 2 lone pairs of electrons. XeF_6 has 1 lone pair of electrons.

Hence option (4) is the answer.

29. Which of the following statements is true?

(1) HF is less polar than HBr

(2) absolutely pure water does not contain any ions

(3) chemical bond formation take place when forces of attraction overcome the forces of repulsion

(4) in covalency transference of electron takes place

Solution:

Chemical bond formation takes place when forces of attraction overcome the forces of repulsion.

Hence option (3) is the answer.

30. Which one of the following pairs of molecules will have permanent dipole moments for both members?

(1) $N0_2$ and $C0_2$

(2) $N0_2$ and 0_3

(3) SiF_4 and $C0_2$

(4) SiF_4 and $N0_2$

Solution:

$N0_2$ and 0_3 have angular shapes. So they will have a net dipole moment.

Hence option (2) is the answer.

31. The states of hybridization of boron and oxygen atoms in boric acid (H_3B0_3) are respectively

(1) sp^2 and sp^2 (2) sp^3 and sp^3

(3) sp^3 and sp^2 (4) sp^2 and sp^3

Solution:

Hybridization of B is sp^2 and O is sp^3

Hence option (4) is the answer.

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

(1) dsp^3 hybridization

(2) sp^3d^2 hybridization

(3) dsp^2 hybridization

(4) sp^3d hybridization

Solution:

sp^3d^2 hybridisation has an octahedral configuration. All the bond angles are 90° in the structure.

Hence option (2) is the answer.

33. Which of the following are arranged in an increasing order of their bond strengths?

(1) $O_2^- < O_2 < O_2^+ < O_2^{2-}$

(2) $O_2^{2-} < O_2^- < O_2 < O_2^+$

(3) $O_2^- < O_2^{2-} < O_2 < O_2^+$

(4) $O_2^+ < O_2 < O_2^- < O_2^{2-}$

Solution:

Higher the bond order, stronger the bonds. The increasing order is $O_2^{2-} < O_2^- < O_2 < O_2^+$.

Hence option (2) is the answer.

34. Bond order and magnetic nature of CN^- are respectively

(1) 3, diamagnetic

(2) 2.5, paramagnetic

(3) 3, paramagnetic

(4) 2.5, diamagnetic

Solution:

Bond order = ½ [n_b - n_a]

= ½ [10-4]

= ½ (6)

= 3

It does not have unpaired electrons. So, it is diamagnetic.

Hence option (1) is the answer.

35. The bond order in NO is 2.5 while that in NO^+ is 3. Which of the following statements is true for these two species?

(1)Bond length in NO^+ is greater than in NO

(2)Bond length is unpredictable

(3)Bond length in NO^+ in equal to that in NO

(4)Bond length in NO is greater than in NO^+

Solution:

When bond order increases, bond length decreases. So the bond length in NO is greater than in NO^+.

Hence option (4) is the answer.