Chemical Bonding and Molecular Structure

Question1

Choose the polar molecule from the following :

[27-Jan-2024 Shift 1]

Options:

A.

CCl_4

B.

CO_2

C.

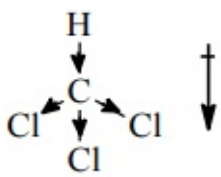
$CH_2 = CH_2$

D.

$CHCl_3$

Answer: D

Solution:



$\mu \neq 0$

$CHCl_3$ is polar molecule and rest all molecules are non-polar

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Question2

Sum of bond order of CO and NO^+ is___

[27-Jan-2024 Shift 1]

Options:

Answer: 6

Solution:

$CO \Rightarrow \overline{C} \equiv \overset{+}{O} : BO = 3$

$NO^+ \Rightarrow N \equiv O^+ : BO = 3$

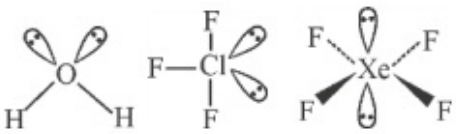
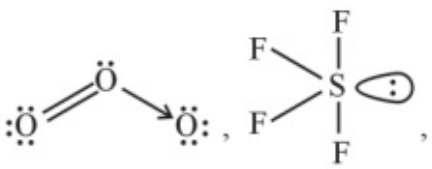
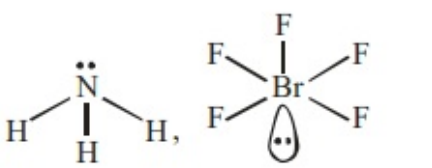
Question3

Number of compounds with one lone pair of electrons on central atom amongst following is O_3, H_2O, SF_4, ClF_3, NH_3, BrF_5, XeF_4 __

[29-Jan-2024 Shift 1]

Answer: 4

Solution:

Question4

The number of species from the following which are paramagnetic and with bond order equal to one is___

$H_2, He_2^+, O_2^+, N_2^{2-}, O_2^{2-}, F_2, Ne_2^+, B_2$

[29-Jan-2024 Shift 1]

Answer: 1

Solution:

Magnetic behaviour		Bond order
H_2	Diamagnetic	1
O_2^+	Paramagnetic	0.5
He_2^+	Paramagnetic	2.5
N_2^{2-}	Paramagnetic	2
O_2^{2-}	Diamagnetic	1
F_2	Diamagnetic	1
Ne_2^+	Paramagnetic	0.5
B_2	Paramagnetic	1

Question5

The total number of molecules with zero dipole moment among CH_4, BF_3, H_2O, HF, NH_3, CO_2 and SO_2 is_____

[29-Jan-2024 Shift 2]

Answer: 3

Solution:

Molecules with zero dipole moment = CO_2, CH_4, BF_3

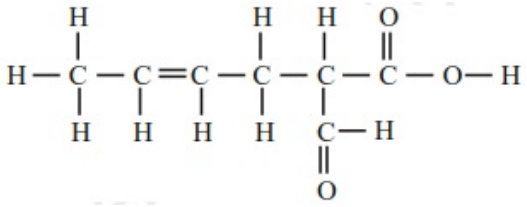
Question6

The total number of 'Sigma' and Pi bonds in 2formylhex-4-enoic acid is

[29-Jan-2024 Shift 2]

Answer: 22

Solution:



22 bonds

Question7

The total number of anti bonding molecular orbitals, formed from 2 s and 2p atomic orbitals in a diatomic molecule is___

[29-Jan-2024 Shift 2]

Answer: 4

Solution:

Antibonding molecular orbital from 2 s = 1

Antibonding molecular orbital from 2p = 3

Total = 4

Question8

Match List-I with List-II

List-I Molecule	List-II Shape
(A) BrF_5	(I) T-shape
(B) H_2O	(II) See saw
(C) ClF_3	(III) Bent
(D) SF_4	(IV) Square pyramidal

[30-Jan-2024 Shift 1]

Options:

A.

(A)-I, (B)-II, (C)-IV, (D)-III

B.

(A) -II, (B)-I, (C)-III, (D)-IV

C.

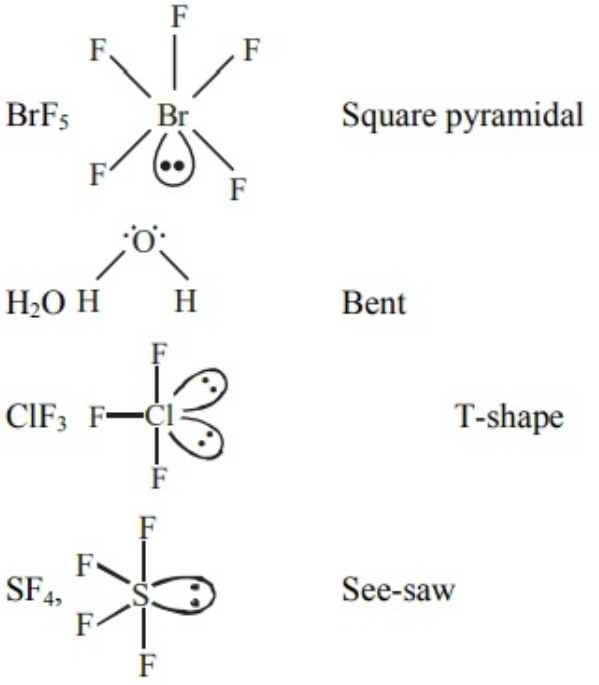
(A)-III, (B)-IV, (C)-I, (D)-II

D.

(A)-IV, (B)-III, (C)-I, (D)-II

Answer: D

Solution:



Question9

The total number of molecular orbitals formed from 2 s and 2p atomic orbitals of a diatomic molecule

[30-Jan-2024 Shift 1]

Answer: 8

Solution:

Two molecular orbitals $\sigma 2s$ and $\sigma^* 2s$.

Six molecular orbitals $\sigma 2p_z$ and $\sigma^* 2p_z$.

$\pi 2p_x$, $\pi 2p_y$ and $\pi^* 2p_x$, $\pi^* 2p_y$

Question10

Given below are two statements:

Statement-I: Since fluorine is more electronegative than nitrogen, the net dipole moment of NF_3 is greater than NH_3.
Statement-II: In NH_3, the orbital dipole due to lone pair and the dipole moment of NH bonds are in opposite direction, but in NF3 the orbital dipole due to lone pair and dipole moments of N-F bonds are in same direction.

In the light of the above statements. Choose the most appropriate from the options given below.

[30-Jan-2024 Shift 2]

Options:

A.

Statement I is true but Statement II is false.

B.

Both Statement I and Statement II are false.

C.

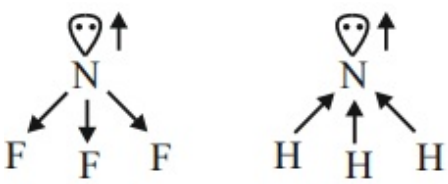
Both statement I and Statement II is are true.

D.

Statement I is false but Statement II is are true.

Answer: B

Solution:



Question11

The linear combination of atomic orbitals to form molecular orbitals takes place only when the combining atomic orbitals
A. have the same energy
B. have the minimum overlap
C. have same symmetry about the molecular axis
D. have different symmetry about the molecular axis
Choose the most appropriate from the options given below:

[31-Jan-2024 Shift 1]

Options:

A.

A, B, C only

B.

A and C only

C.

B, C, D only

D.

B and D only

Answer: B

Solution:

* Molecular orbital should have maximum overlap

* Symmetry about the molecular axis should be similar

Question12

The number of species from the following in which the central atom uses sp3 hybrid orbitals in its bonding is_____

NH_3, SO_2, SiO_2, $BeCl_2$, CO_2, H_2O, CH_4, BF_3

[31-Jan-2024 Shift 1]

Answer: 4

Solution:

$NH_3 \longrightarrow sp^3$

$SO_2 \longrightarrow sp^2$

$SiO_2 \longrightarrow sp^3$

$BeCl_2 \longrightarrow sp$

$CO_2 \longrightarrow sp$

$H_2O \longrightarrow sp^3$

$CH_4 \longrightarrow sp^3$

$BF_3 \longrightarrow sp^2$

Question13

Which of the following is least ionic?

[31-Jan-2024 Shift 2]

Options:

A.

$BaCl_2$

B.

AgCl

C.

KCl

D.

$CoCl_2$

Answer: B

Solution:

$AgCl < CoCl_2 < BaCl_2 < KCl$ (ionic character)

Reason: Ag^+has pseudo inert gas configuration.

Question14

A diatomic molecule has a dipole moment of 1.2D. If the bond distance is 1Å, then fractional charge on each atom is ___ $\times 10^{-1}$ esu.

(Given 1D = 10^{-18} esu cm)

[31-Jan-2024 Shift 2]

Answer: 0

Solution:

$\mu = 1.2D = q \times d$

$\Rightarrow 1.2 \times 10^{-10}\,esu\,Å = q \times 1Å$

$\therefore q = 1.2 \times 10^{-10}\,esu$

Question15

Arrange the bonds in order of increasing ionic character in the molecules. LiF, K_2O, N_2, SO_2 and CIF_3

[1-Feb-2024 Shift 1]

Options:

A.

$CIF_3 < N_2 < SO_2 < K_2O < LiF$

B.

$LiF < K_2O < CIF_3 < SO_2 < N_2$

C.

$N_2 < SO_2 < CIF_3 < K_2O < LiF$

D.

$N_2 < CIF_3 < SO_2 < K_2O < LiF$

Answer: C

Solution:

Increasing order of ionic character

$N_2 < SO_2 < ClF_3 < K_2O < LiF$

Ionic character depends upon difference of electronegativity (bond polarity).

Question16

Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : PH_3 has lower boiling point than NH_3.
Reason (R) : In liquid state NH_3 molecules are associated through vander waal's forces, but PH_3 molecules are associated through hydrogen bonding.

In the light of the above statements, choose the most appropriate answer from the options given below:

[1-Feb-2024 Shift 1]

Options:

A.

Both (A) and (R) are correct and (R) is not the correct explanation of (A)

B.

(A) is not correct but (R) is correct

C.

Both (A) and (R) are correct but (R) is the correct explanation of (A)

D.

(A) is correct but (R) is not correct

Answer: D

Solution:

Unlike NH_3, PH_3 molecules are not associated through hydrogen bonding in liquid state. That is why the boiling point of PH3 is lower than NH_3.

Question17

The number of molecules/ion/s having trigonal bipyramidal shape is …… .

PF_5, BrF_5, PCl_5, $[PtCl_4]^{2-}$, BF_3, $Fe(CO)_5$

[1-Feb-2024 Shift 1]

Answer: 3

Solution:

PF_5, PCl_5, $Fe(CO)_5$; Trigonal bipyramidal

BrF_5; square pyramidal

$[PtCl_4]^{-2}$; square planar

BF_3; Trigonal planar

Question18

Given below are two statements :

Statement (I) : A π bonding MO has lower electron density above and

below the inter-nuclear asix.
Statement (II) : The π* antibonding MO has a node between the nuclei.

In the light of the above statements, choose the most appropriate answer from the options given below:

[1-Feb-2024 Shift 2]

Options:

A.

Both Statement I and Statement II are false

B.

Both Statement I and Statement II are true

C.

Statement I is false but Statement II is true

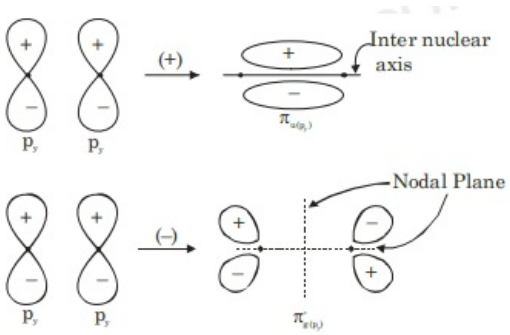
D.

Statement I is true but Statement II is false

Answer: C

Solution:

A π bonding molecular orbital has higher electron density above and below inter nuclear axis



Question19

Select the compound from the following that will show intramolecular hydrogen bonding.

[1-Feb-2024 Shift 2]

Options:

A.

H_2O

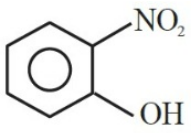
B.

NH_3

C.

C_2H_5OH

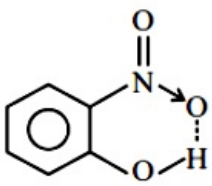
D.



Answer: D

Solution:

$H_2O, NH_3, C_2H_5OH \Rightarrow$ Intermolecular H-Bonding



⇒ Intramolecular H-Bonding

Question20

What is the number of unpaired electron(s) in the highest occupied molecular orbital of the following species : N_2 : N_2^+; O_2; O_2^+?
[24-Jan-2023 Shift 2]

Options:

A. 0, 1, 2, 1

B. 2, 1, 2, 1

C. 0, 1, 0, 1

D. 2, 1, 0, 1

Answer: A

Solution:

N_2

$$\sigma 1\, s^2 \sigma^* 1\, s^2 \sigma 2\, s^2 \sigma^* 2\, s^2 \pi 2p_x^{\,2} = \pi 2p_y^{\,2} \underbrace{\sigma 2p_z^{\,2}}_{\text{HOMO}}$$

$$N_2^+ - \sigma 1\, s^2 \sigma^* 1\, s^2 \sigma^* 2\, s^2 \sigma^* 2\, s^2 \pi 2p_x^{\,2} = \pi 2p_y^{\,2} \underbrace{\sigma 2p_z^{\,1}}_{\text{HOM}}$$

$$O_2 - \sigma 1\, s^2 \sigma^* 1\, s^2 \sigma 2\, s^2 \sigma^* 2\, s^2 \sigma 2p_z^{\,2}$$

$$\pi 2p_x^{\,2} = \pi 2p_y^{\,2}$$

$$\pi^* 2p_x^{\,1} = \pi^* 2p_y^{\,1} (\text{HOMO})$$

$O_2^+ - \sigma s^2\sigma * 1\ s^2\sigma 2\ s^2\sigma * 2\ s^2\sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2$
$\pi * 2p_x^1 = \pi * 2p_y^0$(HOMO)
$N_2 \Rightarrow 0$ unpaired e^- in HOMO
$N_2^+ \Rightarrow 1$ unpaired e^- in HOMO
$O_2 \Rightarrow 2$ unpaired e^- in HOMO
$O_2^+ \Rightarrow 1$ unpaired e^- in HOMO

Question21

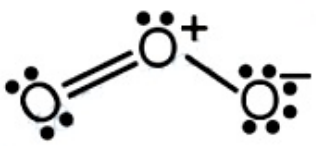
The total number of lone pairs of electrons on oxygen atoms of ozone is _____

[25-Jan-2023 Shift 1]

Answer: 6

Solution:

(Total no, of lone pairs on oxygen atoms = 6



Question22

Statement I :- Dipole moment is a vector quantity and by convention it is depicted by a small arrow with tail on the negative centre and head pointing towards the positive centre.
Statement II :- The crossed arrow of the dipole moment symbolizes the direction of the shift of charges in the molecules.
In the light of the above statements, choose the most appropriate answer from the options given below :-
[25-Jan-2023 Shift 2]

Options:

A. Both Statement I and Statement II are correct.

B. Statement I is incorrect but Statement II is correct.

C. Both Statement I and Statement II are incorrect.

D. Statement I is correct but Statement II is incorrect.

Answer: D

Solution:

Statement II : The corssed arrow symbolises the direction of the shift of electron density in the molecule.

Question23

The number of given orbitals which have electron density along the axis is _____

p_x, p_y, p_z, d_{xy}, d_{yz}, d_{xz}, d_z, $d_{x^2-y^2}$

[25-Jan-2023 Shift 2]

Answer: 5

Solution:

p_x, p_y, p_z, d_{z^2}&$d_{x^2-y^2}$ are axial orbitals.

Question24

According to MO theory the bond orders for O_2^{2-}, CO and NO^+ respectively, are

[29-Jan-2023 Shift 2]

Options:

A. 1,3 and 3

B. 1, 3 and 2

C. 1,2 and 3

D. 2,3 and 3

Answer: A

Solution:

Solution:
Theory based.

Question25

Match List I with List II:

List I (Complexes)	List II (Hybridis ation)
(A) $[Ni(CO)_4]$	I. sp^3
(B) $[Cu(NH_3)_4]^{2+}$	II. dsp^2
(C) $[Fe(NH_3)_6]^{2+}$	III. sp^3d^2
(D) $[Fe(H_2O)_6]^{2+}$	IV. $d^2 sp^3$

[30-Jan-2023 Shift 2]

Options:

A. A - II, B - I, C - III, D - IV

B. A - I, B - II, C - III, D - IV

C. A - II, B - I, C - IV, D - III

D. A - I, B- II, C - IV, D - III

Answer: D

Solution:

Solution:
For $[Fe(NH_3)_6]^{+2}$, $\Delta_0 < P$, hence the pairing of electrons does not occur in t_{2g}. Therefore complex is outer orbital and its hybridisation is sp^3d^2.

List I (Complexes)	List II (Hybridis ation)
$[Ni(CO)_4]$	sp^3
$[Cu(NH_3)_4]^{2+}$	dsp^2
$[Fe(NH_3)_6]^{2+}$	sp^3d^2
$[Fe(H_2O)_6]^{2+}$	sp^3d^2

Question26

Match List I with List II

List I	List II
A. XeF_4	I. See - saw
B. SF_4	II. Square planar
C. NH_4^+	III. Bent T– shaped
D. BrF_3	IV. Tetrahedral

Choose the correct answer from the options given below :
[31-Jan-2023 Shift 1]

Options:

A. A-IV, B-III, C-II, D-I

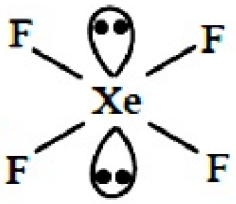
B. A-II, B-I, C-III, D-IV

C. A-IV, B-I, C-II, D-III

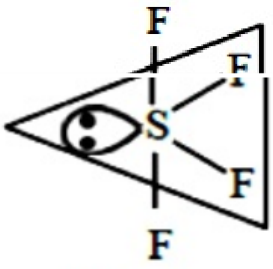
D. A-II, B-I, C-IV, D-III

Answer: D

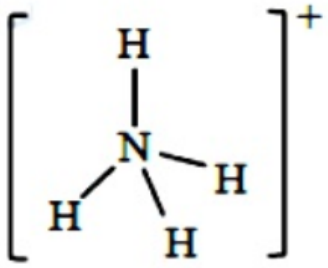
Solution:

(A) 

Square planer

(B) SF_4 

See-Saw

(C) NH_4^+ 

Tetrahedral

(D) BrF_3 

F

Bent T- Shaped

Question27

For OF_2 molecule consider the following:
(A) Number of lone pairs on oxygen is 2 .
(B) FOF angle is less than 104.5˚.
(C) Oxidation state of O is −2.
(D) Molecule is bent ' V ' shaped.
(E) Molecular geometry is linear.
Correct options are:
[30-Jan-2023 Shift 1]

Options:

A. C, D, E only

B. B, E, A only

C. A, C, D only

D. A, B, D only

Answer: D

Solution:

- Two lone pair one oxygen
- Molecule is ' v ' shaped
- Bond angle is less than 104.5˚(102˚)
- O · S· of ' O ' is +2

Question28

Match List I with List II

LIST-I (molecules/ions)	LIST-II (No. of lone pairs of e^- on central atom)
(A) IF_7	I. Three
(B) ICl_4^-	II. One
(C) XeF_6	III. Two
(D) XeF_2	IV. Zero

Choose the correct answer from the options given below:
[30-Jan-2023 Shift 1]

Options:

A. A - II, B - III, C - IV, D - I

B. A - IV, B - III, C - II, D - I

C. A - II, B - I, C - IV, D - III

D. A - IV, B - I, C - II, D - III

Answer: B

Solution:

Solution:

IF_7	zero lone pair
ICl_4^-	two lone pair
XeF_6	one lone pair
XeF_2	three lone pair

Question29

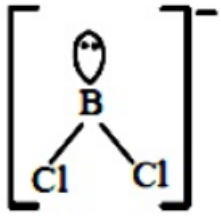
Amongst the following, the number of species having the linear shape is _____.

XeF_2, I_3^+, C_3O_2, I_3^-, CO_2, SO_2, BeCl and BCl_2^{Θ}

[31-Jan-2023 Shift 2]

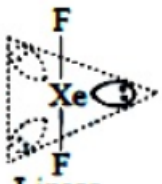
Answer: 5

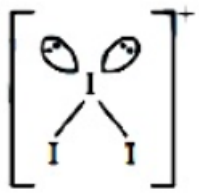
Solution:

(i)  BCl_2^-

(ii) Cl—Be—Cl $BeCl_2$

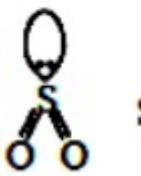
(iii) I_3^- 
Linear

(iv) XeF_2 
Linear

(v)  I_3^+
V - Shape

(vi) CO_2 O = C = O
Linear

(vii C_3O_2 (O=C=C=C=O)
Linear

(viii)  SO_2
V-Shape

Question30

The number of species from the following which have square pyramidal structure is

PF_5, BrF_4^-, IF_5; BrF_5, $XeOF_4$, ICl_4^-

[6-Apr-2023 shift 1]

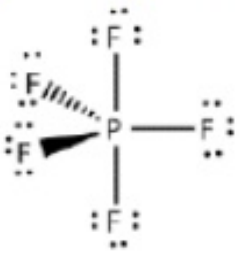
Answer: 3

Solution:

PF_5

sp^3d (0 lone pair)

Trigonal bipyramidal



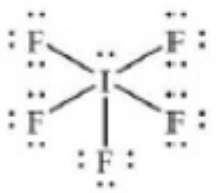
BrF_4^-,

sp^3d^2 (2 lone pair)

square planar

IF_5

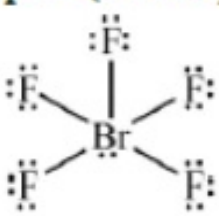
sp^3d^2 (1 lone pair)



square pyramidal

BrF_5

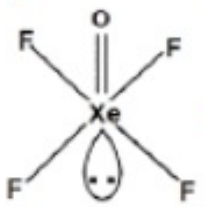
sp^3d^2 (1 lone pair)



square pyramidal

$XeOF_4$

sp^3d^2 (1 lone pair)



square pyramidal

ICl_4^-

sp^3d^2 (2 lone pair)

square planar

Question31

The number of species having a square planar shape from the following is_____

XeF_4, SF_4, SiF_4, BF_4^-, BrF_4^-, $[Cu(NH_3)_4]^{2+}$, $[FeCl_4]^{2-}$, $[PtCl_4]^{2-}$

[6-Apr-2023 shift 2]

Answer: 4

Solution:

XeF_4, BrF_4^{-1}, $[Cu(NH_3)_4]^{+2}$, $[PtCl_4]^{-2}$ has square planar shape.

Question32

In an ice crystal, each water molecule is hydrogen bonded to _____ neighbouring molecules.
[6-Apr-2023 shift 2]

Answer: 4

Solution:

Solution:
In ice each water molecule is hydrogen bonded with four other water molecules.

Question33

Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : Butan-1-ol has higher boiling point than ethoxyethane.
Reason R : Extensive hydrogen bonding leads to stronger association of molecules. In the light of the above statements, choose the correct answer from the options given below:
[8-Apr-2023 shift 1]

Options:

A. Both A and R are true but R is not the correct explanation of A

B. Both A and R are true and R is the correct explanation of A

C. A is false but R is true

D. A is true but R is false

Answer: B

Solution:

Solution:
At comparable molecular mass, alcohol has higher b.p. than ether due to H-bond, because H-bond leads to stronger associated of molecules.

Question34

The number of following factors which affect the percent covalent character of the ionic bond is _____
[8-Apr-2023 shift 1]

Options:

A. Polarising power of cation

B. Extent of distortion of anion

C. Polarisability of the anion

D. Polarising power of anion

Answer: C

Solution:

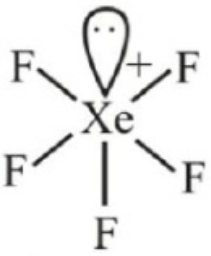
Solution:
Percent covalent character of the ionic bond
(1) Polarising power of cation
(2) Extent of distortion of anion
(3) Polarisability of the anion

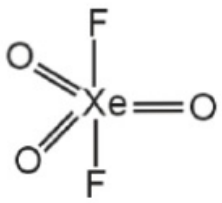
Question35

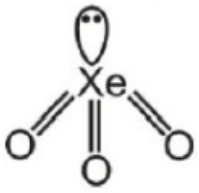
The number of species from the following carrying a single lone pair on central atom Xenon is
_____XeF_5^+, XeO_3, XeO_2F_2, XeF_5^-, XeO_3F_2, $XeOF_4$, XeF_4
[8-Apr-2023 shift 2]

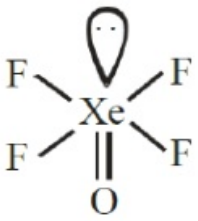
Answer: 4

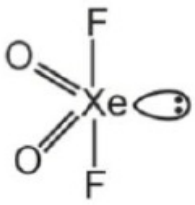
Solution:

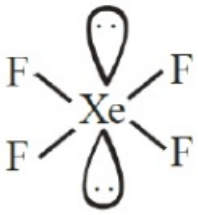
XeF_5^+ 

XeO_3F_2 

XeO_3 

$XeOF_4$ 

XeO_2F_2 

XeF_4 

Question36

The pair from the following pairs having both compounds with net non-zero dipole moment is
[10-Apr-2023 shift 1]

Options:

A. cis-butene, trans-butene

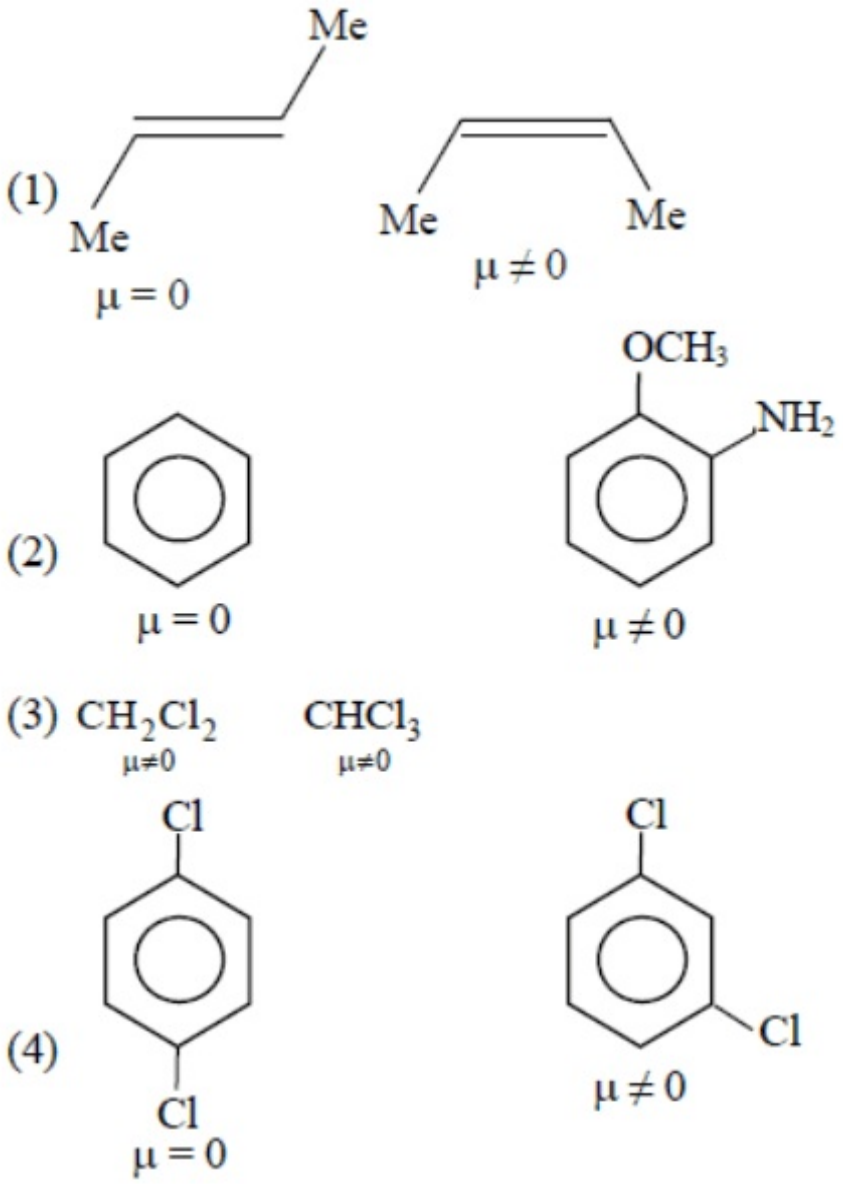
B. Benzene, anisidine

C. CH_2Cl_2, $CHCl_3$

D. 1,4-Dichlorohenzene, 1,3-Dichlorobenzene

Answer: C

Solution:



Question37

The compound which does not exist is
[10-Apr-2023 shift 1]

Options:

A. $PbEt_4$

B. BeH_2

C. NaO_2

D. $(NH_4)_2BeF_4$

Answer: C

Solution:

Sodium superoxide is not stable

Question38

The number of bent-shaped molecule/s from the following is _____
N_3^-, NO_2^-, I_3^-, O_3, SO_2
[10-Apr-2023 shift 1]

Answer: 3

Solution:

N_3^-linear
NO_2^-bent
I_3^-linear
O_3 bent
SO_2 bent

Question39

The sum of lone pairs present on the central atom of the interhalogen IF_5 and IF_7 is _____
[10-Apr-2023 shift 1]

Options:

Answer: 1

Solution:

IF_5 = 1 lone pair
IF_7 = 0 lone pair
1 + 0 = 1

Question40

Match list I with list II

List I Species	List II Geometry/ Shape
A. H_3O^+	I. Tetrahedral
B. Acetylide anion	II. Linera
C. NH_4^+	III. Pyramidal
D. ClO_2^-	IV. Bent

Choose correct answer from the options given below: [11-Apr-2023 shift 1]

Options:

A. A-III, B-IV, C-I, D-II

B. A-III, B-IV, C-II, D-I

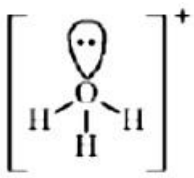
C. A-III, B-I, C-II, D-IV

D. A-III, B-II, C-I, D-IV

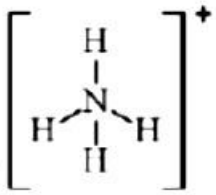
Answer: D

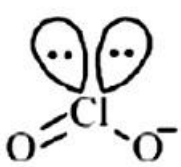
Solution:

Molecule/Ion Hybridisation Shape

H_3O^+ sp^3 Pyramidal 

Acelylide sp linear $\bar{C} \equiv \bar{C}$

NH_4^+ sp^3 tetrahedral 

ClO_2^- sp^3 Bent 

Question41

Which one of the following pairs is an example of polar molecular solids?
[11-Apr-2023 shift 2]

Options:

A. SO_2(s), CO_2(s)

B. SO_2(s), NH_2 (s)

C. MgO(s), SO_2 (s)

D. HCl (s), AlN(s)

Answer: B

Solution:

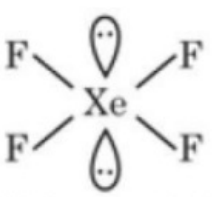
SO_2 and NH_3 are polar molecules. They are constituent particles of polar molecular solids.

Question42

The maximum number of lone pairs of electrons on the central atom from the following species is _____
ClO_3^-, XeF_4, SF_4 and I_3^-
[11-Apr-2023 shift 2]

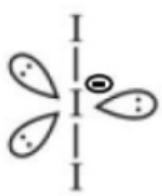
Answer: 3

Solution:

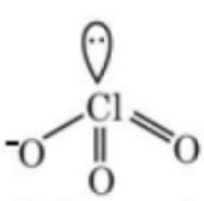


[2 lone pair]

[1 lone pair]



[3 lone pair]



[1 lone pair]

Question43

The bond order and magnetic property of acetylide ion are same as that of
[12-Apr-2023 shift 1]

Options:

A. N_2^+

B. O_2^+

C. NO^+

D. O_2^-

Answer: C

Solution:

$CH \equiv C^- \quad NO^+ \rightarrow 14$
$B.O \quad = 3 \quad 1B \cdot O = 3$
Both are diamagnetic because both have absence of unpaired electron.

Question44

Given below are two statements :
Statement I : $SbCl_5$ is more covalent than $SbCl_3$
Statement II : The higher oxides of halogens also tend to be more stable than lower ones.
In the light of the above statements, choose the most appropriate answer from the options given below
[12-Apr-2023 shift 1]

Options:

A. Statement I is correct but statement II is incorrect

B. Both statement I and statement II are incorrect

C. Both statement I and statement II are correct

D. Statement I is incorrect but statement II is correct

Answer: C

Solution:

I → $SbCl^{+5}$ is more covalent due to sb in higher 0.5 more covalent due to more charge.
II → Higher oxides of halogen tend to be more stable because higher oxidation states are less reactive and also the size of the atoms are more higher so they are less reactive.

Question45

In which of the following processes, the bond order increases and paramagnetic character changes to diamagnetic one? [13-Apr-2023 shift 1]

Options:

A. $O_2 \rightarrow O_2^+$

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

C. $NO \rightarrow NO^+$

D. $N_2 \rightarrow N_2^+$

Answer: C

Solution:

NO is paramagnetic with BO = 2.5, $NO^+$is diamagnetic with BO = 3

Question46

CIF_5 at room temperature is a: [13-Apr-2023 shift 1]

Options:

A. Colourless liquid with square pyramidal geometry

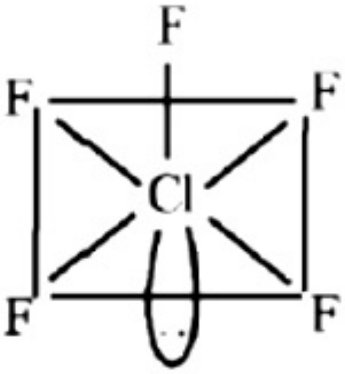
B. Colourless gas with trigonal bipyramidal geometry

C. Colourless gas with square pyramidal geometry

D. Colourless liquid with trigonal bipyramidal geometry

Answer: A

Solution:



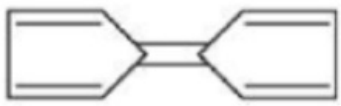
ClF_5 is colourless liquid.

Question47

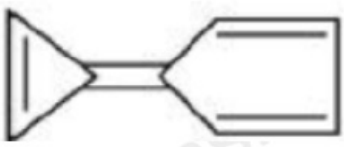
Among the following compounds, the one which shows highest dipole moment is
[13-Apr-2023 shift 1]

Options:

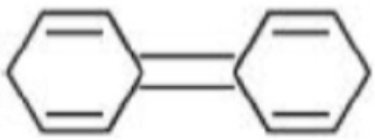
A.



B.



C.

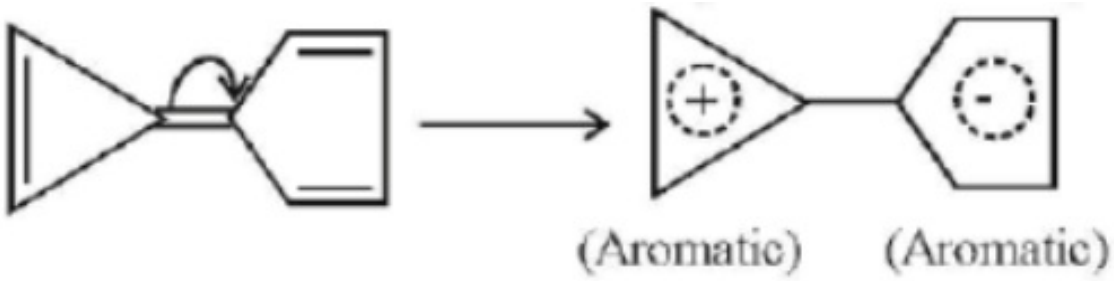


D.

Answer: B

Solution:

Among the given compounds, the following compound has the highest dipole moment because both the +ve and -ve ends acquire aromaticity.



Question48

Match List I with List II

LIST I	LIST II
A. Weak intermolecular farces of attraction	I. Hexamethylenendiamine + adipic
B. Hydrogen bonding	II. $AlEt_3 + TiCl_4$
C. Heavily branched polymer	III. 2-chloro-1,3-butadiene
D. High density polymer	IV. Phenol + formaldehyde

Choose the correct answer from the options given below : [13-Apr-2023 shift 2]

Options:

A. A-IV, B-I, C-III, D-II

B. A-III, B-I, C-IV, D-II

C. A-II, B-IV, C-I, D-III

D. A-IV, B-II, C-III, D-I

Answer: B

Solution:

- Hexamethylenediamine on reaction with adipic acid forms Nylon 6, 6 which shows H-bonding due to presence of amide group.
- $AlEt_3 + TiCl_4$ is Ziegler-Natta catalyst used to prepare high density polyethylene.
- 2-chloro-1, 3-butadiene (chloroprene) is monomer of neoprene which is a rubber (an elastomer)
- Phenol - formaldehyde forms Bakelite which is heavily branched (cross-linked) polymer

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Question49

Given below are two statements :
Statement I: SO_2 and H_2O both possess V-shaped structure.
Statement II : The bond angle of SO_2 less than that of H_2O
In the light of the above statements, choose the most appropriate answer from the options given below :
[13-Apr-2023 shift 2]

Options:

A. Both Statements I and Statement II are incorrect

B. Both Statement I and Statements II are correct

C. Statement I is correct but Statement II is incorrect

D. Statements I is incorrect but Statement II is correct

Answer: C

Solution:

Solution:
Both are bent in shape.
Bond angle of SO_2(sp^2) is greater than that of H_2O(sp^3) due to higher repulsion of multiple bonds.

Question50

Consider the following statements:
(A) NF_3 molecule has a trigonal planar structure.
(B) Bond length of N_2 is shorter than O_2

(C) Isoelectronic molecules or ions have identical bond order
(D) Dipole moment of HS is higher than that of water molecule.
Choose the correct answer from the options given below:
[15-Apr-2023 shift 1]

Options:

A. (A) and (B) are correct

B. (C) and (D) are correct

C. (B) and (C) are correct

D. (A) and (D) are correct

Answer: C

Solution:

$N_2 + O_2$
$N \equiv NO = O$
B.O. $-3 > 2$
B.L. $3 < 2$
Isoelectronic haveIdentical bond order

Question51

The correct order of bond orders of C_2^{2-}, N_2^{2-} and O_2^{2-} is, respectively
[24-Jun-2022-Shift-2]

Options:

A. $C_2^{2-} < N_2^{2-} < O_2^{2-}$

B. $O_2^{2-} < N_2^{2-} < C_2^{2-}$

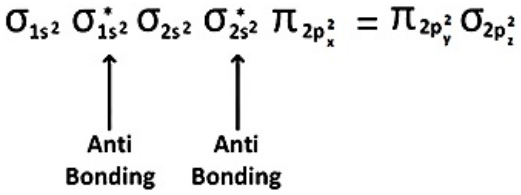
C. $C_2^{2-} < O_2^{2-} < N_2^{2-}$

D. $N_2^{2-} < C_2^{2-} < O_2^{2-}$

Answer: B

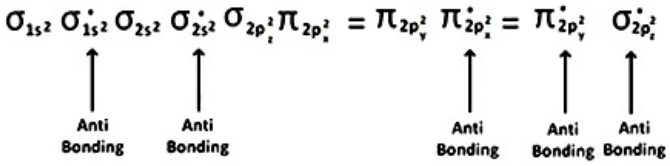
Solution:

(1) Bond order $= \frac{1}{2}[N_b - N_a]$
$N_b =$ No of electrons in bonding molecular orbital
$N_a =$ No of electrons in anti bonding molecular orbital
(2) upto 14 electrons, molecular orbital configuration is



Here N_a = Anti bonding electron = 4 and N_b = 10

(3) After 14 electrons to 20 electrons molecular orbital configuration is -



Here $N_a = 10$

and $N_b = 10$

In O atom 8 electrons present, so in O_2, $8 \times 2 = 16$ electrons present.

in O_2^{2-} no of electrons = 18

(A) Molecular orbital configuration of O_2^{2-}(18 electrons) is

$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^2}{}^* = \pi_{2p_y{}^2}{}^*$

$\therefore\ N_b = 10$

$N_a = 8$

$\therefore\ BO = \frac{1}{2}[10 - 8] = 1$

(B) C_2^{2-} has 14 electrons.

Moleculer orbital configuration of C_2^{2-} is

$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\sigma_{2p_z{}^2}$

$\therefore N_a = 4$

$N_b = 10$

$\therefore\ BO = \frac{1}{2}[10 - 4] = 3$

(C) N_2^{2-} has 16 electrons.

Moleculer orbital configuration of N_2^{2-} is

$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\sigma_{2p_z{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^1}{}^*$

$\therefore N_a = 6$

$N_b = 10$

$\therefore\ BO = \frac{1}{2}[10 - 6] = 2$

The correct order of bond orders of C_2^{2-}, N_2^{2-} and O_2^{2-}

$O_2^{2-} < N_2^{2-} < C_2^{2-}$

Question52

Bonding in which of the following diatomic molecule(s) become(s) stronger, on the basis of MO Theory, by removal of an electron?

(A) NO

(B) N_2

(C) O_2

(D) C_2

(E) B_2

Choose the most appropriate answer from the options given below: [25-Jun-2022-Shift-1]

Options:

A. (A), (B), (C) only

B. (B), (C), (E) only

C. (A), (C) only

D. (D) only

Answer: C

Solution:

Solution:
If an electron is removed from the anti-bonding orbital, then it will tend to increase the bond order. The HOMO in NO and O_2 is antibonding molecular orbital.
Hence, in NO and O_2 bond order will increase on loss of electron.

Question53

Amongst BeF_2, BF_3, H_2O, NH_3, CCl_4 and HCl, the number of molecules with non-zero net dipole moment is____ [25-Jun-2022-Shift-2]

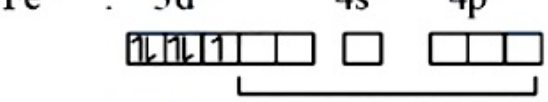
Answer: 3

Solution:

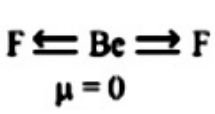
BeF_2, BF_3 and $CCl_4 \Rightarrow \mu_{net} = 0$

H_2O, NH_3 and $HCl \Rightarrow \mu_{net} \neq 0$

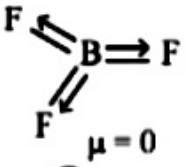
$K_3[Fe(CN)_6]$: Fe^{3+} : $3d^5$ $4s^0$ $4p^0$



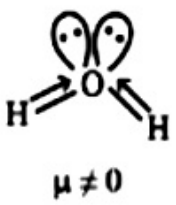
1 unpaired e⁻ d^2sp^3



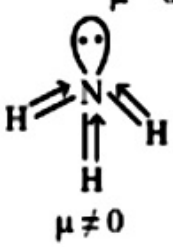
$\mu = 0$



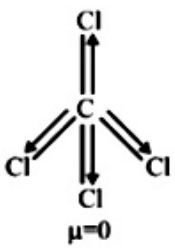
$\mu = 0$



$\mu \neq 0$



$\mu \neq 0$



$\mu = 0$

$\mu \neq 0$

Question54

Consider the ions/molecule
O_2^+, O_2, O_2^-, O_2^{2-}
For increasing bond order the correct option is : [26-Jun-2022-Shift-1]

Options:

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

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

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

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

Answer: A

Solution:

Solution:
(1) Bond strength $\propto$ Bond order

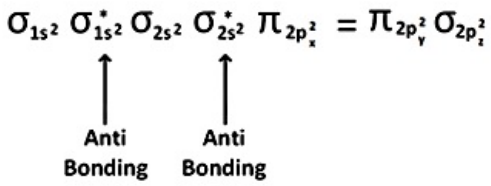
(2) Bond length $\propto \frac{1}{\text{Bond order}}$

(3) Bond order $= \frac{1}{2}[N_b - N_a]$

N_b = No of electrons in bonding molecular orbital

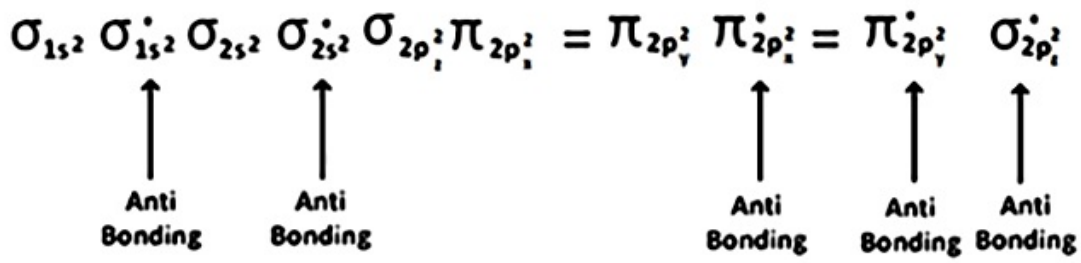
N_a = No of electrons in anti bonding molecular orbital

(4) upto 14 electrons, molecular orbital configuration is



Here N_a = Anti bonding electron = 4 and N_b = 10

(5) After 14 electrons to 20 electrons molecular orbital configuration is - - -



Here $N_a = 10$

and $N_b = 10$

In O atom 8 electrons present, so in O_2, $8 \times 2 = 16$ electrons present.

Then in O_2^+no of electrons = 15

in O_2^-no of electrons = 17

in O_2^{2-} no of electrons = 18

$\therefore$ Molecular orbital configuration of O_2 (16 electrons) is

$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^1}{}^*$
$\therefore N_a = 6$
$N_b = 10$
$\therefore$ BO $= \frac{1}{2}[10-6] = 2$

Molecular orbital configuration of O_2^+(15 electrons) is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^o}{}^*$
$\therefore N_b = 10$
$N_a = 5$
$\therefore$ BO $= \frac{1}{2}[10-5] = 2.5$

Molecular orbital configuration of O_2^-(17 electrons) is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^2}{}^* = \pi_{2p_y{}^1}{}^*$
$\therefore N_b = 10$
$N_a = 7$

$\therefore$ BO $= \frac{1}{2}[10-7] = 1.5$

Molecular orbital configuration of O_2^{2-} (18 electrons) is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^2}{}^* = \pi_{2p_y{}^2}{}^*$
$\therefore N_b = 10$
$N_a = 8$
$\therefore$ BO $= \frac{1}{2}[10-8] = 1$

So, correct order of Bond order is
$O_2^{2-} < O_2^- < O_2 < O_2^+$

Question55

The oxide which contains an odd electron at the nitrogen atom is [26-Jun-2022-Shift-2]

Options:

A. N_2O

B. NO_2

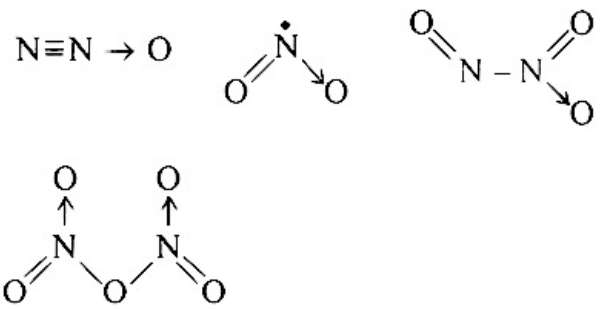
C. N_2O_3

D. N_2O_5

Answer: B

Solution:

Solution:
The oxide of nitrogen which contains odd electron is NO_2



Question56

Amongst SF_4, XeF_4, CF_4 and H_2O, the number of species with two lone pairs of electrons is_____
[26-Jun-2022-Shift-2]

Answer: 2

Solution:

Solution:
Number of lone pair on central atom for H_2O and XeF_4 is equal to 2.

Question57

Based upon VSEPR theory, match the shape (geometry) of the molecules in List-I with the molecules in List-II and select the most appropriate option.

	List - I (Shape)		List - II (Molecules)
(A)	T-shaped	(I)	XeF_{44}
(B)	Trigonal planar	(II)	SF_{44}
(C)	Square planar	(III)	ClF_{33}
(D)	See-saw	(IV)	BF_{33}

[27-Jun-2022-Shift-1]

Options:

A. (A) − (I), (B) − (II), (C) − (III), (D) − (IV)

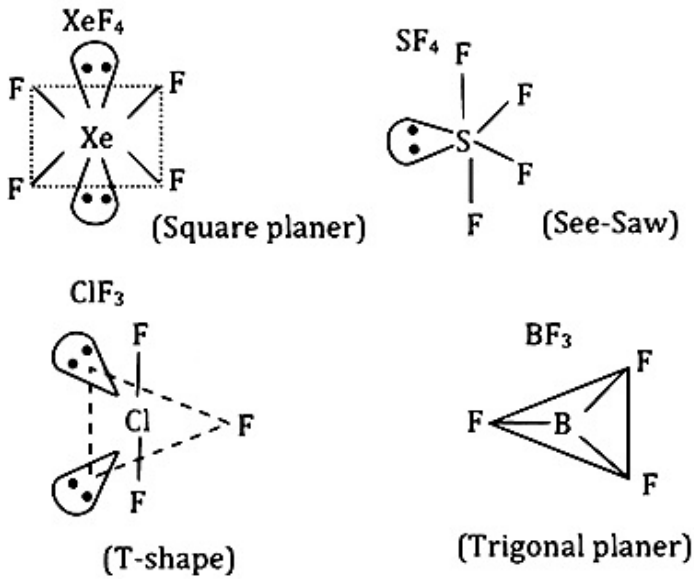
B. (A) - (III), (B) - (IV), (C) - (I), (D) - (II)

C. (A) − (III), (B) − (IV), (C) − (I), (D) − (I)

D. (A) − (IV), (B) − (III), (C) − (I), (D) − (II)

Answer: B

Solution:



Question58

Identify the incorrect statement for PCl_5 from the following. [27-Jun-2022-Shift-2]

Options:

A. In this molecule, orbitals of phosphorous are assumed to undergo sp^3d hybridization.

B. The geometry of PCl_5 is trigonal bipyramidal.

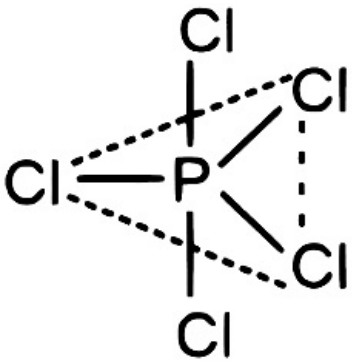
C. PCl_5 has two axial bonds stronger than three equatorial bonds.

D. The three equatorial bonds of PCl_5 lie in a plane.

Answer: C

Solution:

Solution:
PCl_5
All three equatorial bonds in a plane



sp^3d hybridization
Trigonal bipyramidal
Axial bonds are weaker than equatorial bonds.

Question59

The correct order of increasing intermolecular hydrogen bond strength is
[27-Jun-2022-Shift-2]

Options:

A. $HCN < H_2O < NH_3$

B. $HCN < CH_4 < NH_3$

C. $CH_4 < HCN < NH_3$

D. $CH_4 < NH_3 < HCN$

Answer: C

Solution:

Solution:
Due to the high difference in electronegativity of H and N the H-bond strength of NH_3 is highest. There is no H bond in CH_4.
$CH_4 < HCN < NH_3$

Question60

The hybridization of P exhibited in PF_5 is sp^xd^y. The value of y is___
[28-Jun-2022-Shift-1]

Answer: 1

Solution:

PF_5 ⇒ sp^3d hybridisation
(5 sigma bonds, zero lone pair on central atom)
Value of y = 1

Question61

In the structure of SF_4, the lone pair of electrons on S is in. [28-Jun-2022-Shift-2]

Options:

A. equatorial position and there are two lone pair - bond pair repulsions at 90˚.

B. equatorial position and there are three lone pair - bond pair repulsions at 90˚.

C. axial position and there are three lone pair - bond pair repulsion at 90˚.

D. axial position and there are two lone pair - bond pair repulsion at 90˚.

Answer: A

Solution:

Solution:
SF_4 → sp^3d hybridisation.
The lone pair of electrons on S is in an equatorial position and there are two lone pair-bond pair repulsions at 90˚.

Question62

Arrange the following in the decreasing order of their covalent character:
(A) LiCl
(B) NaCl
(C) KCl
(D) CsCl
Choose the most appropriate answer from the options given below : [29-Jun-2022-Shift-1]

Options:

A. (A) > (C) > (B) > (D)

B. (B) > (A) > (C) > (D)

C. (A) > (B) > (C) > (D)

D. (A) > (B) > (D) > (C)

Answer: C

Solution:

Covalent character ∝ polarising power of cation
Correct decreasing order of covalent character
LiCl > NaCl > KCl > CsCl

Question63

Consider the species CH_4, $NH_4^+$and BH_4^-. Choose the correct option with respect to the these species.
[29-Jun-2022-Shift-2]

Options:

A. They are isoelectronic and only two have tetrahedral structures.

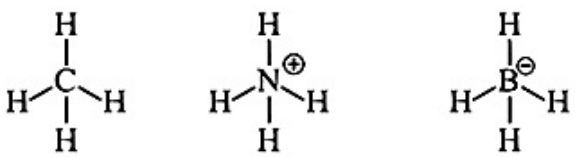
B. They are isoelectronic and all have tetrahedral structures.

C. Only two are isoelectronic and all have tetrahedral structures.

D. Only two are isoelectronic and only two have tetrahedral structures.

Answer: B

Solution:



All are tetrahedral and each have 10 electrons.

Question64

Number of lone pair(s) of electrons on central atom and the shape BrF_3 molecule respectively, are
[29-Jun-2022-Shift-2]

Options:

A. 0, triangular planar.

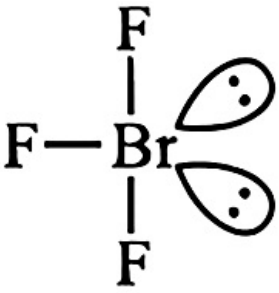
B. 1, pyramidal.

C. 2, bent T-shape.

D. 1, bent T-shape.

Answer: C

Solution:



Steric no. = 5(sp^3d), lone pair = 2
Bent T shape.

Question65

Among the following species
N_2, N_2^+, N_2^-, N_2^{2-}, O_2, O_2^+, O_2^-, O_2^{2-}
the number of species showing dimagnesium is
[25-Jul-2022-Shift-1]

Answer: 2

Solution:

Those species which have unpaired electrons are called paramagnetic species.
And those species which have no unpaired electrons are called diamagnetic species.
(1) N_2 has 14 electrons.
Moleculer orbital configuration of N_2
$= \sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\sigma_{2p_z{}^2}$
Here no unpaired electron present, so it is diamagnetic.
(2) Moleculer orbital configuration of N_2^+(13 electrons)
$= \sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\sigma_{2p_z{}^1}$
Here in N_2^+, 1 unpaired electron present, so it is paramagnetic.
(3) N_2^{2-} has 16 electrons.
Moleculer orbital configuration of N_2^{2-} is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^1}{}^*$
Here 2 unpaired electron present, so it is paramagnetic.
(4) N_2^-has 15 electrons.
Moleculer orbital configuration of $N_2^-$is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^0}{}^*$
Here 1 unpaired electron present, so it is paramagnetic.
(a) O_2^{2-} has 18 electrons.

Moleculer orbital configuration of O_2^{2-} is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^2}{}^* = \pi_{2p_y{}^2}{}^*$
Here is no unpaired electron so it is diamagnetic.
(b) O_2^-has 17 electrons.
Moleculer orbital configuration of O_2^{2-} is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^2}{}^* = \pi_{2p_y{}^1}{}^*$
Here 1 unpaired electron present, so it is paramagnetic.
(c) O_2 has 16 electrons.

Moleculer orbital configuration of O_2 is

$\sigma_{1s^2}\sigma_{1s^2}{}^*\,\sigma_{2s^2}\sigma_{2s^2}{}^*\,\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^1}{}^*$

Here 2 unpaired electron present, so it is paramagnetic.

(d) $O_2{}^+$has 15 electrons.

Moleculer orbital configuration of $O_2{}^+$is

$\sigma_{1s^2}\sigma_{1s^2}{}^*\,\sigma_{2s^2}\sigma_{2s^2}{}^*\,\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^0}{}^*$

Here 1 unpaired electron present, so it is paramagnetic.

Question66

The total number of acidic oxides from the following list is NO, N_2O, B_2O_3, N_2O_5, CO, SO_3, P_4O_{10}

[25-Jul-2022-Shift-2]

Options:

A. 3

B. 4

C. 5

D. 6

Answer: B

Solution:

Solution:

NO, N_2O, CO - neutral oxides

B_2O_3, N_2O_5, SO_3, P_4O_{10}– acidic oxides

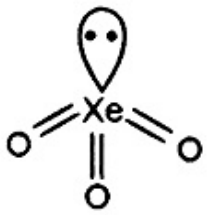
Question67

The sum of number of lone pairs of electrons present on the central atoms of XeO_3, $XeOF_4$ and XeF_6, is

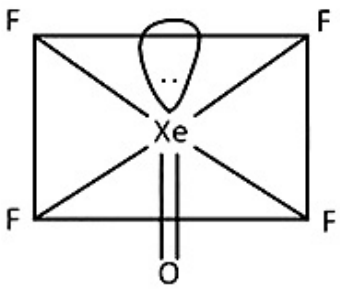
[25-Jul-2022-Shift-2]

Answer: 3

Solution:

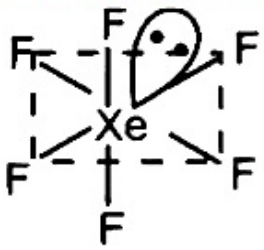


lone pair
on central atom = 1



sp^3d^2 hybridization

From structure, it is clear that it has five bond pairs and one lone pair.



lone pair
on central atom = 1

Question68

Match List-I with List-II :

List I (Compound)	List II (Shape)
(A) BrF_5	(I)bent
(B) $[CrF_6]^{3-}$	(II) square pyramidal
(C) O_3	(III) trigonal bipyramidal
(D) PCl_5	(IV) octahedral

Choose the correct answer from the options given below :
[26-Jul-2022-Shift-1]

Options:

A. (A) − (I), (B) − (II), (C) − (II), (D) − (IV)

B. (A) − (IV), (B) − (II), (C) − (II), (D) − (I)

C. (A) − (II), (B) − (IV), (C) − (I), (D) − (III)

D. (A) − (II), (B) − (IV), (C) − (II), (D) − (I)

Answer: C

Solution:

Solution:
(A) BrF_5 - square pyramidal
(B) $[CrF_6]^{3-}$ - octahedral
(C) O_3 − bent
(D) PCl_5 - trigonal bipyramidal

Question69

Arrange the following in increasing order of their covalent character.
A. CaF_2
B. $CaCl_2$
C. $CaBr_2$
D. CaI_2
Choose the correct answer from the options given below.
[26-Jul-2022-Shift-2]

Options:

A. B < A < C < D

B. A < B < C < D

C. A < B < D < C

D. A < C < B < D

Answer: B

Solution:

From Fajan's rule, for a given metal ion, as the size of anion increases, polarizability of anion increases and hence covalent character of the given ionic compound increases.
Hence, the increasing order of covalent character is $CaF_2 < CaCl_2 < CaBr_2 < CaI_2$

Question70

Given below are two statements.
Statement I_2O_2, Cu^{2+}, and Fe^{3+} are weakly attracted by magnetic field and are magnetized in the same direction as magnetic field.
Statement II: NaCl and H_2O are weakly magnetized in opposite direction to magnetic field.
In the light of the above statements, choose the most appropriate answer from the options given below.
[27-Jul-2022-Shift-1]

Options:

A. Both Statement I and Statement II are correct.

B. Both Statement I and Statement II are incorrect.

C. Statement I is correct but Statement II is incorrect.

D. Statement I is incorrect but Statement II is correct.

Answer: A

Solution:

Solution:
O_2, Cu^{2+} and Fe^{3+} have 2,1 and 5 unpaired electrons respectively, so these are the paramagnetic species. Hence, they are attracted by magnetic field.
NaCl and H_2O are the diamagnetic species so they are repelled by the magnetic field.

Question71

Amongst the following, the number of oxide(s) which are paramagnetic in nature is
Na_2O, KO_2, NO_2, N_2O, ClO_2, NO, SO_2, Cl_2O
[27-Jul-2022-Shift-1]

Answer: 4

Solution:

Solution:
Paramagnetic species: KO_2, NO_2, ClO_2, NO
Diamagnetic species are: Na_2O, N_2O, SO_2, Cl_2O

Question72

According to MO theory, number of species/ions from the following having identical bond order is _____.
CN^-, NO^+, O_2, O_2^+, O_2^{2+}
[27-Jul-2022-Shift-1]

Answer: 3

Solution:

Solution:
CN^-, $NO^+$and O_2^{2+} have bond order of 3
O_2 has bond order of 2
O_2^+has bond order of 2.5
$\therefore$3 species have similar bond order.

Question73

Match List - I with List - II.

List I	List II
(A)$\psi_{MO} = \psi_A - \psi_B$	(I)Dipole moment
(B) $\mu = Q \times r$	(II)Bonding molecular orbital
(C) $\frac{N_b - N_a}{2}$	(III)Anti-bonding molecular orbital
(D)$\psi_{MO} = \psi_A + \psi_B$	(IV)Bond order

Choose the correct answer from the options given below : [27-Jul-2022-Shift-2]

Options:

A. (A) − (II), (B) − (I), (C) − (IV), (D) − (III)

B. (A) − (III), (B) − (IV), (C) − (I), (D) − (II)

C. (A) − (III), (B) − (I), (C) − (IV), (D) − (II)

D. (A) − (III), (B) − (IV), (C) − (II), (D) − (I)

Answer: C

Solution:

Solution:
$\Psi_A - \Psi_B = \Psi_{MO}$ is anti-boding molecular orbital
$\mu = Q \times r$ -is dipole moment
$\frac{N_b - N_a}{2}$ = bond order
$\Psi_A + \Psi_B = \Psi_{MO}$ is bonding molecular orbital.

Question74

The number of molecule(s) or ion(s) from the following having non-planar structure is _____.
NO_3^-, H_2O_2, BF_3, PCl_3, XeF_4, SF_4, XeO_3, PH_4^+, SO_3, $[Al(OH)_4]^-$
[27-Jul-2022-Shift-2]

Answer: 6

Solution:

$NO_3^{\ominus}$→ Trigonal planar (Planar)
H_2O_2→ Open book (Non-planar)
BF_3→ Trigonal planar (Planar)
PCl_3→ Pyramidal (Non-planar)
XeF_4→ Square planar (Planar)
SF_4→ See-Saw (Non-planar) XeO_3→ Pyramidal (Non-planar)
$PH_4^{\oplus}$→ Tetrahedral (Non-planar)
SO_3→ Trigonal planar (Planar)
$[Al(OH)_4]^-$→ Tetrahedral (Non-planar)

Question75

The number of paramagnetic species among the following is _____.
B_2, Li_2, C_2, C_2^-, O_2^{2-}, O_2^+ and He_2^+
[28-Jul-2022-Shift-1]

Answer: 4

Solution:

Those species which have unpaired electrons are called paramagnetic species.
And those species which have no unpaired electrons are called diamagnetic species.
B_2 has 10 electrons.
Molecular orbital configuration of B_2 is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\pi_{2p_x{}^1} = \pi_{2p_y{}^1}$
Here two unpaired electrons present. So it is paramagnetic.
O_2^{2-} has 18 electrons.
Moleculer orbital configuration of O_2^{2-} is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^2}{}^* = \pi_{2p_y{}^2}{}^*$
Here is no unpaired electron so it is diamagnetic.
O_2^+has 15 electrons.
Moleculer orbital configuration of $O_2^+$is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\sigma_{2p_z{}^2}\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\pi_{2p_x{}^1}{}^* = \pi_{2p_y{}^0}{}^*$
Here 1 unpaired electron present, so it is paramagnetic.
C_2 has 12 electrons.
Moleculer orbital configuration of C_2
$= \sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\pi_{2p_x{}^2} = \pi_{2p_y{}^2}$
Here no unpaired electron present, so it is diamagnetic.
C_2^-has 13 electrons.

Moleculer orbital configuration of $C_2^-$is
$\sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}\sigma_{2s^2}{}^*\pi_{2p_x{}^2} = \pi_{2p_y{}^2}\sigma_{2p_z{}^1}$
Here 1 unpaired electron present, so it is paramagnetic.
Li_2 has 6 electrons.

$Li_2 = \sigma_{1s^2}\sigma_{1s^2}{}^*\sigma_{2s^2}$
Here no unpaired electron present, so it is diamagnetic.
Configuration of He_2^+(3 electrons) is $= \sigma_{1s^2}\sigma_{1s^1}{}^*$

Here 1 unpaired electron present, so it is paramagnetic.

Question76

Given below are two statements: One is labelled as Assertion A and the other is labelled as Reason R
Assertion A : Zero orbital overlap is an out of phase overlap.
Reason R: It results due to different orientation \/ direction of approach of orbitals.
In the light of the above statements, choose the correct answer from the options given below
[28-Jul-2022-Shift-2]

Options:

A. Both A and R are true and R is the correct explanation of A

B. Both A and R are true but R is NOT the correct explanation of A

C. A is true but R is false

D. A is false but R is true

Answer: A

Solution:

Zero overlapping is something in which there is no overlapping between two orbitals. The first condition is that the two orbitals should not be symmetrical and the second condition is that both orbitals should be in different planes.

Question77

Number of lone pairs of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6, respectively, are :
[29-Jul-2022-Shift-1]

Options:

A. 0, 1, 2 and 2

B. 2, 1, 2 and 0

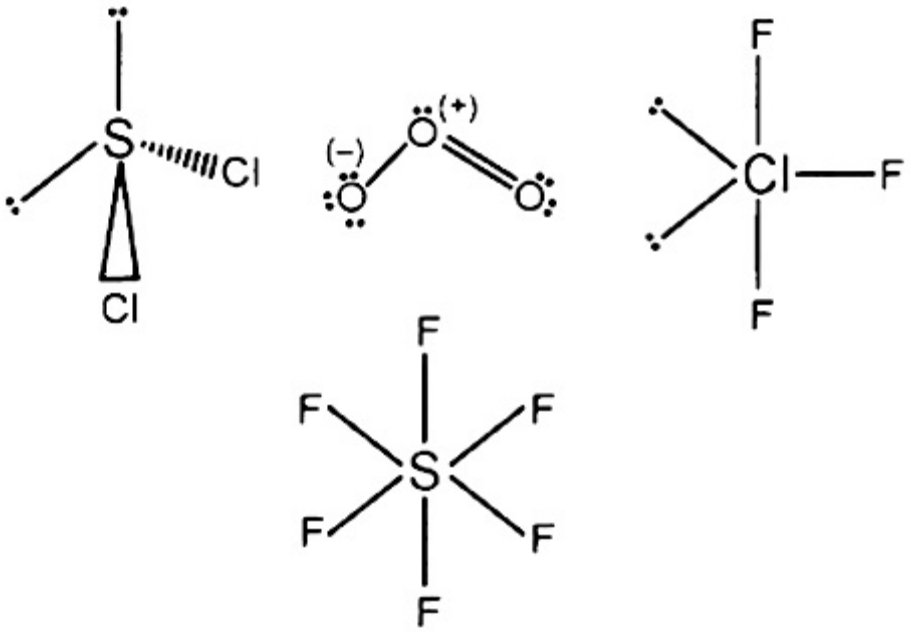
C. 1, 2, 2 and 0

D. 2, 1, 0 and 2

Answer: B

Solution:

The number of lone pair of electrons in the central atom of SCl_2, O_3, ClF_3 and SF_6 are 2, 1, 2 and 0 respectively
Their structures are as,

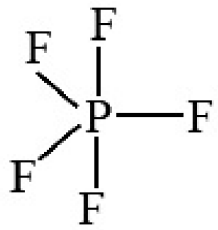


Question78

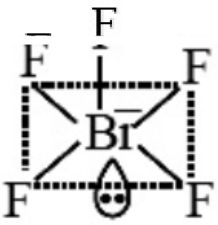
Consider, PF_5, BrF_5, PCl_3, SF_6, $[ICl_4]^-$, ClF_3 and IF_5.
Amongst the above molecule(s)/ion(s), the number of molecule(s)/ion(s) having sp^3d^2 hybridisation is _____.
[29-Jul-2022-Shift-2]

Answer: 4

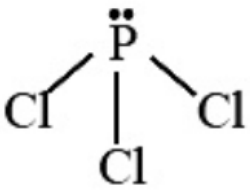
Solution:



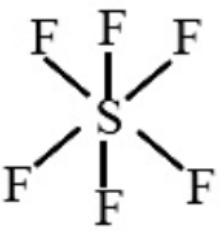
→ sp^3d Hybridisation



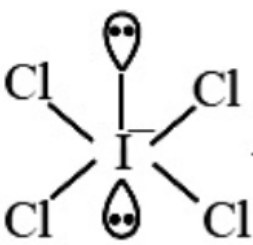
→ sp^3d^2 Hybridisation



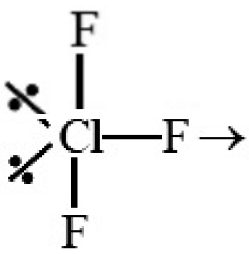
→ sp^3 Hybridisation



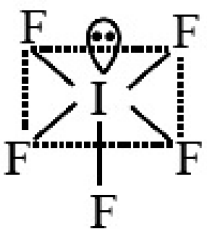
→ sp^3d^2 Hybridisation



→ sp^3d^2 Hybridisation



→ sp^3d Hybridisation



→ sp^3d^2 Hybridisation

Question79

Match List-I with List-II

	List-I(Molecule)		List-II(Bond order)
A.	Ne_2	(i)	1
B.	N_2	(ii)	2
C.	F_2	(iii)	0
D.	O_2	(iv)	3

Choose the correct answer from the options given below.
[26 Feb 2021 Shift 2]

Options:

A. (A-iii), (B-iv), (C-i), (D-ii)

B. (A-i), (B-ii), (C-iii), (D-iv)

C. (A-ii), (B-i), (C-iv), (D-iii)

D. (A-iv), (B-iii), (C-ii), (D-i)

Answer: A

Solution:

(A) $Ne_2(20e^-)$

$\Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 \pi 2p_y^2 \pi^* 2p_x^2 \pi^* 2p_y^2 \sigma^* 2p_z^2$

Bond order $= \frac{10-10}{2} = 0 \Rightarrow$ (iii) of List-II.

(B) $N_2(14e^-)$

$\Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2, \pi 2p_y^2 \sigma 2p$

Bond order $= \frac{10-4}{2} = 3 \Rightarrow$ (iv) of List-II.

(c) $F_2(18e^-)$

$\Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 \pi 2p_y^2 \pi^* 2p_y^2 \pi^* 2$

Bond order $= \frac{10-8}{2} = 1 \Rightarrow$ (i) of List-II.

(d) $O_2(16e^-)$

$\Rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 \pi 2p_y^2 \pi^* 2p_x^1 \pi^* 2p_y^1$

Bond order $= \frac{10-6}{2} = 2 \Rightarrow$ (ii) of List-II.

The correct matching is option (a).

No. of electrons in antibonding MO (Molecular Orbital)

Note : Bond order $= \frac{-\text{ No. of electrons in bonding MO}}{2}$

Question80

According to molecular orbital theory, the species among the following that does not exist is
[25 Feb 2021 Shift 1]

Options:

A. O_2^{2-}

B. He_2^-

C. Be_2

D. He_2^+

Answer: C

Solution:

Solution:
According to Molecular Orbital Theory (MOT), electronic configuration and their bond order of given options are as follows -
$O_2^{2-} = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2, \pi 2p_y^2, \pi^* 2p_x^2, \pi^* 2p_y^2$

[No. of bonding electrons

Bond order $= r = \frac{-\text{ No. of antibonding electrons}]}{2}$

$= \frac{10-8}{2} = \frac{2}{2} = 1$

- He_2^- = $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^1$

Bond order $= \frac{3-2}{2} = \frac{1}{2} = 0.5$

- Be_2 = $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2$

Bond order $= \frac{4-4}{2} = 0$

- He_2^+ = $\sigma 1s^2, \sigma^* 1s^1$

Bond order $= \frac{2-1}{2} = \frac{1}{2} = 0.5$

If bond order of chemical species is zero then that chemical species does not exist. Therefore, Be_2 does not exist.

Question81

Which of the following are isostructural pairs?

A. SO_4^{2-} and CrO_4^{2-}

B. $SiCl_4$ and $TiCl_4$

C. NH_3 and NO_3^-

D. BCl_3 and $BrCl_3$

[24feb2021shift1]

Options:

A. C and D only

B. A and B only

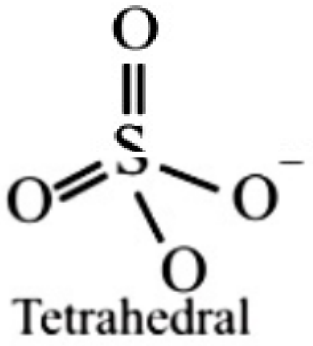
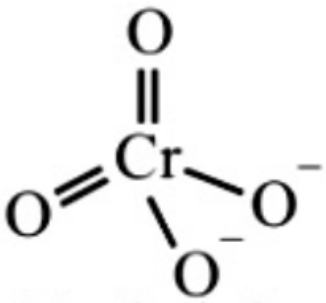
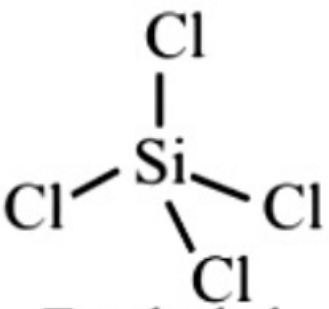
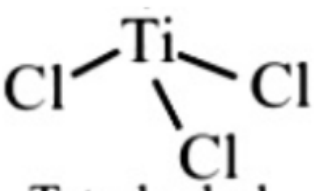
C. A and C only

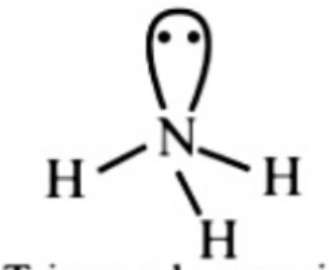
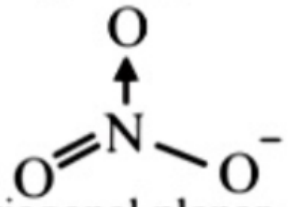
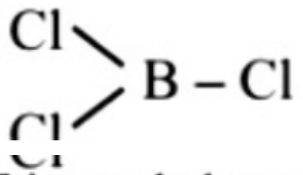
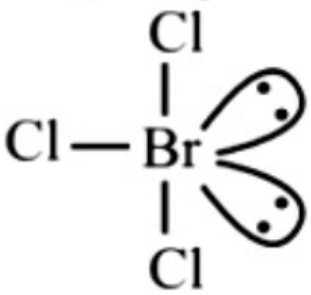
D. B and C only

Answer: B

Solution:

Isostructural means same structure.

Species	Structure
(A) SO_4^{2-}	 Tetrahedral
CrO_4^{2-}	 Tetrahedral
(B) $SiCl_4$	 Tetrahedral
$TiCl_4$	 Tetrahedral

(C) NH_3 NO_3^-	 Triagonal pyramidal  Triagonal planar
(D) BCl_3 $BrCl_3$	 Triagonal planar  T-shape

Question82

Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) Dipole-dipole interactions are the only non-covalent interactions, resulting in hydrogen bond formation.
Reason (R) Fluorine is the mostelectronegative element and hydrogenbonds in HF are symmetrical.
In the light of the above statements, choose the most appropriate answer from the options given below.
[26 Feb 2021 Shift 1]

Options:

A. A is false but R is true.

B. Both A and R are true and R is the correct explanation of A.

C. A is true R is false.

D. Both A and R are true but R is not the correct explanation of A.

Answer: A

Solution:

Assertion is false but Reason is true.
Corrected Assertion Diple-dipole interactions are purely covalent interactions of dipolar covalent bonds.
Ends of dipoles of a polar covalent bonds possess partial charges (δ^+ and δ^-) which are less than unit electronic charge, $e = 1.6 \times 10^{-19}C$.

Question83

The correct shape and I-I-I bond angles respectively in I_3^-, ion are [24 Feb 2021 Shift 2]

Options:

A. distorted trigonal planar, 135˚ and 90˚

B. T-shaped, 180˚ and 90˚

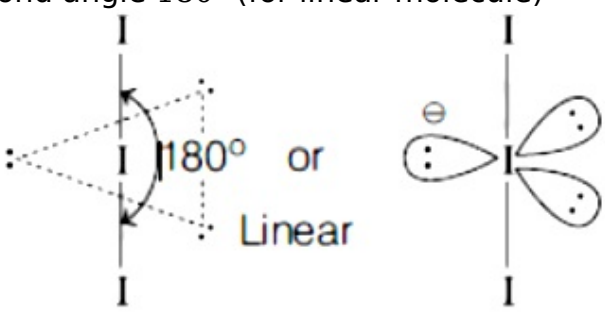
C. Trigonal planar, 120˚

D. Linear, 180˚

Answer: D

Solution:

Hybridisation of central I in I_3^- is sp^3d with 3 lone pair and 2 bond pair.
Shape Linear Lone pair 3 lone pair
Bond angle 180˚ (for linear molecule)



Question84

A hard substance melts at high temperature and is an insulator in both solid and in molten state.
This solid is most likely to be a /an
[18 Mar 2021 Shift 2]

Options:

A. ionic solid

B. molecular solid

C. metallic solid

D. covalent solid

Answer: D

Solution:

Covalent or network solid have very high melting point and they are insulators in their solid and molten form.
If a substance is an insulator in both solid and molten phases, then it cannot be ionic or metallic solid. If the melting point is higher, then it cannot be a molecular solid.
∴ It should be covalent network solid.

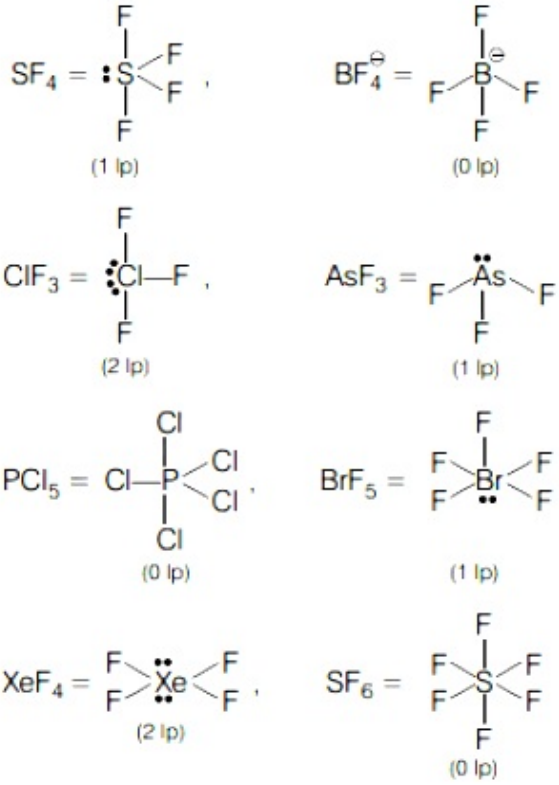
Question85

The number of species below that have two lone pairs of electrons in their central atom is ..... (Round off to the nearest integer)
SF_4, BF_4^-, ClF_3, AsF_3, PCl_5, BrF_5, XeF_4, SF_6
[18 Mar 2021 Shift 2]

Answer: 2

Solution:

Number of lone pairs on central atom in given compounds are as follows



Hence, two (lone pair) lp on central atom is ClF_3 and XeF_4.

Question86

Amongst the following, the linear species is
[17 Mar 2021 Shift 2]

Options:

A. NO_2

B. Cl_2O

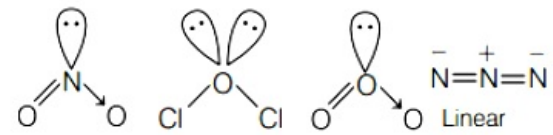
C. O_3

D. N_3^-

Answer: D

Solution:

N_3^- is linear species.



Hybridisation = Number of sigma bond + number of lone pairs + number of coordinate bonds.
Hybridisation of N in NO = 1 + 1 + 1 = 3. So, hybridisation is sp^2 and structure is bent or V-shape.
Hybridisation of O in OCl_2 = 2 + 2 = 4. So, hybridisation is sp^3 and structure is bent or V -shape.
Hybridisation of O in O_3 = 1 + 1 + 1 = 3. So, hybridisation is sp^2 and structure is bent or V-shape. linear.

Question87

A central atom in a molecule has two lone pairs of electrons and forms three single bonds. The shape of this molecule is [17 Mar 2021 Shift 1]

Options:

A. see-saw

B. planar triangular

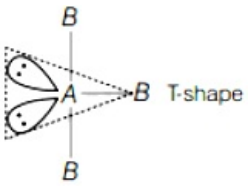
C. T-shaped

D. trigonal pyramidal

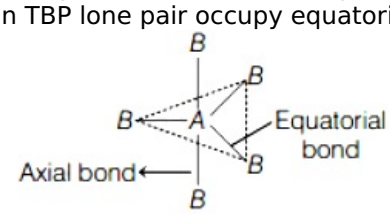
Answer: C

Solution:

Solution:
2 lone pair +3 bond pair
Stearic number = 5
So, general formula is AB_3L_2.
(Here, L = number of lone pair.)
Hybridisation = sp^3d .
So, the shape is T- shape



Note Geometry of the compound having sp^3d hybridisation should to tetragonal bipyramidal (TBP) according to VSEPR theory. But due to two lone pair, geometry is distorted.
In TBP lone pair occupy equatorial position.



Question88

Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) The $H-O-H$ bond angle in water molecule is 104.5°.
Reason (R) The lone pair - lone pair repulsion of electrons is higher than the bond pair - bond pair repulsion.
[16 Mar 2021 Shift 1]

Options:

A. A is false but R is true.

B. Both A and R are true, but R is not the correct correct explanation of A.

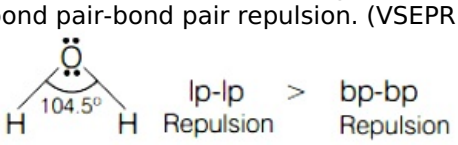
C. A is true but R is false.

D. Both A and R are true, and R is the correct explanation of A.

Answer: D

Solution:

Solution:
Hybridisation of ' $O^{'}$ in H_2O is sp^3 as it is having two lone pair and two sigma bond. Bond angle of sp^3 hybridised compound should be 109.5°.
But in case of water, it is only 104.5° due to repulsion between the lone pairs. Lone pair-lone pair repulsion is higher than bond pair-bond pair repulsion. (VSEPR Theory)



So, both A and R are true and R is the correct explanation of A.

Question89

The total number of electrons in all bonding molecular orbitals of O_2^{2-} is ..... .
(Round off to the nearest integer)

[27 Jul 2021 Shift 2]

Answer: 10

Solution:

Solution:
M. O. Configuration of O_2^{2-} ($(18\bar{e})$
$\sigma 1s^2 \alpha 1s^2 \sigma 2s^2 \,.\, \sigma 2s^2 \sigma 2p_z^{\,2} \pi 2p_x^{\,2} = \pi 2p_y^{\,2}$
$\pi 2p_x^{\,2} = \pi 2p_y^{\,2}$
Total B.M.O electrons = 10

Question90

The difference between bond orders of CO and $NO^{\oplus}$ is $\frac{x}{2}$ where x = _____.
(Round off to the Nearest Integer)
[27 Jul 2021 Shift 1]

Answer: 0

Solution:

Bond order of CO = 3
$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^{\,2} \pi 2p_x^{\,2} \pi 2p_y^{\,2}$
B. O. $= \frac{10-4}{2} = 3$
NO^+:
B. O. $= \frac{8-2}{2} = 3$
Difference $= 3 - 3 = 0$

Question91

In the following the correct bond order sequence is:
[25 Jul 2021 Shift 2]

Options:

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

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

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

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

Answer: C

Solution:

Solution:
O_2 (16 electrons)
$\sigma_{1s}^2, \sigma_{1s}^{*2}, \sigma_{2s}^2, \sigma_{2s}^{*2}, \sigma_{2p_z}^2$
$\pi_{2p_x}^2 = \pi_{2py}^2, \pi_{2p_x}^{*1} = \pi_{2py}^{*1}, \sigma_{2p_z}^*$
Bond order of $O_2 \Rightarrow 2$
Bond order of $O_2^- \Rightarrow 1.5$
Bond order of $O_2^{2-} \Rightarrow 1$
Bond order of $O_2^+ \Rightarrow 2.5$

Question92

Identify the species having one π-bond and maximum number of canonical forms from the following:
[25 Jul 2021 Shift 2]

Options:

A. SO_3

B. O_2

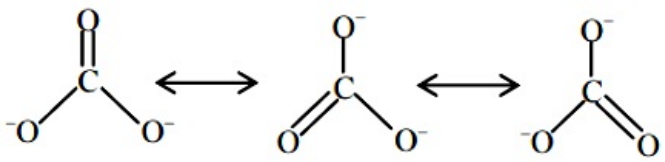
C. SO_2

D. CO_3^{2-}

Answer: D

Solution:

Solution:
Among SO_3, O_2, SO_2 and CO_3^{2-}, only O_2 andCO_3^{2-} has only one π-bond



Question93

The set in which compounds have different nature is :
[20 Jul 2021 Shift 1]

Options:

A. $B(OH)_3$ and H_3PO_3

B. $B(OH)_3$ and $Al(OH)_3$

C. $NaOH$ and $Ca(OH)_2$

D. $Be(OH)_2$ and $Al(OH)_3$

Answer: B

Solution:

Solution:
1) $B(OH)_3$ acidic and H_3PO_3 acidic
2) $B(OH)_3$ acidic and $Al(OH)_3$ amphoteric
3) $NaOH$ basic and $Ca(OH)_2$ basic
4) $Be(OH)_2$ amphoteric and $Al(OH)_3$ amphoteric

Question94

Match List-I with List-II :

List-I (Species)	List-II (Hybrid Orbitals)
(a) SF_4	(i) sp^3d^2
(b) IF_5	(ii) d^2sp^3
(c) NO_2^+	(iii) sp^3d
(d) NH_4^+	(iv) sp^3
	(v) sp

Choose the correct answer from the options given below : [22 Jul 2021 Shift 2]

Options:

A. (a)-(i), (b)-(ii), (c)-(v) and (d)-(iii)

B. (a)-(ii), (b)-(i), (c)-(iv) and (d)-(v)

C. (a)-(iii), (b)-(i), (c)-(v) and (d)-(iv)

D. (a)-(iv), (b)-(iii), (c)-(ii) and (d)-(v)

Answer: C

Solution:

(a) SF_4 – sp^3d hybridisation
(b) IF_5 – sp^3d^2 hybridisation
(c) NO_2^+ –sp hybridisation
(d) NH_4^+ – sp^3 hybridisation

Question95

The hybridisations of the atomic orbitals of nitrogen in NO_2^-, NO_2^+ and NH_4^+ respectively are.
[20 Jul 2021 Shift 2]

Options:

A. sp^3, sp^2 and sp

B. sp, sp^2 and sp^3

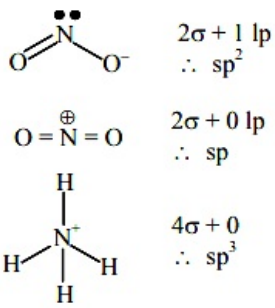
C. sp^3, sp and sp^2

D. sp^2, sp and sp^3

Answer: D

Solution:

Solution:



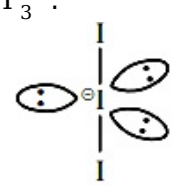
Question96

The number of lone pairs of electrons on the central I atom in I_3^- is _____.
[20 Jul 2021 Shift 1]

Answer: 3

Solution:

I_3^-:



The number of lone pairs of electron on the central atom is 3.

Question97

The bond order and magnetic behaviour of O_2^-ion are, respectively [26 Aug 2021 Shift 2]

Options:

A. 1.5 and paramagnetic

B. 1.5 and diamagnetic

C. 2 and diamagnetic

D. 1 and paramagnetic

Answer: A

Solution:

O_2^-(Total electrons = 17) =

$\sigma 1s^2, \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2$

$\pi^* 2p_x^2 = \pi^* 2p_y^1, \sigma^* 2p_z^0$

Number of unpaired electron = 1

So, it is paramagnetic.

$$\text{Bond order} = \frac{n_b - n_a}{2}$$

$$= \frac{10-7}{2} = 1.5$$

Question98

The interaction energy of London forces between two particles is proportional to r^x, where r is the distance between the particles. The value of x is [26 Aug 2021 Shift 2]

Options:

A. 3

B. -3

C. -6

D. 6

Answer: C

Solution:

In London forces, interaction energy in inversely proportional to the sixth power of the distance between two interacting particles

$\left(\frac{1}{r^6} \text{ or } .r^{-6}\right)$

∴ x is -6.

Question99

The number of species having non-pyramidal shape among the following is

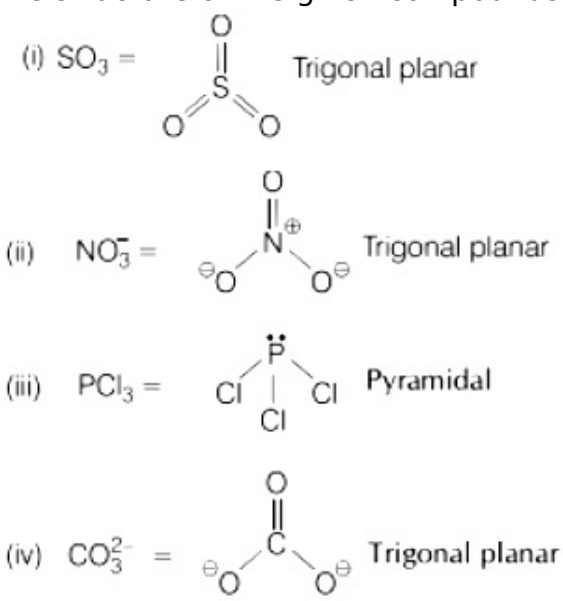
(i) SO_3(ii) NO_3^-(iii) PCl_3(iv) CO_3^{2-}

[27 Aug 2021 Shift 2]

Answer: 3

Solution:

The structure of the given compounds are as follows :



3 molecules/ions i.e. (i), (ii) and (iv) have non-pyramidal shape.

Question100

According to molecular orbital theory, the number of unpaired electron(s) in O_2^{2-} is .....

[31 Aug 2021 Shift 2]

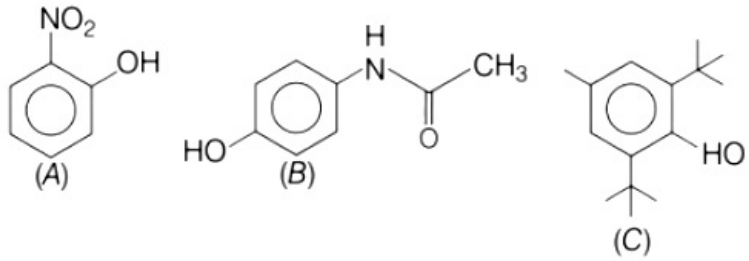
Answer: 0

Solution:

Solution:
In O_2^{2-}, 18 electrons are present.
Configuration is given by
$\sigma 1s^2$, $\sigma * 1s^2$, $\sigma 2s^2$, $\sigma * 2s^2$, $\sigma 2p_z^2$, $\pi 2p_x^2 = \pi 2p_y^2$
$\pi * 2p_x^2 = \pi * 2p_y^2$, $\sigma * 2p_z^0$
So, number of unpaired electrons in $O_2^{2-} = 0$.

Question101

The compound/s which will show significant intermolecular H-bonding is/are



[27 Aug 2021 Shift 2]

Options:

A. (B) only

B. (C) only

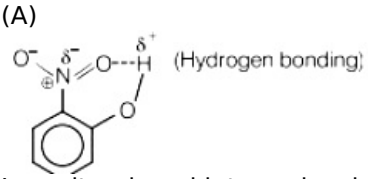
C. (A) and (B)

D. (A),(B) and (C)

Answer: A

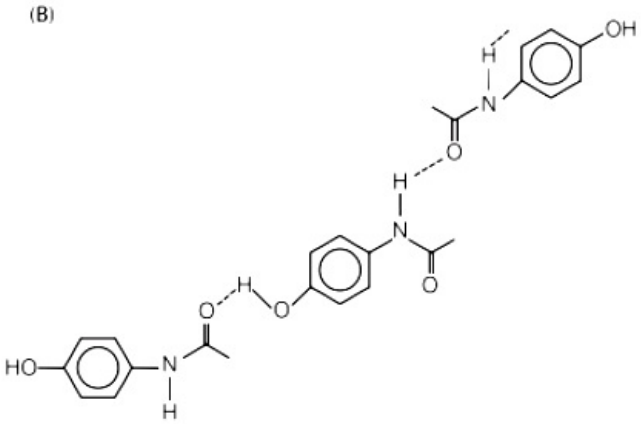
Solution:

Solution:
(A)

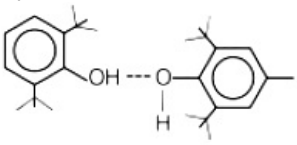


In o-nitrophenol intramolecular hydrogen bonding takes place.

(B)



Extensive H-bonding is observed in this case as two H-atoms bonded to strongly electronegative atoms (nitrogen, oxygen) are present. H-bonding occurs when H-bonded to strongly electronegative atoms exists in the vicinity of other electronegative atoms possessing lone pairs of electron.
(C)



Here, only one hydrogen atom bonded to electronegative oxygen atom is present. So, intermolecular H-bonding is present but not so extensive.
So, option (a) is correct.

Question102

The spin-only magnetic moment value of B_2^+ species is ..... $\times 10^{-2}$ BM. (Nearest integer)
[Given, $\sqrt{3}$ = 1.73]
[1 Sep 2021 Shift 2]

Answer: 173

Solution:

Solution:
Spin only mangnetic moment is given as
$\mu_S = \sqrt{n(n+2)}\,BM$
where, n = number of unpaired electrons
Electronic configuration of $mathrm\,B_2^+$is as follows
$B_2^+ = \sigma 1s^2, \sigma * 1s^2, \sigma 2s^2, \sigma * 2s^2, \pi 2p_y^{\,1} = \pi 2p_z^{\,0}$
$\therefore B_2^+$ has one unpaired electron,
$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73\,BM$
$= 173 \times 10^{-2}\,BM$
$\therefore x \times 10^{-2} = 173 \times 10^{-2}$
$\therefore x = 173$
Hence, answer is 173.

Question103

The dipole moments of CCl_4, $CHCl_3$ and CH_4 are in the order: [Jan. 07, 2020 (I)]

Options:

A. $CHCl_3 < CH_4 = CCl_4$

B. $CCl_4 < CH_4 < CHCl_3$

C. $CH_4 < CCl_4 < CHCl_3$

D. $CH_4 = CCl_4 < CHCl_3$

Answer: D

Solution:

Solution:
Hint: Dipole moment is the separation of two charges by a distance. When one atom is more electronegative than the other, it tries to pull the shared electrons towards itself.Hence, greater the electronegativity of one atom than the other, greater will be the length and more dipole moment.
So dipole moment order is:
$CH_4 = CCl_4 < CHCl_3$

Question104

If the magnetic moment of a dioxygen species is 1.73B . M , it may be: [Jan. 09,2020 (I)]

Options:

A. O_2^- or O_2^+

B. O_2 or O_2^+

C. O_2 or O_2^-

D. O_2, O_2^- or O_2^+

Answer: A

Solution:

Solution:
$\mu = \sqrt{n(n+2)}$ B.M.
$1.73 = \sqrt{n(n+2)}$
$n = 1$
$O_2^+ = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2$
$= \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^0$
$O_2^- = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2$
$= \pi 2p_y^2 \pi^* 2p_x^2 = \pi^* 2p_y^1$

Question105

The bond order and the magnetic characteristics of CN^- are: [Jan. 07, 2020 (II)]

Options:

A. $2\frac{1}{2}$, diamagnetic

B. 3 , diamagnetic

C. 3 , paramagnetic

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

Answer: B

Solution:

Solution:
Total number of electrons in CN^- = 6 + 7 + 1 = 14
$\therefore$ Molecular orbital distribution

$$\sigma l\, s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \left[\begin{array}{c} \pi 2px^2 \\ \pi 2py^2 \end{array} \right] \sigma 2p_z{}^2$$

$\therefore$ Bond order $= \frac{10-4}{2} = 3$
CN is diamagnetic because all electrons are paired.

Question106

The compound that has the largest $H-M-H$ bond angle (M = N , S, C), is [Sep. 05,2020 (II)]

Options:

A. H_2O

B. NH_3

C. H_2S

D. CH_4

Answer: D

Solution:

Solution:
$H_2O - 104.5^\circ$ (sp^3 with 2 lone pair at O)
$NH_3 - 107^\circ$ (sp^3 with 1 lone pair at N)
$CH_4 - 109.5^\circ (sp^3)$

$H_2S - 92^\circ (sp^3$ with 2 lone pair at O)
Lone pair-bond pair repulsion in H_2S will increase because 'S' has lower electronegativity than 'O'. So there will be lesser electron density on 'S' and thus $H - S - H$ bond angle will be smaller than H_2O.

Question107

The molecule in which hybrid MOs involve only one d-orbital of the central atom is:
[Sep. 04, 2020 (II)]

Options:

A. $[Ni(CN)_4]^2$

B. BrF_5

C. XeF_4

D. $[CrF_6]^{3-}$

Answer: A

Solution:

Solution:
(a) $[Ni(CN)_4]^2 = dsp^2$
(b) $BrF_5 = sp^3d^2$
(c) $XeF_4 = sp^3d^2$
(d) $[CrF_6]^3 = d^2sp^2$

Question108

If AB_4 molecule is a polar molecule, a possible geometry of AB_4 is:
[Sep. 02,2020(I)]

Options:

A. Square pyramidal

B. Tetrahedral

C. Rectangular planar

D. Squareplanar

Answer: A

Solution:

Solution:
For AB_4 compound possible geometry are

No. of Bond pair
4
4
4
Structure with sp^3d^2 hybridisation is polar due to lone pair moment while in other possibilities molecules is non-polar.
Square pyramidal can be polar due to lone pair moment as the bond pair moments will get cancelled out.

Question109

The shape\/ structure of $[XeF_5]^-$ and XeO_3F_2, respectively, are: [Sep. 02,2020 (II)]

Options:

A. pentagonal planar and trigonal bipyramidal

B. octahedral and square pyramidal

C. trigonal bipyramidal and pentagonal planar

D. trigonal bipyramidal and trigonal bipyramidal

Answer: A

Solution:

Solution:
(i) XeF_5^- St. No. = Bond pair + Lone Pair
= (5 + 2) = 7
So, hybridisation is = sp^3d^3 and structure is pentagonal planar.
(ii) XeO_3F_2 St. No. = 5
So, hybridisation is = sp^3d and structure is trigonal bipyramidal.

Question110

The molecular geometry of SF_6 is octahedral. What is the geometry of SF_4 (including lone pair(s) of electrons, if any)? [Sep. 02, 2020 (II)]

Options:

A. Tetrahedral

B. Trigonal bipyramidal

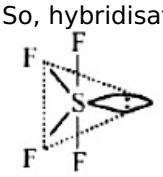
C. Pyramidal

D. Square planar

Answer: B

Solution:

SF_4
Bond pair = 4
Lone pair = 1
Steric number = 5,,
So, hybridisation is sp^3d .



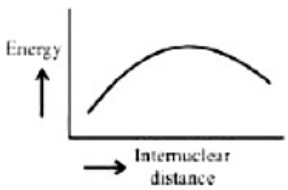
Geometry is trigonal bipyramidal but shape is "See Saw".

Question111

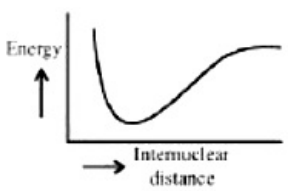
The potential energy curve for the H_2 molecule as a function of internuclear distance is : [Sep. 05, 2020 (I)]

Options:

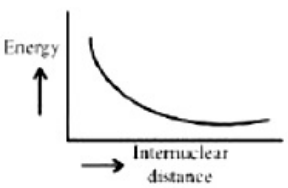
A.



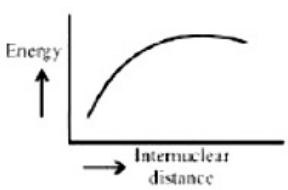
B.



C.



D.



Answer: B

Solution:

When two H-atoms come closer then initially due to attraction P.E. is $-ve$, which decreases more as atoms come closer and after reacting to a minimum value as repulsion starts dominating so, P.E. increases then.

Question112

The structure of PCl_5 in the solid state is: [Sep.05,2020(I)]

Options:

A. tetrahedral $[PCl_4]^+$ and octahedral $[PCl_6]^-$

B. square planar $[PCl_4]^+$ and octahedral $[PCl_6]^-$

C. square pyramidal

D. trigonal bipyramidal

Answer: A

Solution:

Solution:
$2PCl_5(s) \longrightarrow \underset{\text{Tetrahedral}}{[PCl_4]^+} \ \underset{\text{Octahedral}}{[PCl_6]^-}$

Question113

Of the species, NO, NO^+, NO^{2+} and NO^-, the one with minimum bond strength is: [Sep. 03,2020 (I)]

Options:

A. NO^+

B. NO

C. NO^{2+}

D. NO^-

Answer: D

Solution:

Solution:
Molecular orbital configuration for NO is
$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 \pi 2p_y^2 \sigma 2p_z^2 \pi^* 2p_z^1$

Species	Bond border
NO^{+}	3
NO^{2+}	2.5
NO^{-}	2
NO	2.5

Bond strength is directly proportional to the bond order, so NO ' has minimum bond strength.

Question114

Two pi and half sigma bonds are present in: [Jan. 10,2019(I)]

Options:

A. O_2^+

B. N_2

C. O_2

D. N_2^+

Answer: D

Solution:

Solution:

$N_2^+ = 13e^- = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^1$

$B.O = \frac{\text{Bonding electrons} - \text{Antibonding electrons}}{2}$

$B.O. = \frac{9-4}{2} = 2.5 = 2\pi \text{ bond} + 0.5\sigma \text{ bond}$

Question115

According to molecular orbital theory, which of the following is true with respect to Li_2^+ and Li_2^- ? [Jan .9,2019(I)]

Options:

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

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

C. Both are stable

D. Both are un stable

Answer: C

Solution:

Electronic configuratios of Li_2^+ and Li_2^- :
$Li_2^+ : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^1$
$Li_2^- : \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^1$
Now,
Bond order of $Li_2^+ = \frac{1}{2}(3-2) = \frac{1}{2}$
Bond order of $Li_2^- = \frac{1}{2}(4-3) = \frac{1}{2}$
Here, both Li_2^+ and Li_2^- have positive bond order, thus both are stable.

Question116

In which of the following processes, the bond order has increased and paramagnetic character has changed to diamagnetic? [Jan. 9, 2019 (II)]

Options:

A. $NO \rightarrow NO^+$

B. $N_2 \rightarrow N_2^+$

C. $O_2 \rightarrow O_2^+$

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

Answer: A

Solution:

Solution:
In case of NO (paramagnetic) → NO (diamagnetic) the bond order has increased from 2.5 to 3 .
For other cases:
N_2 (Diamagnetic) → N_2^+ (Paramagnetic)
O_2 (Paramagnetic) → O_2^+ (Paramagnetic)
O_2 (Paramagnetic) → O_2^2 (Diamagnetic)
B · O = 2 B · O = 1

Question117

The correct statement about ICl_5 and ICl_4^- is : [April 8, 2019 (II)]

Options:

A. both are is isostructural.

B. $I Cl_5$ is trigonal bipyramidal and $I Cl_4^-$ is tetrahedral.

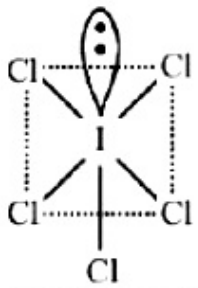
C. $I Cl_5$ is square pyramidal and $I Cl_4^-$ is tetrahedral.

D. $I Cl_5$ is square pyramidal and $I Cl_4^-$ is square planar.

Answer: D

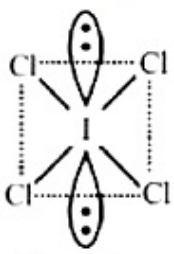
Solution:

$I Cl_5$ is sp^3d^2 hybridised $(5bp, 1lp)$



Square pyramidal

$I Cl_4$ is sp^3d^2 hybridised $(4bp, 2lp)$



Square planar

Question118

The ion that has sp^3d^2 hydridisation for the central atom, is: [April 8, 2019 (II)]

Options:

A. $[I Cl_4]^-$

B. $[I Cl_2]^-$

C. $[I F_6]^-$

D. $[BrF_2]^-$

Answer: A

Solution:

Species	Hybridisation
ICl_2^-	sp^3d
ICl_4^-	sp^3d^2
BrF_2	sp^3d
IF_6^-	sp^3d^3

Question119

During the change of O_2 to O_2^-, the incoming electron goes to the orbital :
[April 10, 2019 (I)]

Options:

A. $\pi 2p_y$

B. $\sigma^* 2p_z$

C. $\pi^* 2p_x$

D. $\pi 2p_x$

Answer: C

Solution:

Solution:
Electronic configuration of O_2 is
$\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2$
$\pi^* 2p_x^1 = \pi^* 2p_y^1$
When an electron is added in O_2 to form O_2^-, the incoming electron goes to $\pi^* 2px$ or $\pi^* 2py$ orbital.

Question120

Among the following, the molecule expected to be stabilised by anion formation is:
C_2, O_2, NO, F_2
[April 9, 2019 (I)]

Options:

A. C_2

B. F_2

C. NO

D. O_2

Answer: A

Solution:

Solution:
Configuration of C_2
$\sigma 1s^2\sigma^*1s^2\sigma 2s^2\sigma^*2s^2\pi 2p_x^{\ 2} = \pi 2p_y^{\ 2}$
Configuration of C_2^{-}
$\sigma l\, s^2\sigma^*1s^2\sigma 2s^2\sigma^*2s^2\pi 2p_x^{\ 2} = \pi 2p_y^{\ 2}\sigma 2p_z^{\ 1}$
Bond order
$= \frac{\text{No.of bounding } e^- - \text{ No.of antibonding } e^-}{2}$
C_2 has s − p mixing and the HOMO is $\pi 2p_x = \pi 2p_y$ and LUMO is $\sigma 2p_z$.
So, the extra electron will occupy bonding molecular orbital and this will lead to increase in bond order.
So, C_2^{-} has more bond order than C_2.

Question121

Among the following molecules/ions, $C_2^{\ 2-}$, $N_2^{\ 2-}$, $O_2^{\ 2-}$, O_2 Which one is diamagnetic and has the shortest bond length? [April 8, 2019(II)]

Options:

A. O_2

B. $N_2^{\ 2-}$

C. $O_2^{\ 2-}$

D. $C_2^{\ 2-}$

Answer: D

Solution:

Solution:
Bond length $\propto \frac{1}{\text{Bond order}}$ and diamagnetic species has no unpaired electron in their molecular orbitals.

	No. of unpairedelectrons	Bondorder	Magneticcharacter
C_2^{2-}	0	3	diamagnetic
N_2^{2-}	2	2	paramagnetic
O_2^{2-}	0	1	diamagnetic
O_2	1	2	paramagnetic

$\therefore C_2^{2-}$ has least bond length and is diamagnetic.

Question122

Which of the following compounds contain(s) no covalent bond(s)? KCl, PH_3, O_2, B_2H_6, H_2SO_4

[2018]

Options:

A. KCl, B_2H_6, PH_3

B. KCl, H_2SO_4

C. KCl

D. KCl, B_2H_6

Answer: C

Solution:

Solution:
KCl is an ionic compound while others (PH_3, O_2, B_2H_6, and H_2SO_4) are covalent compounds.

Question123

Total number of lone pair of electrons in I_3 ion is:

[2018]

Options:

A. 3

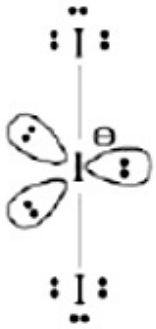
B. 6

C. 9

D. 12

Answer: C

Solution:



∴ Total number of lone pair of electrons is 9.

Question124

Which of the following conversions involves change in both shape and hybridisation?
[Online April 16, 2018]

Options:

A. $H_2O \rightarrow H_3O^+$

B. $BF_3 \rightarrow BF_4^-$

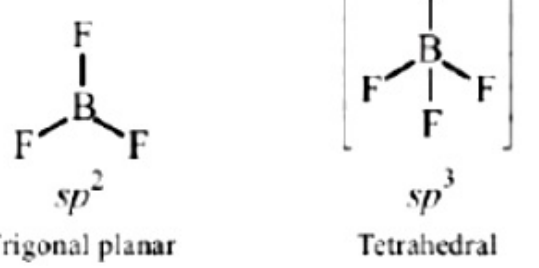
C. $CH_4 \rightarrow C_2H_6$

D. $NH_3 \rightarrow NH_4^+$

Answer: B

Solution:

$BF_3 \longrightarrow BF_4^-$



Question125

The incorrect geometry is represented by
[Online April 16, 2018]

Options:

A. NF_3 – trigonal planar

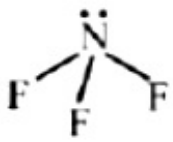
B. BF_3 -trigonal planar

C. AsF_5 -trigonal bipyramidal

D. H_2O – bent

Answer: A

Solution:



NF_3 has trigonal pyramidal geometry. N atom has one lone pair and three bond pairs of electrons. The electron pair geometry is tetrahedral and molecular geometry is trigonal pyramidal. The bond angles are lower than tetrahedral bond angles due to lone pair - lone pair and lone pair - bond pair repulsions. N atom is sp^3 hybridised.

Question126

Identify the pair in which the geometry of the species is Tshape and square pyramidal, respectively
[Online April 15, 2018(I)]

Options:

A. ICl_2^- and ICl_5

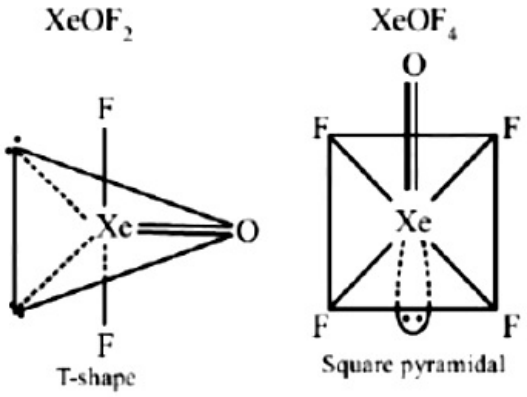
B. IO_3^- and $IO_2F_2^-$

C. ClF_3 and IO_4

D. $XeOF_2$ and $XeOF_4$

Answer: D

Solution:



Question127

The decreasing order of bond angles in BF_3, NH_3, PF_3 and I_3^- is: [Online April 15, 2018 (I)]

Options:

A. $I_3^- > BF_3 > NH_3 > PF_3$

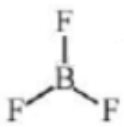
B. $BF_3 > I_3^- > PF_3 > NH_3$

C. $BF_3 > NH_3 > PF_3 > I_3^-$

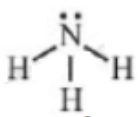
D. $I_3^- > NH_3 > PF_3 > BF_3$

Answer: A

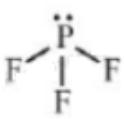
Solution:



B is sp^2, bond angle $= 120^\circ$

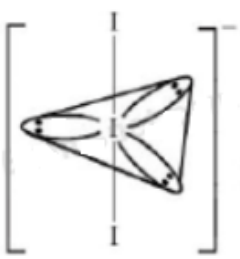


N is sp^3 with $1lp$, bond angle $= 107^\circ$



P is sp^3 with $1lp$, when central atom

size ↑, bond angle ↓, $\therefore NH_3 > PF_3$



I is sp^3d (linear), bond angle $= 180^\circ$

$\therefore$ Dereasing order of bond angle is $I_3^- > BF_3 > NH_3 > PF_3$

Question128

According to molecular orbital theory, which of the following will not be a viable molecule?
[2018]

Options:

A. He_2^{2+}

B. He_2^{+}

C. H_2^{-}

D. H_2^{2-}

Answer: D

Solution:

Species	No. of e^-s	Elec. conf.	Bond border
He_2^{+}	$(4-1=3)$	$\sigma_{1s}^2\sigma^*1s^1$	$\frac{2-1}{2}=0.5$
H_2^{-}	$(2+1=3)$	$\sigma_{1s}^2\sigma^*1s^1$	$\frac{2-1}{2}=0.5$
H_2^{2-}	$(2+2=4)$	$\sigma_{1s}^2\sigma^*1s^2$	$\frac{2-2}{2}=0$
He_2^{2+}	$(4-2=2)$	$\sigma 1s^2$	$\frac{2-0}{2}=1$

Molecule having zero bond order will not be a viable molecule.

Question129

$H-N\overset{I}{---}N\overset{II}{---}N$ In hydrogen azide, the bond orders of bonds (I) and (II) are
[Online April 15,2018(I)]

Options:

A. I <2, II >2

B. I >2, II >2

C. I >2, II <2

D. I <2, II <2

Answer: A

Solution:

As in the resonance structure of hydrogen azide, it can be seen that number of $N-N$ bond for bond (I) ≤ 2.

$$H-\ddot{N}^{(I)}=N^{+(II)}=\bar{\ddot{N}}: \longleftrightarrow H-\bar{\ddot{N}}^{(I)}-N^{+(II)}\equiv\ddot{N}:$$

Hence for bond (I), bond order will be <2 whereas for bond (II), number of bond ≥ 2. Thus its bond order will be >2.

Question130

Which of the following best describes the diagram of molecular orbital?

[Online April 15, 2018 (II)]

Options:

A. A bonding π orbital

B. A non-bonding orbital

C. An antibonding σ orbital

D. An antibonding π orbital

Answer: D

Solution:

Solution:
An antibonding π orbital best describes the given diagram of a molecular orbital. Two orbitals laterally overlap to form π bond. Out of phase combination of these two p orbitals give π^* MO.

Question131

In the molecular orbital diagram for the molecular ion, N_2^+, the number of electrons in the σ_{2p} molecular orbital is:
[Online April 15,2018(I)]

Options:

A. 0

B. 2

C. 3

D. 1

Answer: D

Solution:

Total electrons in $N_2^+ = (7 \times 2) - 1 = 13$

$N_2^+ \rightarrow K\,K\,\sigma(2s)^2\sigma^*(2s)^2\pi(2p_x)^2 = \pi(2p_y)^2\sigma(2p_z)^1$

Number of electron in σ_{2p_z} is 1

Question132

sp^3d^2 Hybridisation is not displayed by: [Online April 8, 2017]

Options:

A. BrF_5

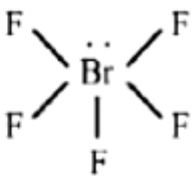
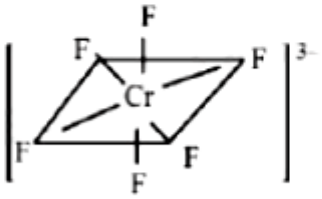
B. SF_6

C. $[CrF_6]^{3-}$

D. PF_5

Answer: D

Solution:

(a)BrF_5		sp^3d^2
(b) SF_6		sp^3d^2
(c) $[CrF_6]^3$		sp^3d^2
(d) PF_5		sp^3d

Question133

The group having triangular planar structures is : [Online April 9, 2017]

Options:

A. BF_3, NF_3, CO_3^{2-}

B. CO_3^{2-}, NO_3^-, SO_3

C. NH_3, SO_3, CO_3^{2-}

D. NCl_3, BCl_3, SO_3

Answer: B

Solution:

Group	Hybridisation	Shape
(a) BF_3	sp^2	Triangular Planar (T.P.)
NF_3	sp^3	Tetrahedral (T)
CO_3^{2-}	sp^2	T.P.
(b) CO_3^{2-}	sp^2	T.P.
NO_3^-	sp^2	T.P.} (All have same hybridisation)
SO_3	$sp2$	T.P.
(c) NH_3	sp^3	T
SO_2	sp^3	T.P.
CO_3^{2-}	sp^2	T.P.
(d) NCl_3	sp^3	T
BCl_3	sp^2	T.P.
SO_3	sp^2	T.P.

Question134

Which of the following is paramagnetic? [Online April 8, 2017]

Options:

A. NO^+

B. CO

C. O_2^{2-}

D. B_2

Answer: D

Solution:

Solution:

	Total electron
No^+	14
CO	14
O_2^{2-}	18
B_2	10

$NO^+ \Rightarrow KK \cdot \sigma(2s)^2\sigma^*(2s)^2 \cdot (\pi 2p_x)^2$
$= (\pi 2p_y)^2 \cdot (\sigma 2p_z)^2$ diamagnetic
$CO \Rightarrow KK \cdot \sigma(2s)^2\sigma^*(2s)^2 \cdot (\pi 2p_x)^2$
$= (\pi 2p_y)^2 \cdot (\sigma 2p_z)^2$ diamagnetic
$O_2^{2-} \Rightarrow KK \cdot \sigma(2s)^2\sigma^*(2s)^2 \cdot \sigma(2p_z)^2(\pi 2p_x)^2$
$= (\pi 2p_y)^2 \cdot \pi^*(2p_x)^2 = \pi^*(2p_y)^2$ diamagnetic
$B_2 \Rightarrow KK \cdot \sigma(2s)^2\sigma^*(2s)^2 \cdot \pi(2p_x)^1 = \pi(2p_y)$ paramagnetic

---

Question135

Which of the following species is not paramagnetic? [2017]

Options:

A. NO

B. CO

C. O_2

D. B_2

Answer: B

Solution:

NO→ One unpaired electron is present in π^* molecular orbit, hence paramagnetic.
(b) $CO(14) \rightarrow KK\sigma 2s^2\pi 2p_x^2 = \pi 2p_y^2\sigma 2p_z^2\sigma^* 2s^2$
No unpaired electron, hence diamagnetic.
(c) $O_2(16)$→
$KK\sigma 2s^2\sigma^* 2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi^* 2p_x^1 = \pi^* 2p_y^1$
Two unpaired electrons, hence paramagnetic.
(d) $B_2(10) \rightarrow KK\sigma 2s^2\sigma^* 2s^2\pi 2p_x^1 = \pi 2p_y^1$
B_2 contains two unpaired electrons, hence paramagnetic.

Question136

The species in which the N atom is in a state of sp hybridisation is : [2016]

Options:

A. NO_3^-

B. NO_2

C. NO_2^+

D. NO_2^-

Answer: C

Solution:

Solution:
Hybridisation (H) = [No. of valence electrons of central atom + No. of monovalent atoms attached to it +(−ve charge if any −(+ ve charge if any)]
NO_2^+ = i.e. sp hybridisation
NO_2^- = i.e. sp^2 hybridisation
NO_3^- = i.c. sp^2 hybridisation
The Lewis structure of NO_2 shows a bent molecular geometry with trigonal planar electron pair geometry hence the hybridization will be sp^2.

Question137

The group of molecules having identical shape is: [Online April 9, 2016]

Options:

A. PCl_5, IF_5, XeO_2F_2

B. BF_3, PCl_3, XcO_3

C. SF_4, XeF_4, CCl_4

D. ClF_3, $XeOF_2$, XeF_3^+

Answer: D

Solution:

Solution:

$ClF_3 \longrightarrow$ Hybridisation $= 3 + \frac{1}{2}[7-3] = 5(sp^3d)$

$XeOF_2 \longrightarrow$ Hybridisation $= 3 + \frac{1}{2}[8-4] = 5(sp^3d)$

$XeF_3^+ \longrightarrow$ Hybridisation $= 3 + \frac{1}{2}[8-3-1] = 5(sp^3d)$

All molecules have sp^3d hybridisation and 2 lone pairs. Hence all have identical (T-shape).

Question138

The bond angle $H-X-H$ is the greatest in the compound: [Online April 10,2016]

Options:

A. PH_3

B. CH_4

C. NH_3

D. H_2O

Answer: B

Solution:

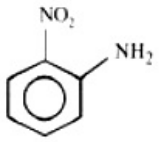
Solution:
More the number of lone pairs on central atom, the greater is the contraction caused in the angle between bond pairs. In CH_4 there is no lone pair of electrons, hence bond angle is greatest.

Question139

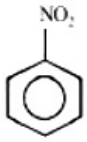
Which compound exhibits maximum dipole moment among the following ? [Online April 11, 2015]

Options:

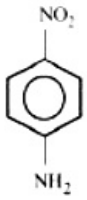
A.



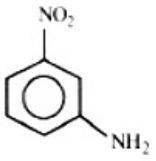
B.



C.



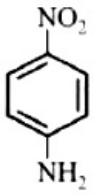
D.



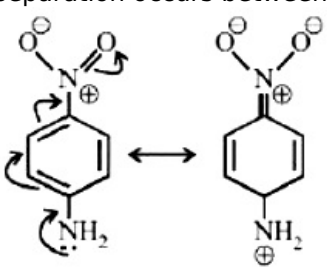
Answer: C

Solution:

Solution:



Dipole moment = (Distance between opposite charges) x (charge, q)
$\mu = q \times d$
So, greater the distance between the opposite charges higher the dipole. Due to the resonance the greater charge separation occurs between charges due to linearity.



Question140

Molecule AB has a bond length of 1.617A and a dipole moment of 0.38D. The fractional charge on each atom (absolute magnitude) is : ($e_0 = 4.802 \times 10^{-10}$ esu)

[Online April 11, 2015]

Options:

A. 0.5

B. 0.05

C. 0

D. 1.0

Answer: B

Solution:

Solution:
Dipole moment (μ) = q × d
$\Rightarrow 1D \approx 10^{-18}$ esu cm
0.38×10^{-18} esu cm = q × (1.617×10^{-8}cm)
$q = 2.35 \times 10^{-11}$ esu

$$\text{So, fractional charge} = \frac{\text{Partial charge}}{\text{Total charge}} = \frac{q}{Q}$$

$$= \frac{2.35 \times 10^{-11}\ \text{esu}}{4.802 \times 10^{-10}\ \text{esu}} = 0.049 \approx 0.05$$

Question141

After understanding the assertion and reason, choose the correct option.

Assertion : In the bonding molecular orbital (MO) of H_2, electron density is increased between the nuclei.
Reason : The bonding MO is $\Psi_A + \Psi_B$, which shows destructive interference of the combining electron waves.
[Online April 10, 2015]

Options:

A. Assertion is incorrect, reason is correct.

B. Assertion is correct, reason is incorrect.

C. Assertion and reason are correct and reason is the correct explanation for the assertion.

D. Assertion and reason are correct, but reason is not the correct explanation for the assertion.

Answer: B

Solution:

Solution:
Assertion is correct but reason is incorrect. Bonding MO shows constructive interference of the combining electron waves.

Question142

Amongst $LiCl$, $RbCl$, $BeCl_2$ and $MgCl_2$ the compounds with the greatest and the least ionic character, respectively are: [Online April 19, 2014]

Options:

A. LiCl and RbCl

B. RbCl and $BeCl_2$

C. $MgCl_2$ and $BeCl_2$

D. RbCl and $MgCl_2$

Answer: B

Solution:

Solution:
According to Fajan's rules smaller, highly charged cation has greatest covalent character while large cation with smaller charge has greatest ionic character.

Question143

Which of these statements is not true? [Online April 19, 2014]

Options:

A. NO^+ is not isoelectronic with O_2

B. B is always covalent in its compounds

C. In aqueous solution, the Tl^+ ion is much more stable than Tl^{+3}

D. $LiAlH_4$ is a versatilereducing agent in organic synthesis.

Answer: A

Solution:

Solution:
NO^+ has 14 electrons and O_2 has 16 electrons. Therefore, they are not isoelectronic species.
Boron forms covalent bond in its compound.
$T1^+$ is much more stable than Tl^{3+} as going down the group the stability of lower oxidation number increases due to inert pair effect.
$LiAlH_4$ is a selective reducing agent in organic synthesis.
Hence, option A is not true.

Question144

The correct order of bond dissociation energy among N_2, O_2, O_2^- is shown in which of the following arrangements? [Online April 11, 2014]

Options:

A. $N_2 > O_2^- > O_2$

B. $O_2^- > O_2 > N_2$

C. $N_2 > O_2 > O_2^-$

D. $O_2 > O_2^- > N_2$

Answer: C

Solution:

Solution:
The bond order of N_2, O_2, and O_2^- are 3,2 and 1.5 respectively.
Since higher bond order implies higher bond dissociation energy, hence the correct order will be $N_2 > O_2 > O_2^-$

Question145

The number and type of bonds in C_2^{2-} ion in CaC_2 are: [Online April 9, 2014]

Options:

A. One σ bond and one π -bond

B. One σ bond and two π -bond

C. Two σ bond and two π -bond

D. Two σ bond and one π -bond

Answer: B

Solution:

Solution:
C_2^{2-} ion $\rightarrow [C \equiv C]^{2-}$ Dicarbide ion C_2^{2-} has 1 sigma and 2 pi bonds.
There are two π bonds and one σ bond in a triple bond.

Question146

Which of the following molecules has two sigma (σ) and two pi (π) bonds?
[Online April 12, 2014]

Options:

A. C_2H_4

B. N_2F_2

C. $C_2H_2Cl_2$

D. HCN

Answer: D

Solution:

Solution:
$H \overset{\sigma}{-} C \overset{\pi,\sigma}{\equiv} N$
$\underset{\pi}{}$
Therefore, HCN has 2π and 2σ bonds.σ

Question147

Which one of the following properties is not shown by NO?
[2014]

Options:

A. It is diamagnetic in gaseous state

B. It is neutral oxide

C. It combines with oxygen to form nitrogen dioxide

D. Its bond order is 2.5

Answer: A

Solution:

Solution:
Nitric oxide is paramagnetic in the gaseous state because of the presence of one unpaired electron in its outermost shell.
The electronic configuration of NO is
$\sigma K K \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 = \pi 2p_y^2 \pi^* 2p_x^1 = \pi^* 2p_y^0$

Question148

Which one of the following molecules is paramagnetic?
[Online April 19, 2014]

Options:

A. N_2

B. NO

C. CO

D. O_3

Answer: B

Solution:

Solution:
The molecular orbital configuration of the molecules given is
Total no. of electrons in N O = 7(N) + 8(O) = 15
Hence E.C. of N O = K K $\sigma(2s)^2\sigma^*(2s)^2\sigma 2p_z^2$
$\pi(2p_x)^2\pi(2p_y)^2\pi^*(2p_x)^1$
Due to presence of one unpaired electron N O is paramagnetic. Except NO all are diamagnetic due to absence of unpaired electrons.

Question149

Which of the following has unpaired electron(s)? [Online April 9, 2014]

Options:

A. N_2

B. O_2^-

C. N_2^{2+}

D. O_2^{2-}

Answer: B

Solution:

Solution:
$O_2^-(17)$ = K K $(\sigma 2s)^2(\sigma^* 2s^2)(\sigma 2p_z)^2$
$(\pi 2p_x)^2 = (\pi 2p_y)^2(\pi^* 2p_x)^2 = (\pi^* 2p_y)^1$
One unpaired electron - paramagnetic.

Question150

Which one of the following molecules is polar? [Online April 9, 2013]

Options:

A. XeF_4

B. IF_5

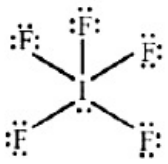
C. SbF_5

D. CF_4

Answer: B

Solution:

Solution:
The geometry of IF_5 is square pyramide with an unsymmetric charge distribution, therefore this molecule is polar.



Question151

Bond distance in HF is 9.17×10^{-11}m. Dipole moment of HF is 6.104×10^{-30}Cm. The percentage ionic character in HF will be : (electron charge $= 1.60 \times 10^{-19}$C) [Online April 23, 2013]

Options:

A. 61.0%

B. 38.0%

C. 35.5%

D. 41.5%

Answer: D

Solution:

Solution:
Given $e = 1.60 \times 10^{-19}$C
$d = 9.17 \times 10^{-11}$m
From $\mu = e \times d$
$\mu = 1.60 \times 10^{-19} \times 9.17 \times 10^{-11}$
$= 14.672 \times 10^{-30}$
% ionic character

$$= \frac{\text{Observed dipole moment}}{\text{Dipole moment for } 100\%} \text{ ionic bond}$$

$$= \frac{6.104 \times 10^{-30}}{14.672 \times 10^{-30}} \times 100$$

$= 41.5\%$

Question152

The shape of IF_6^- is:
[Online April 23, 2013]

Options:

A. Trigonally distorted octahedron

B. Pyramidal

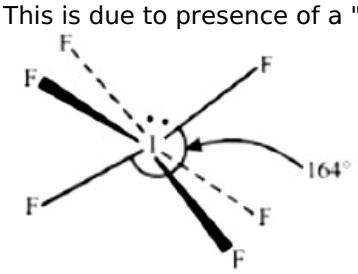
C. Octahedral

D. Square antiprism

Answer: A

Solution:

Solution:
The structure of IF_6^- is distorted octahedral.
This is due to presence of a "weak" lone pair.



Question153

In which of the following sets, all the given species are isostructural?
[Online April 25, 2013]

Options:

A. CO_2, NO_2, ClO_2, SiO_2

B. PCl_3, $AlCl_3$, BCl_3, $SbCl_3$

C. BF_3, NF_3, PF_3, AlF_3

D. BF_4^-, CCl_4, NH_4^+, PCl_4^+

Answer: D

Solution:

Solution:
All have tetrahedral structure.

Question154

In which of the following pairs of molecules\/ions, both the species are not likely to exist?
[2013]

Options:

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

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

C. H_2^{2+}, He_2

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

Answer: C

Solution:

Solution:
$H_2^{2+} = \sigma 1s^0 \sigma^* 1s^0$
Bond order for $H_2^{2+} = \frac{1}{2}(0-0) = 0$
$He_2 = \sigma 1s^2 \sigma^* 1s^2$
Bond order for $He_2 = \frac{1}{2}(2-2) = 0$
So both H_2^{2+} and He_2 do not exist.

Question155

Which one of the following molecules is expected to exhibit diamagnetic behaviour?
[2013]

Options:

A. C_2

B. N_2

C. O_2

D. S_2

Answer: 0

Solution:

Solution:
The molecular orbital structures of C_2 and N_2 are
$N_2 = KK\sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$
$C_2 = KK\sigma 2s^2 \sigma^* 2s^2 \pi 2py_x^2 = \pi 2p_y^2$

Both N_2 and C_2 have paired electrons, hence they are diamagnetic.

Question156

Which of the following is the wrong statement [2013]

Options:

A. ONCl and ONO - are not isoelectronic.

B. O_3 molecule is bent

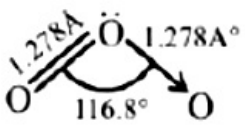
C. Ozone is violet-black in solid state

D. Ozone is diamagnetic gas.

Answer: 0

Solution:

Solution:
All options are correct,
(a) ON Cl $= 8 + 7 + 17 = 32e^-$
ON O^- $= 8 + 7 + 8 + 1 = 24e^-$ not isoelectronic



(b) The central atom is sp^2 hybridised with one lone pair.
(c) It is a pale blue gas. At -249.7°, it forms violet black crystals.
(d) It is diamagnetic in nature due to absence of unpaired electrons.

Question157

Stability of the species Li_2, Li_2^- and Li_2^+ increases in the order of : [2013]

Options:

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: B

Solution:

$Li_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$

$\therefore$ Bond order $= \frac{1}{2}(4-2) = 1$

$Li_2^+ = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^1$

B.O. $= \frac{1}{2}(3-2) = 0.5$

$Li_2^- = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^1$

B.O. $= \frac{1}{2}(4-3) = 0.5$

The bond order of Li_2^+ and Li_2^- is same but Li_2^+ is more stable than Li_2^- because Li_2^+ is smaller in size and has 2 electrons in antibonding orbitals whereas Li_2^- has 3 electrons in antibonding orbitals. Hence Li_2^+ is more stable than Li_2^-

---

Question158

In which of the following ionization processes the bond energy has increased and also the magnetic behaviour has changed from paramagnetic to diamagnetic?
[Online April 9, 2013]

Options:

A. $NO \rightarrow NO^+$

B. $N_2 \rightarrow N_2^+$

C. $C_2 \rightarrow C_2^+$

D. $O_2 \rightarrow O_2^+$

Answer: A

Solution:

Solution:
For NO Total no. of electrons $= 15$
$B \cdot O = 2.5$
Mag. behaviour = paramagnetic
For NO^+
Total no. of electrons $= 14$
$B \cdot O = 3$
Mag. behaviour = diamagnetic

Question159

Bond order normally gives idea of stability of a molecular species. All the molecules viz. H_2, Li_2 and B_2 have the same bond order yet they are not equally stable. Their stability order is
[Online April 22, 2013]

Options:

A. $H_2 > B_2 > Li_2$

B. $Li_2 > H_2 > B_2$

C. $Li_2 > B_2 > H_2$

D. $B_2 > H_2 > Li_2$

E. None of above

Answer: E

Solution:

Solution:
(N) None of the given option is correct.
The molecular orbital configuration of the given molecules is
$H_2 = \sigma 1s^2 \sigma 1s^0$ (no anti-bonding electron)
$Li_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2$(two anti-bonding electrons)
$B_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \{\pi 2p_y^1 = \pi 2p_z^1\}$
(4 anti-bonding electrons)
Though the bond order of all the species are same (B · O = 1) but stability is different. This is due to difference in the presence of no. of anti-bonding electron. Higher the no. of anti-bonding electron lower is the stability hence the correct order is $H_2 > Li_2 > B_2$

Question160

The internuclear distances in O − O bonds for O_2^+, O_2, O_2^- and O_2^{2-} respectively are: [Online April 25, 2013]

Options:

A. $1.30\mathring{A}$, $1.49\mathring{A}$, $1.12\mathring{A}$, $1.21\mathring{A}$

B. $1.49\mathring{A}$, $1.21\mathring{A}$, $1.12\mathring{A}$, $1.30\mathring{A}$

C. $1.21\mathring{A}$, $1.12\mathring{A}$, $1.49\mathring{A}$, $1.30\mathring{A}$

D. $1.12\mathring{A}$, $1.21\mathring{A}$, $1.30\mathring{A}$, $1.49\mathring{A}$

Answer: D

Solution:

Solution:
The bond length follows the order
$O_2^+ < O_2 < O_2^- < O_2^{2-}$
According to this the possible values are
1.12Å, 1.21Å, 1.30Å, 1.49Å

Question161

ortho-Nitrophenol is less soluble in water than p - and m - nitrophenols because :
[2012]

Options:

A. o -nitrophenol is more volatile steam than those of m and p -isomers.

B. o -nitrophenol shows intramolecular H-bonding

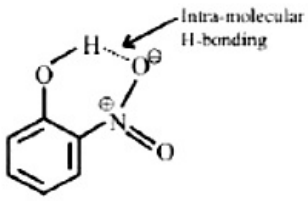
C. o-nitrophenol shows intermolecular H-bonding

D. Melting point of o -nitrophenol is lower than those of m - and p -isomers.

Answer: B

Solution:

Solution:
Compounds involved in chelation become non-polar. Consequently such compounds are soluble in non-polar solvents like ether, benzene etc. and are only sparingly soluble in water, whereas meta and para isomers are more soluble in water & less soluble in non-polar solvents.



Question162

Among the following, the species having the smallest bond length is [Online May 7,2012]

Options:

A. NO^{-}

B. NO^{+}

C. O_2

D. NO

Answer: B

Solution:

Solution:
$NO(16) - B.O, -2$ & $O_2(16) - B, O, -2$
$NO^{+}(14) - B.O \cdot -3$ $NO(15) - B.O \cdot -2.5$
Higher the bond order lower is the bond length. Hence NO^{+} will have smallest bond.

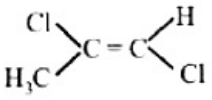
Question163

Among the following chloro-compound having the lowest dipole moment is
[Online May 12, 2012]

Options:

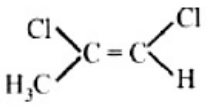
A. CH_3Cl

B.



C. CH_2Cl_2

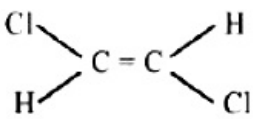
D.



Answer: C

Solution:

Solution:



Dipole moment (μ) = 0

Question164

Although CN^- ion and N_2 molecule are isoelectronic, yet N_2 molecule is chemically inert because of
[Online May 12, 2012]

Options:

A. presence of more number of electrons in bonding orbitals

B. low bond energy

C. absence of bond polarity

D. uneven electron distribution.

Answer: C

Solution:

In nitrogen molecule, both the nitrogen atoms have same electronegativity. So it has zero polarity and hence less tendency to break away and forms ions.

Question165

In which of the following pairs, the two species are not isostructural ? [2012]

Options:

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

B. PCl_4^+ and $SiCl_4$

C. PF_5 and BrF_5

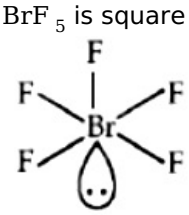
D. AlF_6^{3-} and SF_6

Answer: C

Solution:

Solution:
PF_5 is trigonal bipyramidal

BrF_5 is square pyramidal (distorted)



Question166

The formation of molecular complex $BF_3 - NH_3$ results in a change in hybridisation of boron [Online May 12, 2012]

Options:

A. from sp^2 to dsp^2

B. from sp^2 to sp^3

C. from sp^3 to sp^2

D. from sp^3 to sp^3d

Answer: B

Solution:

In BF_3, B is sp^2 hybridized with one empty p_z orbital. The empty p_z orbital of BF_3 can be filled by lone pair of molecules such as NH_3. When this occurs a tetrahedral molecule or ion is formed which is sp^3 hybridized.

Question167

Which of the following has the square planar structure? [Online May 19, 2012]

Options:

A. XeF_4

B. NH_4^+

C. BF_4^-

D. CCl_4

Answer: A

Solution:

Solution:
XeF_4 has square pyramidal structure, while NH_4^+, BF_4^- and CCl_4 have tetrahedral structure.

Question168

Among the following species which two have trigonal bipyramidal shape?

(I) NI_3
(II) I_3^-
(III) SO_3^{2-}
(IV) NO_3^-
[Online May 26, 2012]

Options:

A. I and III

B. III and IV

C. I and IV

D. II and III

Answer: A

Solution:

Solution:

Specise	Hybridisation	Shape
NI_3	sp^3	Trigonal pyramidal
I_3^-	sp^3d	Linear
SO_3^{2-}	sp^3	Trigonal pyramidal
NO_3^-	sp^2	Trigonal planer

Hence, NI_3 and SO_3^{2-} have same shape.

Question169

The number of types of bonds between two carbon atoms in calcium carbide is : [2011RS]

Options:

A. One sigma, one pi

B. Two sigma, onc pi

C. Two sigma, two pi

D. One sigma, two pi

Answer: D

Solution:

Solution:
Calcium carbide exists as Ca^{2+} and C_2^{2-}. According to the molecular orbital model, C_2^{2-} should have following molecular orbital configuration:
$KK\sigma 2s^2\sigma^*2s^2\pi 2p_x^2 = \pi 2p_y^2\sigma 2p_z^2$
Thus M.O. configuration suggests that it contains one σ & two π bonds.

Question170

Which one of the following pairs of species have the same bond order? [2008]

Options:

A. CN^- and NO^+

B. CN^- and CN^+

C. O^-, and CN^-

D. NO^+ and CN^+

Answer: A

Solution:

Solution:
For any species to have same bond order we can expect them to have same number of electrons. Calculating the number of electrons in various species.
$O_2^-(8+8+1=17)$; $CN^-(6+7+1=14)$
$NO^+(7+8-1=14)$; $CN^+(6+7-1=12)$
We find CN^- and NO^+ both have 14 electrons, so they have same bond order.

Question171

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 $C-F$ bond is [2008]

Options:

A. stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4.

B. 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.

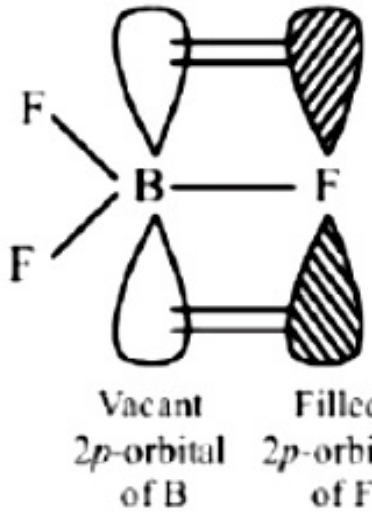
C. lower degree of $p\pi-p\pi$ interaction between B and F in BF_3 than that between C and F in CF_4.

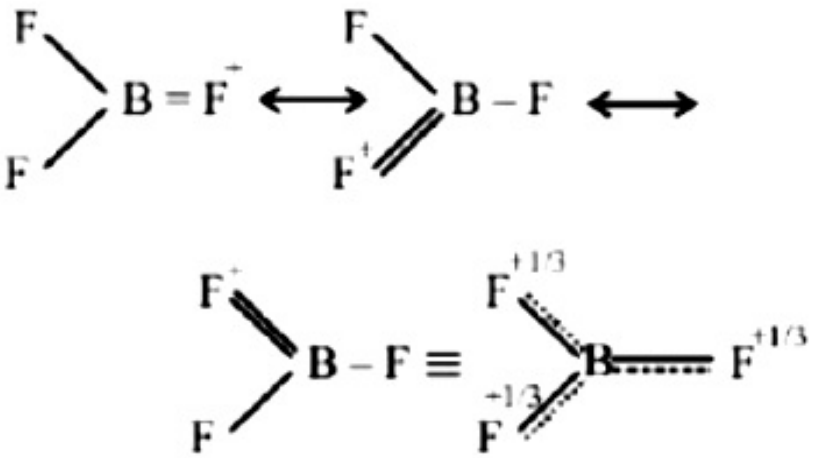
D. smaller size of B -atom as compared to that of C -atom.

Answer: B

Solution:

Solution:
Note: The delocalised $p\pi-p\pi$ bonding between filled p -orbital of F and vacant p -orbital of B leads to shortening of $B-F$ bond length which results in higher bond dissociation energy of the $B-F$ bond.





Question172

Using MO theory, predict which of the following species has the shortest bond length?
[2008]

Options:

A. O_2^+

B. O_2^-

C. O_2^{2-}

D. O_2^{2+}

Answer: D

Solution:

Bond order

$$= \frac{\text{No.of bonding electrons} - \text{No.of antibonding electrons}}{2}$$

Bond order in $O_2^+ = \frac{10-5}{2} = 2.5$

Bond order in $O_2^- = \frac{10-7}{2} = 1.5$

Bond order in $O_2^{2-} = \frac{10-8}{2} = 1$

Bond order in $O_2^{2+} = \frac{10-4}{2} = 3$

Since, bond order $\propto \frac{1}{\text{Bond length}}$

$\therefore$ Bond length is shortest in O_2^{2+}.

Question173

Which of the following hydrogen bonds is strongest? [2007]

Options:

A. $O-H---F$

B. $O-H---H$

C. $F-H---F$

D. $O-H---O$

Answer: C

Solution:

Solution:
Note: Greater the difference between electronegativity of bonded atoms, stronger will be bond. Since F is most electronegative, hence $F-H.....F$ is the strongest bond.

Question174

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+}, Be^{2+}? [2007]

Options:

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

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

Solution:

Solution:
Smaller the size and higher the charge, more will be the polarising power of the cation. Since the order of the size of cation is $K^{+} > Ca^{2+} > Mg^{2+} > Be^{2+}$, so the correct order of polarising power is
$K^{+} < Ca^{2+} < Mg^{2+} < Be^{2^{2}}$

Question175

Which of the following species exhibits the diamagnetic bchaviour? [2007]

Options:

A. NO

B. O_2^{2-}

C. O_2^{+}

D. O_2

Answer: B

Solution:

Solution:
Diamagnetic specics have no unpaired electrons whereas paramagnetic species has one or more unpaired electrons.
For electronic configuration of O_2^{+}, O_2 and O_2^{2}, consult Q.2.
O_2 and O_2^{+} have 2 and 1 unpaired electron respectively, while O_2^{2-} has no unpaired electron
$NO \rightarrow KK\sigma 2s^2\sigma^{*}2s^2\sigma 2p_z^{\ 2}\pi 2p_x^{\ 2} = \pi 2p_y^{\ 2}$
$\pi^{*}2p_x^{\ 1} = \pi^{*}2p_y^{\ 0}$
Thus no has one unpaired electron

Question176

In which of the following ionization processes, the bond order has increased and the magnetic behaviour has changed? [2007]

Options:

A. $N_2 \rightarrow N_2^+$

B. $C_2 \rightarrow C_2^+$

C. $NO \rightarrow NO^+$

D. $O_2 \rightarrow O_2^+$.

Answer: C

Solution:

Solution:
(a) N_2: bond order 3 , diamagnetic
N_2^+: bond order 2.5, paramagnetic
(b) C_2: bond order 2 , diamagnetic
C_2^+: bond order 1.5, paramagnetic
(c) NO: bond order 2.5, paramagnetic
NO^+ : bond order 3, diamagnetic
(d) O_2 : bond order 2, paramagnetic
O_2^+: bond order 2.5, paramagnetic

Question177

In which of the following molecules\/ions are all the bonds not equal? [2006]

Options:

A. XeF_4

B. BF_4

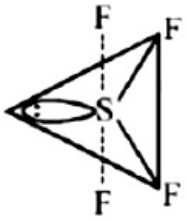
C. SF_4

D. SiF_4

Answer: C

Solution:

In SF_4 the hybridisation is sp^3d and the shape of molecule is



It contains two different bonds i.e., axial and equatorial.

Question178

The decreasing values of bond angles from $NH_3(106^\circ)$ to $SbH_3(101^\circ)$ down group- 15 of the periodic table is due to [2006]

Options:

A. decreasing l p − bp repulsion

B. decreasing electronegativity

C. increasing bp − bp repulsion

D. increasing p -orbital character in sp^3

Answer: B

Solution:

Solution:
The bond angle decreases on moving down the group due to decrease in bond pair-bond pair repulsion.
NH_3 107°
PH_3 94°
AsH_3 92°
SbH_3 91°
BiH_3 90°
Note: This can also be explained due to decrease in electronegativity from N to Bi.

Question179

Which of the following molecules/ions does not contain unpaired electrons? [2006]

Options:

A. N_2^+

B. O_2

C. O_2^{2-}

D. B_2

Answer: C

Solution:

Solution:
The distribution of electrons in MOs is as follows :
N_2^+(electrons 13) $\Rightarrow KK\sigma 2s^2\sigma^*2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^1$
$\Rightarrow KK\sigma 2s^2\sigma 2s^2\sigma 2p_x^2 \Rightarrow O_2$(electron 16)
$\pi 2p_x^2 = \pi 2p_y^2\pi^*2p_x^1 = \pi^*2p_y^1$
$\Rightarrow KK\sigma 2s^2\sigma^*2s^2\sigma 2p_x^2 \Rightarrow O_2^{2-}$(electron 18)
$\pi 2p_x^2 = \pi 2p_y^2\pi^*2p_x^2 = \pi^*2p_y^2$
B_2(electrons 10) $\Rightarrow KK\sigma 2s^2\sigma^*2s^2\sigma 2p_x^2$
$KK\sigma 2s^2\sigma^*2s^2\pi 2p_x^1 = \pi 2p_y^1$
Only O_2^{2-} does not contain any unpaired electron.

Question180

Lattice energy of an ionic compound depends upon [2005]

Options:

A. Charge on the ion and size of the ion

B. Packing of ions only

C. Size of the ion only

D. Charge on the ion only

Answer: A

Solution:

Solution:
The value of lattice energy depends on the charge present on the two ions and the distance between them.

Question181

Which of the following species is diamagnetic in nature? [2005]

Options:

A. H_2^-

B. H_2^+

C. H_2

D. He_2^+

Answer: C

Solution:

Solution:
A diamagnetic substance contains no unpaired electron. H_2 is diamagnetic as it contains all paired electrons
$H_2 = \sigma ls^2$, $H_2^+ = ols^1$, $H_2^- = \sigma ls^2 \sigma ls$
(diamagnetic) (paramagnetic) (paramagnetic)
$He_2^+ = \sigma ls^2 \sigma^* ls$
(paramagnetic)

Question182

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? [2004]

Options:

A. Bond length in NO^+ is equal to that in NO

B. Bond length in NO is greater than in NO^+

C. Bond length in NO^+ is greater than in NO

D. Bond length is unpredictable

Answer: B

Solution:

Solution:
Now since bond order of NO^+ (3) is higher than that of NO(2.5). Thus bond length of NO^+ will be shorter.

Question183

The correct order of bond angles (smallest first) in H_2S, NH_3, BF_3 and SiH_4 is [2004]

Options:

A. $H_2S < NH_3 < SiH_4 < BF_3$

B. $NH_3 < H_2S < SiH_4 < BF_3$

C. $H_2S < SiH_4 < NH_3 < BF_3$

D. $H_2S < NH_3 < BF_3 < SiH_4$

Answer: A

Solution:

Solution:
The order of bond angles
$BF_3 > SiH_4 > NH_3 > H_2S$
$120^\circ \quad 109^\circ 28' \quad 107^\circ \quad 92.5$

Question184

The states of hybridization of boron and oxygen atoms in boric acid (H_3BO_3) are respectively
[2004]

Options:

A. sp^3 and sp^2

B. sp^2 and sp^3

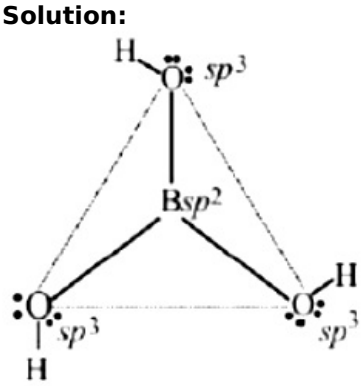
C. sp^2 and sp^2

D. sp^3 and sp^3

Answer: B

Solution:

Solution:



Question185

Which one of the following has the regular tetrahedral structure? (Atomic nos. : B = 5, S = 16, Ni = 28, Xe = 54)
[2004]

Options:

A. BF_4^-

B. SF_4

C. XeF_4

D. $[Ni(CN)_4]^{2-}$

Answer: A

Solution:

Solution:
XeF_4 (sp^3d^2, square planar),
$[Ni(CN)_4]^{2-}$ (dsp^2, square planar)
BF_4^- (sp^3, tetrahedral), SF_4 (sp^3d, see saw shaped)

Question186

The maximum number of 90° angles between bond pair bond pair of electrons is observed in
[2004]

Options:

A. dsp^2 hybridization

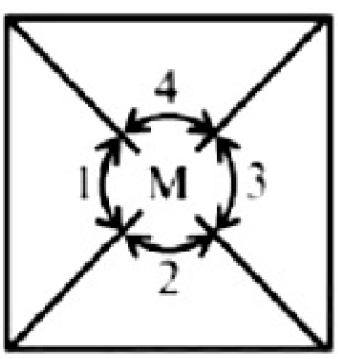
B. sp^3d hybridization

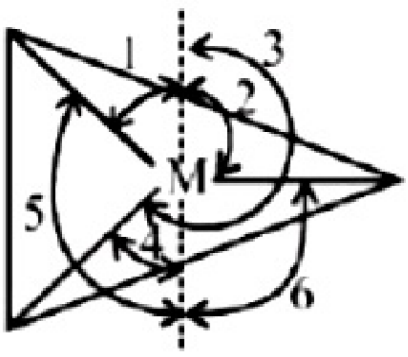
C. dsp^3 hybridization

D. sp^3d^2 hybridization

Answer: D

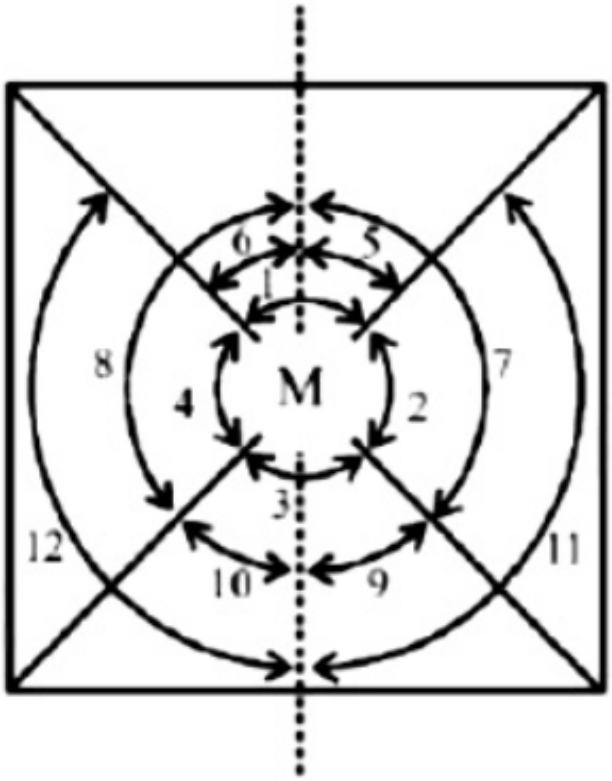
Solution:





dsp^2 hybridisation
Number of 90° angle between bonds = 4

sp^3d or dsp^3 hybridisation
Number of 90° angle between bonds = 6



sp^3d^2 Hybridisation

Number of 90° angle between bonds = 12

Question187

An ether is more volatile than an alcohol having the same molecular formula. This is due to
[2003]

Options:

A. alcohols having resonance structures

B. intermolecular hydrogen bonding in ethers

C. intermolecular hydrogen bonding in alcohols

D. dipolar character of ethers

Answer: C

Solution:

In ether, there is no H-bonding while alcohols have intermolecular H-bonding.

Question188

Which one of the following pairs of molecules will have permanent dipole moments for both members?
[2003]

Options:

A. NO_2 and CO_2

B. NO_2 and O_3

C. SiF_4 and CO_2

D. SiF_4 and NO_2

Answer: B

Solution:

Solution:
Both NO_2 and O_3 have angular shape and hence will have net dipole moment.

Question189

Which one of the following compounds has the smallest bond angle in its molecule ?
[2003]

Options:

A. OH_2

B. SH_2

C. NH_3

D. SO_2

Answer: B

Solution:

In nH_2S, due to low electronegativity of sulphur the l.p. − l.p. repulsion is more than b . p. − b . p. repulsion and hence the bond angle is minimum.

Question190

The pair of species having identical shapes for molecules of both species is
[2003]

Options:

A. XeF_2, CO_2

B. BF_3, PCl_3

C. PF_5, IF_5

D. CF_4, SF_4

Answer: A

Solution:

Solution:
Both XeF_2 and CO_2 have a linear structure.
$F - Xe - F \quad O = C = O$

Question191

In which of the following species the interatomic bond angle is $109^\circ 28^{''}$?
[2002]

Options:

A. NH_3, BF_4^-

B. NH_4^+, BF_3

C. NH_3, BF_4

D. NH_2^-, BF_3.

Answer: A

Solution:

Solution:
In NH_3 and BF_4^-, the hybridisation is sp^3 and the bond angle is almost $109^\circ 28'$.

Question192

Hybridisation of the underline atom changes in: [2002]

Options:

A. AlH_3 changes to AlH_4^-

B. H_2xO changes to H_3O^+

C. NH_3 changes to NH_4^+

D. in all cases

Answer: A

Solution:

Solution:

$$\text{Hybridisation} = \frac{1}{2}\left[\left(\begin{array}{c}\text{No. of electrons}\\ \text{in valence}\\ \text{shell of atom}\end{array}\right) + \left(\begin{array}{c}\text{No.of monovalent}\\ \text{atoms around it}\end{array}\right) - \left(\begin{array}{c}\text{Charge on}\\ \text{cation}\end{array}\right) + \left(\begin{array}{c}\text{Charge on}\\ \text{anion}\end{array}\right)\right.$$

(a) For AlH_3

Hybridisation of Al atom $= \frac{1}{2}[3 + 3 - 0 + 0] = 3 = sp^2$

For AlH_4,

Hybridisation of A1 atom $= \frac{1}{2}[3 + 4 - 0 + 1] = 4 = sp^3$

(b) For H_2O,

Hybridisation of O atom

$= \frac{1}{2}[6 + 2 - 0 + 0] = 4 = sp^3$

For H_3O^+,

Hybridisation of O atom

$= \frac{1}{2}[6 + 3 - 1 + 0] = 4 = sp^3$

(c) For NH_3,

Hybridisation of N atom

$= \frac{1}{2}[5 + 3 - 0 + 0] = 4 = sp^3$

For NH_4^+,

Hybridisation of N atom

$= \frac{1}{2}[5 + 4 - 1 + 0] = 4 = sp^3$

Thus hybridisation changes only in option (a).

Question193

Which of the following are arranged in an increasing order of their bond strength?
[2002]

Options:

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

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

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

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

Answer: B

Solution:

$O_2^+(15)$

$= KK\sigma 2s^2\sigma 2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi^* 2p_x^1 = \pi 2p_y^0$

Bond order $= \frac{1}{2}(8 - 3) = \frac{5}{2} = 2.5$

$O_2(16) = KK\sigma 2s^2\sigma^t 2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi^* 2p_x^1 = \pi^* 2p_y^1$

Bond order $= \frac{1}{2}(8 - 4) = 2$

$O_2^-(17) = KK\sigma 2s^2\sigma^* 2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi^* 2p_x^2 = \pi^* 2p_y^1$

Bond order $= \frac{1}{2}(8 - 5) = 1.5$

$O_2^2(18) = KK\sigma 2s^2\sigma^* 2s^2\sigma 2p_z^2\pi 2p_x^2 = \pi 2p_y^2\pi^* 2p_x^2 = \pi^* 2p_y^2$

Bond order $= \frac{1}{2}(8 - 6) = 1$

Note: As we know that as the bond order decreases, stability also decreases and hence the bond strength also decreases. Therefore the correct order of their increasing bond strength is

$O_2^2 < O_2^- < O_2 < O_2^+$
