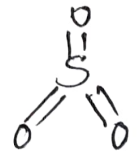
Class: IX

Hybridization

Teaching Taste

Q1) Ans:- A.

Solution:-



In this structure sulphur atom forms the maximum no. of covalent bonds which results into lowest energy for SO_3.

Q2) Ans:- D.

Solution:- $H = \frac{1}{2}[V + M - C + A]$

ICl_2^+

$H = \frac{1}{2}[7 + 2 - 1] = \frac{1}{2}[8] = 4$.

sp^3 hybridisation involved.

Q3) Ans:- C.

Solution:- CH_4 has regular geometry because of absence of lone pairs.

Q4) Ans:- A.

Solution:- In CH_4, C has sp^3 hybridization & after combustion it forms CO_2 where C has sp hybridization.

(Q5) Ans:- D

Solution:- There are 12 90° angles in sp^3d^2 hybrisation.

(Q6) Ans:- C

Solution:- XeF_4 is square planar

BF_4^- & SiF_4 are tetrahedral.

All bonds are equal in these molecules.

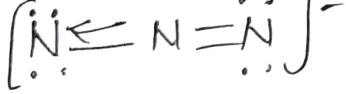
However in SF_4 there is sp^3d hybridization having 2 axial & 2 equatorial S-F bonds.

The all the bond in SF_4 are not equal.

(Q7) Ans:- B.

Solution:-

N_3^-



sp

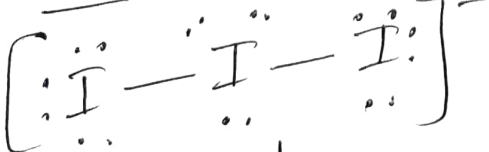
linear.

NO_2^+

sp

linear.

I_3^-



sp^3d

Linear.

Q8) Ans:- D.

Solution:- If the central atom undergoes either sp, sp^2 hybridisation. So they are flat.

If the central atom undergoes either sp^3, sp^3d, (or) sp^3d^2, then around the central atom planarity not possible.

$C_6H_6 \rightarrow sp^2$, $C_2H_4 \rightarrow sp^2$, $SO_3 \rightarrow sp^2$,

$C_2H_6 \rightarrow sp^3 \rightarrow$ not flat.

Q9) Ans:- B.

Solution:-

In $SO_4^{2-} \Rightarrow$ Bond pairs = 4, Lonepairs = 0 $\rightarrow sp^3$.

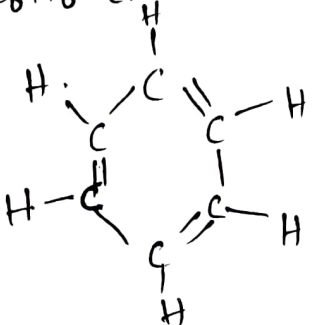
In $SF_4 \rightarrow$ B.P = 4, lone pairs = 1 $\rightarrow sp^3d$ hybridisation.

In $SF_2 \rightarrow$ B.P = 2, lone pairs = 2 $\rightarrow sp^3$ hybridisation

In $S_8 \rightarrow$ B.P = 2, L.P = 2 $\rightarrow sp^3$ hybridisation.

Q10) Ans:- B.

Solution:- C_6H_6 (Benzene).



12 — bonds

3 — π bonds.

The Carbon atoms are bonded through sp^2-sp^2 overlap while six C-H bond is formed by sp^2-s sigma bond. Thus 6 sp^2-s sigma bonds.

Multiple Correct Answer Type

Q11) Ans:- B, D

Solution:-

A) BF_3, C_2H_4, C_6H_6 → sp^2 hybridisation.

B) BeF_2 → F–Be–F → sp hybridisation.

C_2H_2 → H–C≡C–H → sp^2 hybridisation.

CO_3^{-2} → sp^2 hybridisation.

C) NH_3, H_2O, CCl_4 → sp^3 hybridisation.

D) CH_4 → sp^3 hybridisation.

C_2H_4 → sp^2 hybridisation

C_2H_2 → sp hybridisation.

Q12) Ans:- A.

Solution:- I_3^- ion is linear.

I_3^- has sp^3d hybridisation as it has 3 lone pairs and 2 bond pairs.

Q13) Ans:- B.

Solution:-

→ NO_3^- & CO_3^{2-} are an ideal trigonal planar because, the bond angle for both is 120°.

→ The hybridisation of NO_3^- & CO_3^{2-} is sp^2.

Q14) Ans:- C, D.

Solution:-

A) $PCl_5 \rightarrow sp^3d \rightarrow$ Trigonal bipyramidal.

$ICl_4^- \rightarrow sp^3d^2 \rightarrow$ Square planar.

B) $NH_3, H_2O \rightarrow sp^3$

$NH_3 \rightarrow$ Pyramidal shape.

$H_2O \rightarrow$ V-shape

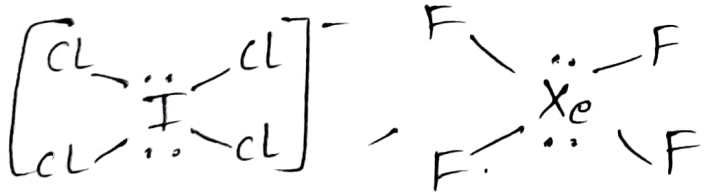
C) $NH_3, ClO_3^- \rightarrow sp^3$, pyramidal shape.

D) $ICl_4^- \rightarrow sp^3d^2 \rightarrow$ Square planar.

$XeF_4 \rightarrow sp^3d^2 \rightarrow$ Square planar.

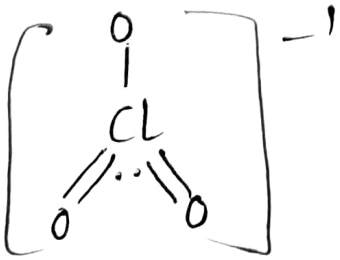
Q15) Ans:- D.

Solution:- ICl_4^-, XeF_4 are square planar.



Q16) Ans:- B.

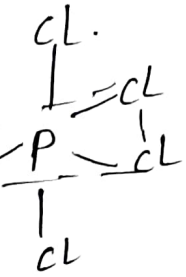
Solution:- ClO_3^- is pyramidal shape.



Integer Type

Q17) Ans:- 3.

Solution:- PCl_5 has sp^3d hybridization with trignal bipyramidal shape. It contains 2 axial & 3 equitorial bonds



Q18) Ans:- 1

Solution:-

→ ICl_2^- and $BeCl_2$ are linear but ICl_2^- has sp^3d and $BeCl_2$ hay sp hybridization.

Matrix Matching

Q19) Ans:- A) S B) Q C) R D) P.

Solution:-

A) $[NO_3]^-$ → S) sp^2

B) $[ClO_3]^-$ → Q) sp^3.

C) $[Fe(CN)_6]^{3-}$ → R) d^2sp^3.

D) $[ICl_2]^-$ → P) sp^3d.

Q20) Ans:- A) Q, S B) R C) T D) P, U, V.

Solution:-

A) Linear → Q) I_3^- S) XeF_2

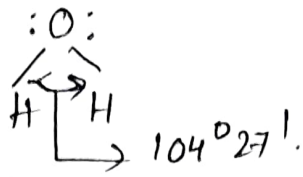
B) Bent → R) O_3.

C) Tetrahedral → T) OF_2

D) Planar → P) CO_3^{2-} U) XeF_4 V) SO_3.

Learner's Task

Q1) Ans:- D.

Solution:- $H_2O \rightarrow$ 

Q2) Ans:- C.

Solution:-

$BeCl_2 \rightarrow sp$, linear.

$BCl_3 \rightarrow sp^2$, trigonal planar.

Q3) Ans:- C

Solution:- $CO_2 \rightarrow O=C=O \rightarrow$ Linear.

$CS_2 \rightarrow S=C=S \rightarrow$ Linear.

Q4) Ans:- A

Solution:-

CH_4 (Methane) $\rightarrow sp^3$.

C_2H_4 (Ethene) $\rightarrow sp^2$

C_2H_2 (Ethyne) $\rightarrow sp$

Q5) Ans:- A.

Solution:-

Methane $\rightarrow sp^3 \rightarrow 5\% \rightarrow 25\%$.

Ethene $\rightarrow sp^2 \rightarrow 5\% \rightarrow 33\%$.

Ethyne $\rightarrow sp \rightarrow 5\% \rightarrow 50\%$.

Q1) Ans:- C.

Solution:-

sp^3d^2 with no lone pair → Octahedral.

sp^3d^2 with 1 lone pair → Square pyramidal.

sp^3d^2 with 2 lone pairs → Square planar.

Q2). Ans:- A

A) H_2CO_3 → Polar compound → sp^2 hybridisation.

B) SiF_4 → Non polar → sp^3 hybridisation

C) BF_3 → Non polar → sp^2 hybridisation

D) $HClO_2$ → Non polar → sp^3 hybridisation.

Q3) Ans:- B.

Solution:- A square planar complex is formed by hybridisation of s, p_x, p_y, $d_{x^2-y^2}$ atomic orbitals. All these orbitals lie in the xy plane. Four ligands also lie in the xy plane. This results in maximum overlap.

Q4) Ans:- B.

Solution:- NO_2^+ → sp hybridisation.

NO_3^- → sp^2 hybridisation.

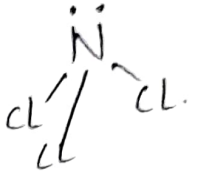
NH_4^+ → sp^3 hybridisation.

Q5) Ans:- D.

Solution:-

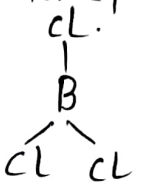
A) NH_3 → 3 bond pairs, 1 lone pair → Trigonal pyramidal

B) NCl_3 → 3 bond pairs, 1 lone pair
Trigonal pyramidal



C) PF_3 → 3 bond pairs, 1 lone pair
Trigonal pyramidal.

D) BCl_3 → 3 bond pairs, 0 lone pairs
Trigonal planar



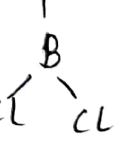
JEE Main Level Questions

Q1) Ans:- C.

Solution:-

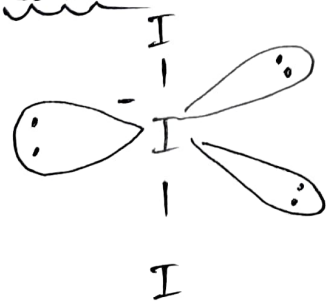
A) $BeCl_2$ → sp, linear → Cl — Be — Cl

C) BCl_3 → sp^2, trigonal planar →



Q2) Ans:- A.

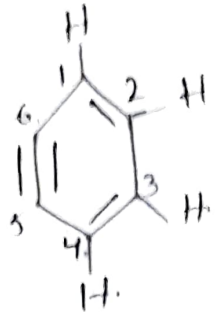
Solution:-



The central iodine atom undergoes sp^3d hybridisation & has 3 lone pairs & 2 bond pairs. So, I_3^- has trigonal bipyramidal geometry & linear shape.

Q3:- Ans:- A.

Solution:-



1, 2, 3, 4 → sp^2 hybridisation → 4.

5, 6 → sp hybridisation → 2

Q4) Ans:- B.

Solution:- In H_3BO_3,

→ B has 3 bond pair of Electrons → sp^2

Oxygen has 2 lone pairs & 2 bond pairs → sp^3.

Q5) Ans:- C.

Solution:-

PF_5 → 5 bond pairs, 0 lone pair → sp^3d hybridisation
Trigonal bipyramidal

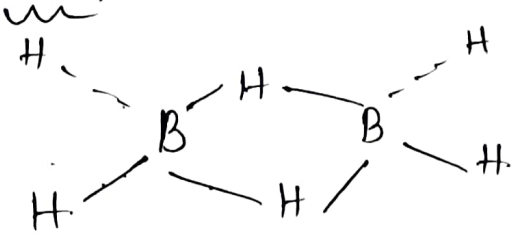
BrF_5 → 5 bond pairs, 1 lone pair.

sp^3d^2 hybridisation → Square pyramidal.

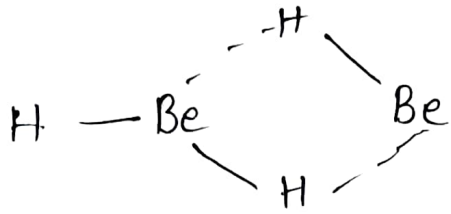
Q6) Ans:- D.

PCl_4^+, BF_4^-, ClO_4^- → 4 bond pairs, 0 lonepairs
involves sp^3 hybridisation.

Q7) Ans:- B.



→ sp^3 hybridisation



→ sp^2 hybridisation.

Q8) Ans:- B.

Solution:- Two hybrid orbitals 120° apart are sp^2 hybridized.

% S character = $\frac{1}{3} \times 100\% = 33\%$.

Q9) Ans:- C.

Solution:-

PCl_3 → 3 bond pairs, 1 lone pair → sp^3.

PCl_5 → 5 bond pairs, 0 lone pair → sp^3d.

Q10) Ans:- C.

Solution:-

BF_4^- → 4 bond pairs, no lone pair.

sp^3 hybridisation.

Advanced Level Questions

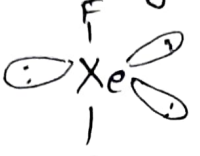
(Q11) Ans:- A, B, D.

Solution:-

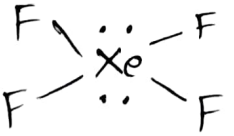
A) $XeOF_3^+$ → 1 'σ' bond with oxygen, 1 'π' with oxygen, 3 σ bonds with F and one lone pair.

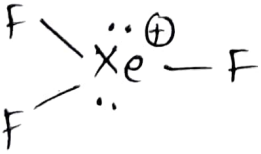
Total hybridised orbitals = 1+3+1 = 5

sp^3d hybridisation.

B) XeF_2 → 

2 bond pairs,
3 lone pairs.
Total = 5
sp^3d hybridisation.

C) XeF_4 →  → sp^3d^2 hybridisation.

D) XeF_3^+ →  → sp^3d hybridisation

(Q12) Ans:- B, C.

A) XeF_5^- → 5 bond pairs, 2 lone pairs → sp^3d^3.

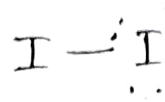
B) XeO_6^{4-} → 6 bond pairs, 0 lone pairs → sp^3d^2

C) $XeOF_4$ → 5 bond pairs, 1 lone pair → sp^3d^2

D) XeF_6 → 6 bond pairs, 1 lone pair → sp^3d^3.

Q13) Ans:- A, B, C.

Solution:-

A) I_3^- →  → sp^3d

B) SF_4 → 4 bond pairs, 1 lone pair → sp^3d

C) PF_5 → 5 bond pairs, 0 lone pairs → sp^3d

D) IF_5 → 5 bond pairs, 1 lone pair → sp^3d^2

Q14) Ans:- B.

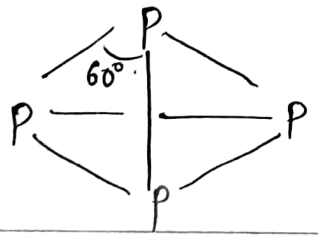
A) H_2S → 92.1°.

B) H_2O → 104° 27'.

C) H_2Se → 91°.

Q15) Ans:- C.

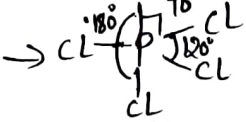
Solution:- P_4 molecule is tetrahedral.

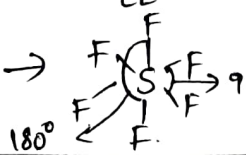


Q16) Ans:- C.

Solution:- A) sp^2 → Triangular planar → 120°.

B) sp^3 → Tetrahedral → 109.5°.

C) sp^3d → Trigonal bipyramidal → 

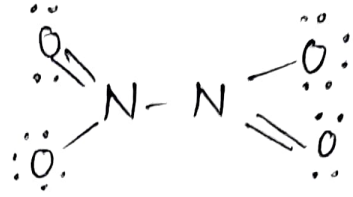
D) sp^3d^2 → Square bipyramidal → 

Integer Type

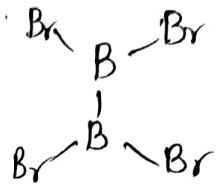
Q17) Ans:- 6.

Solution:-

1) N_2O_4 → planar.



2) B_2Br_4 → planar.



3) Ga_2H_6 → Not planar

4) B_2F_4 → planar.

5) CoF_2 → Trigonal planar.

6) $CoCl_2$ → Trigonal planar.

7) $C(CN)_3^-$ → Trigonal planar.

8) SOF_2 → Trigonal pyramidal.

Q18) Ans:- 1

Solution:-

Bond length.

BF_4^- → 143pm. → Equal bond lengths.

SF_4 → axial bonds (164 ±) and Equitorial 155±.

SiF_4 → All bond lengths are equal.

XeF_4 → All bond lengths are equal.

Q19) Ans:- 7

Solution:- XeF_6.

→ 1 lone pair, 6 bond pairs.

Total = 7

Matrix Matching

Q20) Ans:- A) p B) r C) q D) s.

A) C-H bond in Ethyne → p) Sp-s overlap.

B) P-Cl bond in $POCl_3$. → r) sp^3-p overlap

C) Br-Br bond in Br_3^- → q) sp^3d - p overlap.

D) C-C bond in Ethane. → s) sp^3-sp^3 overlap.