

Hybridization

Teaching Task

Q1) Ans:- A.

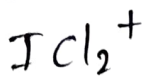
Solution:-



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

Q2) Ans:- D.

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



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

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 hybridisation.

Q6)

Ans:- c

Solution:- XeF_4 is square planar

BF_4^- & SiF_4 are tetrahedral.

All bonds are equal in these molecules.

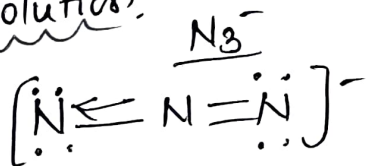
However in SF_4 there is sp^3d hybridization having 2 axial & 2 equatorial S-F bonds.

The all the bond in SF_4 are not equal.

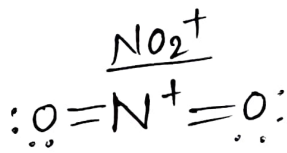
Q7)

Ans:- B.

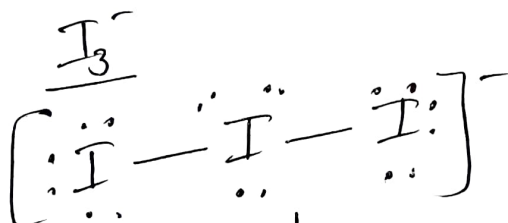
Solution:-



sp
linear.



sp
linear.



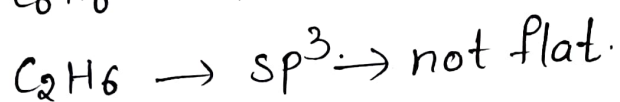
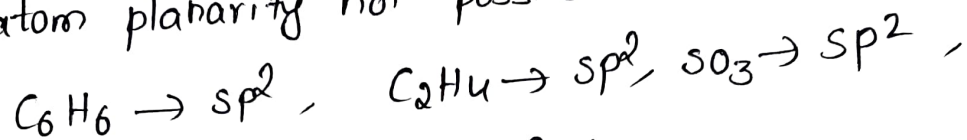
sp^3d

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.



Q9) Ans:- B.

Solution:-

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

In $SF_6 \rightarrow$ B.P = 6, lone pairs = 0 $\rightarrow sp^3d^2$ hybridisation.

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

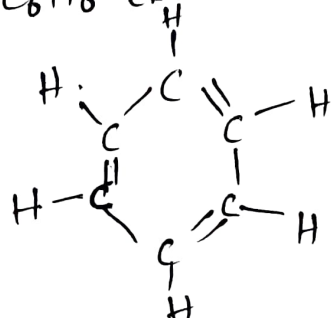
In $SF_2 \rightarrow$ B.P = 2, lone pairs = 2 $\rightarrow sp^3$ hybridisation.

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

Q10) Ans:- B.

Solution:-

C_6H_6 (Benzene).



12 σ 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) $\text{BF}_3, \text{C}_2\text{H}_4, \text{C}_6\text{H}_6 \rightarrow \text{sp}^2$ hybridisation.

B) $\text{BeF}_2 \rightarrow \text{F}-\text{Be}-\text{F} \rightarrow \text{sp}$ hybridisation.

$\text{C}_2\text{H}_2 \rightarrow \text{H}-\text{C}\equiv\text{C}-\text{H} \rightarrow \text{sp}$ hybridisation.

$\text{CO}_3^{2-} \rightarrow \text{sp}^2$ hybridisation.

C) $\text{NH}_3, \text{H}_2\text{O}, \text{CCl}_4 \rightarrow \text{sp}^3$ hybridisation.

D) $\text{CH}_4 \rightarrow \text{sp}^3$ hybridisation.

$\text{C}_2\text{H}_4 \rightarrow \text{sp}^2$ hybridisation.

$\text{C}_2\text{H}_2 \rightarrow \text{sp}$ hybridisation.

Q12) Ans:- B.

Solution:- I_3^- ion is linear. $\text{:}\ddot{\text{I}}-\ddot{\text{I}}-\ddot{\text{I}}\text{:}$

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

Q13) Ans:- A

Solution:-

$\rightarrow \text{NO}_3^-$ & CO_3^{2-} are an ideal trigonal planar because, the bond angle for both is 120° .

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

Q14) Ans: C.

Solution:

A) $\text{PCl}_5 \rightarrow \text{sp}^3\text{d} \rightarrow \text{Trigonal bipyramidal.}$

$\text{ICl}_4^- \rightarrow \text{sp}^3\text{d}^2 \rightarrow \text{Square planar.}$

B) $\text{NH}_3, \text{H}_2\text{O} \rightarrow \text{sp}^3$

$\text{NH}_3 \rightarrow \text{Pyramidal shape.}$

$\text{H}_2\text{O} \rightarrow \text{V-shape}$

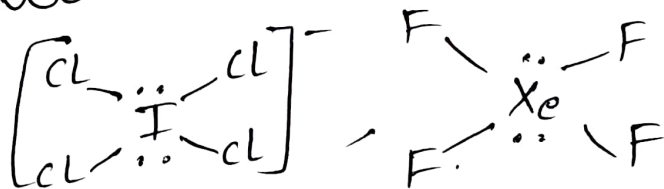
C) $\text{NH}_3, \text{ClO}_3^- \rightarrow \text{sp}^3, \text{pyramidal shape.}$

D) $\text{ICl}_4^- \rightarrow \text{sp}^3\text{d}^2 \rightarrow \text{Square planar.}$

$\text{ClO}_3^- \rightarrow \text{sp}^3 \rightarrow \text{pyramidal shape.}$

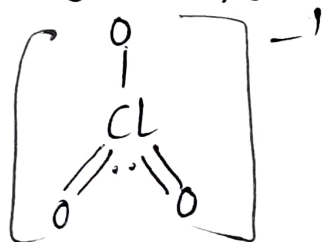
Q15) Ans: D.

Solution: $\text{ICl}_4^-, \text{XeF}_4$ are square planar.



Q16) Ans: B.

Solution: ClO_3^- is pyramidal shape.

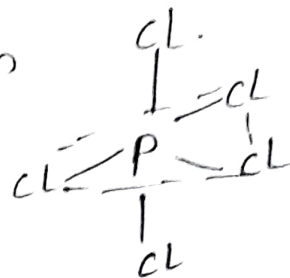


Integer Type

Q17) Ans: 3.

Solution: PCl_5 has sp^3d hybridization with trigonal bipyramidal shape.

It contains 2 axial & 3 equatorial bonds



Q18) Ans: 1

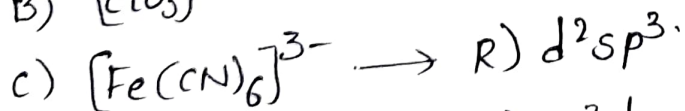
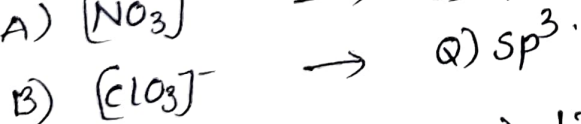
Solution:

$\rightarrow \text{ICl}_2^-$ and BeCl_2 are linear but ICl_2^- has sp^3d and BeCl_2 has sp hybridization.

Matrix Matching

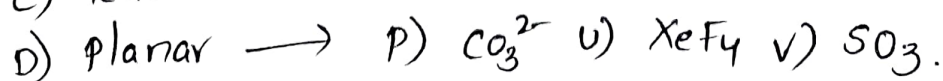
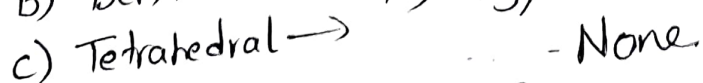
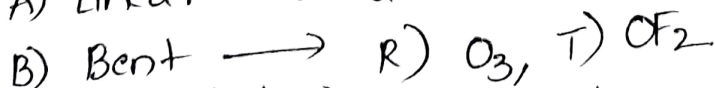
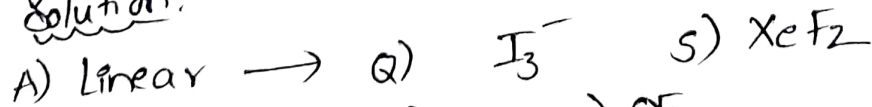
Q19) Ans: A) S B) Q C) R D) P.

Solution:



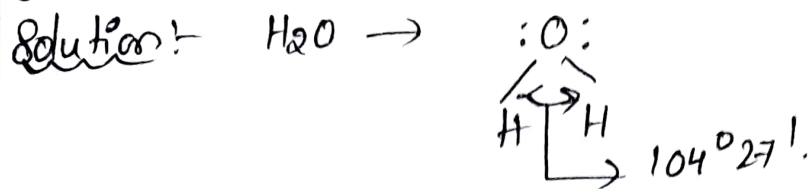
Q20) Ans: A) Q, S B) R, T C) None D) P, U, V.

Solution:



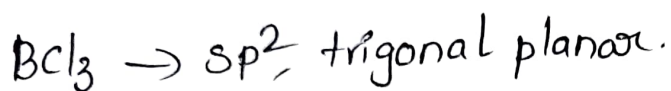
Learner's Task

Q1) Ans: D.

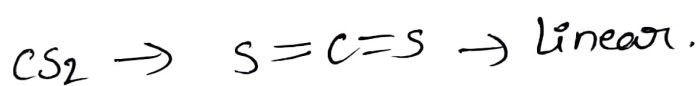
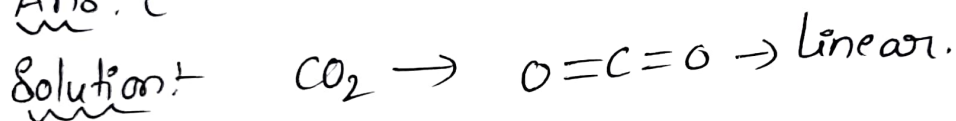


Q2) Ans: C.

Solution:

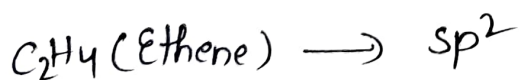
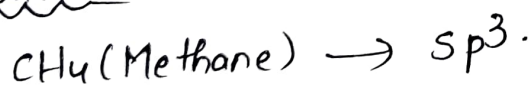


Q3) Ans: C



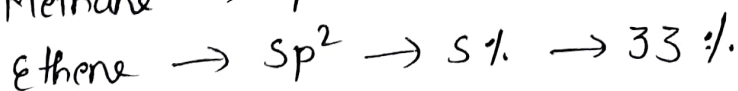
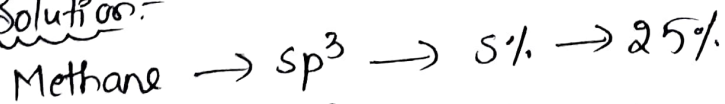
Q4) Ans: A

Solution:



Q5) Ans: A.

Solution:



Q1) Ans:- C.

Solution:-

sp^3d^2 with no lone pair \rightarrow Octahedral.

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

sp^3d^2 with 2 lone pairs \rightarrow Square planar.

Q2) Ans:- A

A) $H_2CO_3 \rightarrow$ Polar compound $\rightarrow sp^2$ hybridisation.

B) $SiF_4 \rightarrow$ Non polar $\rightarrow sp^3$ hybridisation

C) $BF_3 \rightarrow$ Non polar $\rightarrow sp^2$ hybridisation

D) $HClO_2 \rightarrow$ Non polar $\rightarrow sp^3$ 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:- $NO_2^+ \rightarrow sp$ hybridisation.

$NO_3^- \rightarrow sp^2$ hybridisation.

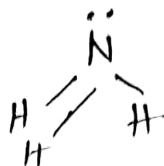
$NH_4^+ \rightarrow sp^3$ hybridisation.

Q5)

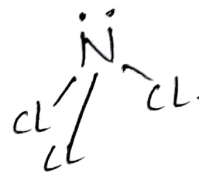
Ans: - D.

Solution:

A) $\text{NH}_3 \rightarrow$ 3 bond pairs, 1 lone pair \rightarrow Trigonal pyramidal



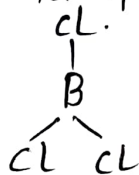
B) $\text{NCl}_3 \rightarrow$ 3 bond pairs, 1 lone pair
Trigonal pyramidal



C) $\text{PF}_3 \rightarrow$ 3 bond pairs, 1 lone pair
Trigonal pyramidal.



D) $\text{BCl}_3 \rightarrow$ 3 bond pairs, 0 lone pairs
Trigonal planar



JEE Main Level Questions

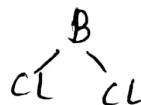
Q1)

Ans: - c.

Solution:

A) $\text{BeCl}_2 \rightarrow$ sp , linear \rightarrow $\text{Cl}-\text{Be}-\text{Cl}$

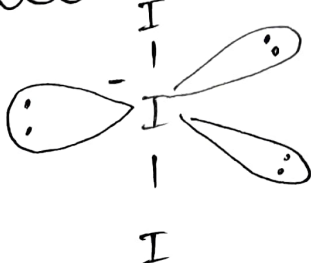
B) $\text{BCl}_3 \rightarrow$ sp^2 , trigonal planar \rightarrow



Q2)

Ans: - A.

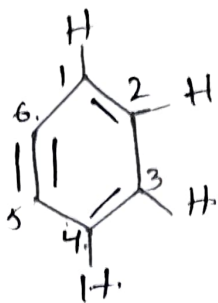
Solution:



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 \rightarrow sp^2 hybridisation \rightarrow 4.

5, 6 \rightarrow sp hybridisation \rightarrow 2.

Q4) Ans:- B.

Solution:- In H_3BO_3 ,

\rightarrow B has 3 bond pairs of electrons $\rightarrow sp^2$

Oxygen has 2 lone pairs & 2 bond pairs $\rightarrow sp^3$.

Q5) Ans:- C.

Solution:-

$PF_5 \rightarrow$ 5 bond pairs, 0 lone pairs $\rightarrow sp^3d$ hybridisation
Trigonal bipyramidal

$BrF_5 \rightarrow$ 5 bond pairs, 1 lone pair.

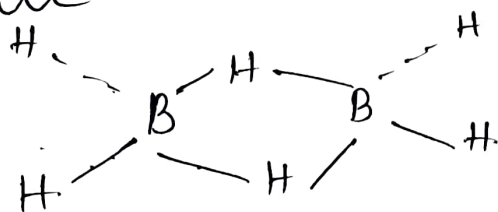
sp^3d^2 hybridisation \rightarrow Square pyramidal.

Q6) Ans:- D.

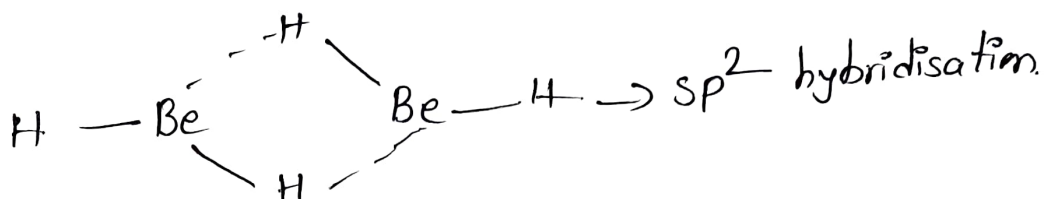
PCl_4^+ , BF_4^- , $ClO_4^- \rightarrow$ 4 bond pairs, 0 lone pairs
involves sp^3 hybridisation.

Q7)

Ans: B.



$\rightarrow sp^3$ hybridisation



$\rightarrow sp^2$ hybridisation.

Q8)

Ans: B.

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

$$\% \text{ s character} = \frac{1}{3} \times 100\% = 33\%$$

Q9)

Ans: C.

Solution:

PCl3 \rightarrow 3 bond pairs, 1 lone pair $\rightarrow sp^3$.

PCl5 \rightarrow 5 bond pairs, 0 lone pairs $\rightarrow sp^3d$.

Q10)

Ans: C.

Solution:

BH4- \rightarrow 4 bond pairs, no lone pairs.

sp^3 hybridisation.

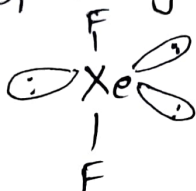
Advanced Level Questions

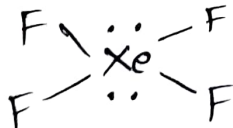
Q11) Ans:- A, B, D.

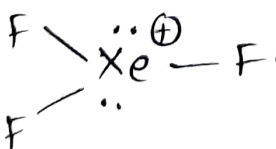
Solution:-

A) XeOF_3^+ \rightarrow 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) $\text{XeF}_2 \rightarrow$  2 bond pairs,
 3 lone pairs.
 Total = 5
 sp^3d hybridisation.

C) $\text{XeF}_4 \rightarrow$  $\rightarrow sp^3d^2$ hybridisation.

D) $\text{XeF}_3^+ \rightarrow$  $\rightarrow sp^3d$ hybridisation.

Q12) Ans:- B, C.

A) $\text{XeF}_5^- \rightarrow$ 5 bond pairs, 2 lone pairs $\rightarrow sp^3d^3$.

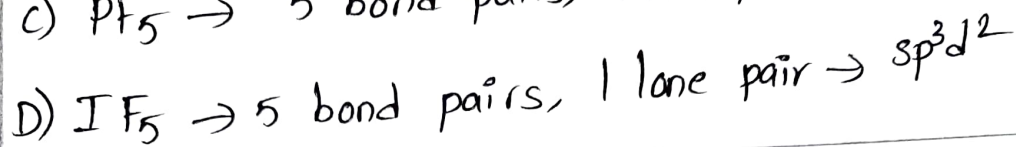
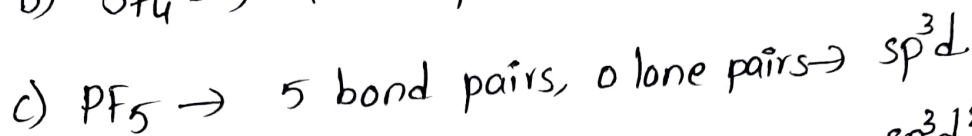
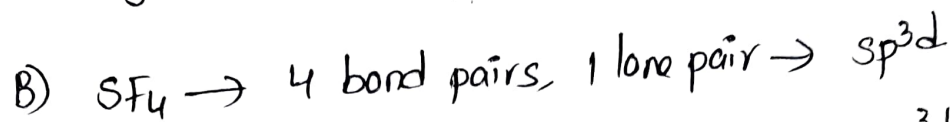
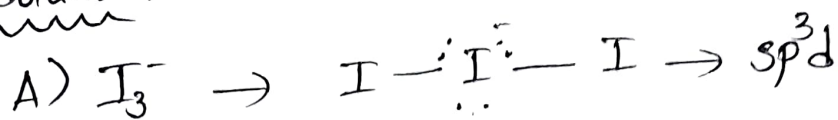
B) $\text{XeO}_6^{4-} \rightarrow$ 6 bond pairs, 0 lone pairs $\rightarrow sp^3d^2$.

C) $\text{XeOF}_4 \rightarrow$ 5 bond pairs, 1 lone pair $\rightarrow sp^3d^2$.

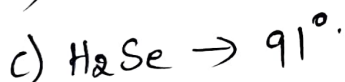
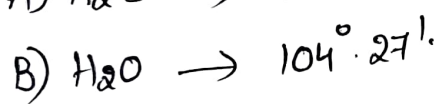
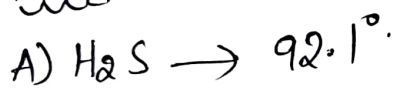
D) $\text{XeF}_6 \rightarrow$ 6 bond pairs, 1 lone pair $\rightarrow sp^3d^3$.

Q13) Ans:- A, B, C.

Solution:-

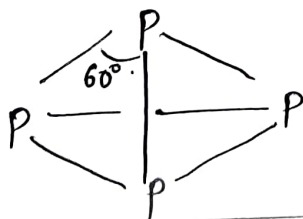


Q14) Ans:- B.



Q15) Ans:- C.

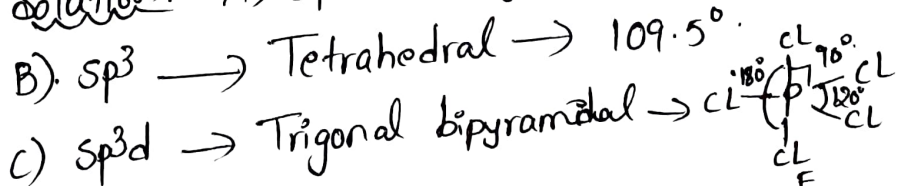
Solution:- P_4 molecule is tetrahedral.



Q16) Ans:- C.

Solution:- A) $sp^2 \rightarrow$ Triangular planar $\rightarrow 120^\circ$.

B) $sp^3 \rightarrow$ Tetrahedral $\rightarrow 109.5^\circ$.



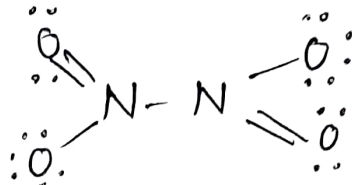
D) $sp^3d^2 \rightarrow$ Square bipyramidal \rightarrow

Integer Type

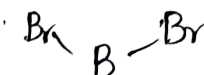
Q17) Ans:- 6.

Solution:-

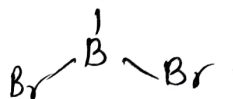
1) $N_2O_4 \rightarrow$ Planar.



2) $B_2Br_4 \rightarrow$ Planar.



3) $Ga_2H_6 \rightarrow$ Not planar



4) $B_2F_4 \rightarrow$ Planar.

5) $COF_2 \rightarrow$ Trigonal planar.

6) $COCl_2 \rightarrow$ Trigonal planar.

7) $C(CN)_3^- \rightarrow$ Trigonal planar.

8) $SOF_2 \rightarrow$ Trigonal pyramidal.

Q18) Ans:- 1

Solution:-

$BF_4^- \rightarrow$ Bond lengths. $143\text{pm.} \rightarrow$ Equal bond lengths.

$SF_6 \rightarrow$ axial bonds $(164 \pm)$ and Equatorial $155 \pm$.

$SiF_4 \rightarrow$ All bond lengths are equal.

$XeF_4 \rightarrow$ 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.

HYBRIDIZATION KEY

TEACHING TASK										
JEE MAINS LEVEL QUESTIONS										
1	2	3	4	5	6	7	8	9	10	
A	D	C	A	D	C	B	D	B	B	
JEE ADVANCED LEVEL QUESTIONS										
11	12	13	14	15	16	17	18	19	20	
B,D	B	A	C	D	B	3	1	A-S,B-Q,C-R,D-P		
20-A-Q,S,B-R,TC-NONE ,D-P,U,V										
LEARNERS TASK										
1	2	3	4	5	6	7	8	9	10	
D	C	C	A	A	C	A	B	B	D	
JEE MAINS LEVEL QUESTIONS										
1	2	3	4	5	6	7	8	9	10	
C	A	A	B	C	D	B	B	C	C	
JEE ADVANCED LEVEL QUESTIONS										
11	12	13	14	15	16	17	18	19	20	
A,B,D	B,C	A,B,C	B	C	C	6	1	7		
A-p,B-r,C-q,D-s										