

Hybridisation

101. (a) Bond angle of hydrides decreases down the group.
102. (b) Hybridization of N in NH_3 is sp^3 that of Pt in $[PtCl_4]^{2-}$ is dsp^2 that P in PCl_5 is sp^3d and that of B in BCl_3 is sp^2 .
103. (d) NH_4^+ and SO_4^{2-} both show sp^3 -hybridization and tetrahedral structure.
104. (a) It shows sp^3d^3 -hybridization. Hence the bond angle is about 72° .
105. (b) ClO_2

Explanation (Word-friendly format):

- $CO_2 \rightarrow$ Linear shape ($O=C=O$), hybridization of C is sp .
- $I_3^- \rightarrow$ Linear shape, central iodine is sp^3d hybridized (3 lone pairs cause linear geometry).
- $ClO_2 \rightarrow$ Bent (angular) shape because chlorine has one lone pair and two bonding pairs.
Hence, **ClO_2 is not linear.**

106. (a) SCl_4

Explanation (Word-friendly format):

- $SO_4^{2-} \rightarrow$ Tetrahedral (central S is sp^3 hybridized).
- $Ni(CO)_4 \rightarrow$ Tetrahedral (Ni uses sp^3 hybridization).
- $NiCl_4^{2-} \rightarrow$ Tetrahedral geometry due to sp^3 hybridization in high-spin complex.
- $SCl_4 \rightarrow$ Has one lone pair on sulfur \rightarrow actual shape is **see-saw**, not tetrahedral.

Therefore, **SCl_4 is not tetrahedral.**



107. (a) s-character increases with increase in bond angle.

Hybridization	s%	Angle
sp	50	180°
sp^2	33.3	120°
sp^3	25	109.28°
sp^3d^1	20	90° and 120°

108. (b) IF_7 molecule shows sp^3d^3 – hybridization.

109. (a) Spherically symmetrical

Explanation (Word-friendly format):

When all five d orbitals are completely filled (d^{10} configuration), the electron density is uniformly distributed around the nucleus. This results in **spherical symmetry**, similar to s orbitals.

Therefore, a d^{10} configuration is spherically symmetrical

110. (a) PCl_3 contain three bonding and one lone pair electron. Hence shows sp^3 – hybridization.

111. (a) Ammonia and $(BF_4)^{-1}$ shows sp^3 – hybridization.

112. (b) For square planar geometry hybridization is dsp^2 involving s, p_x, p_y and $d_{x^2-y^2}$ orbital.

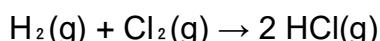
113. (b) All carbon atoms of benzene consist of alternate single and double bond and show sp^2 hybridization.

114. (a) $427 \text{ kJ}\cdot\text{mol}^{-1}$



Working (Word-friendly):

Consider the reaction:



Energy required to break bonds = $D(\text{H}-\text{H}) + D(\text{Cl}-\text{Cl}) = 430 + 242 = 672 \text{ kJ}$.

Energy released on forming 2 H-Cl bonds = $2 \times D(\text{H}-\text{Cl})$.

The reaction enthalpy $\Delta H(\text{reaction}) = [\text{energy to break}] - [\text{energy released forming bonds}]$

$$\text{So: } \Delta H = 672 - 2 \cdot D(\text{H}-\text{Cl})$$

Given ΔH_t for HCl = $-91 \text{ kJ} \cdot \text{mol}^{-1}$ (since 91 kJ is released per mole of HCl formed, the reaction $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$ releases 182 kJ), the reaction enthalpy for 1 mol $\text{H}_2 + 1 \text{ mol Cl}_2 \rightarrow 2 \text{ HCl}$ is:

$$\Delta H = 2 \times (-91) = -182 \text{ kJ}$$

Plug in: $-182 = 672 - 2 \cdot D(\text{H}-\text{Cl})$

$$\text{Rearrange: } 2 \cdot D(\text{H}-\text{Cl}) = 672 + 182 = 854$$

$$D(\text{H}-\text{Cl}) = 854 / 2 = 427 \text{ kJ} \cdot \text{mol}^{-1}$$

115. (d) PtCl_4^{2-}

Explanation (Word-friendly):

- **dsp^2 hybridization** corresponds to a **square-planar** geometry (one d, one s and two p orbitals mix).
- PtCl_4^{2-} (Pt(II) , d^8) is typically **square planar** $\rightarrow dsp^2$.
- NiCl_4^{2-} is usually **tetrahedral** (sp^3) for high-spin Ni(II).
- SCl_4 is see-saw (derived from trigonal bipyramidal, sp^3d).
- NH_4^+ is tetrahedral (sp^3).

116. (c) BCl_3 molecule show sp^2 -hybridization and planar structure.





CHEMICAL BONDING

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117. (c) BCl_3 Boron trichloride molecule shows sp^2 -hybridization and trigonal planar structure.

118. (b) SO_2 molecule shows sp^2 -hybridization and bent structure.

119. (c) Due to multiple bonding in N_2 molecule.

120. (a) % of s-character in

$$CH_4 = \frac{100}{4} = 25, \quad C_2H_4 = \frac{100}{3} = 33,$$

$$C_2H_2 = \frac{100}{2} = 50$$

