

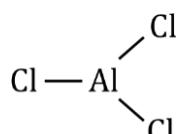
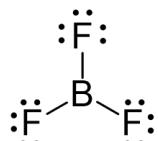


## DPP - 6

## SOLUTION

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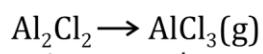
1.



Structure of Aluminium Chloride ( $\text{AlCl}_3$ )

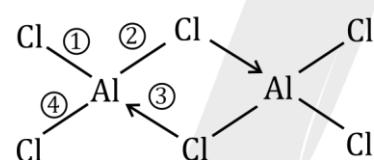
$\text{AlCl}_3$  is a covalent compound.  $\text{AlCl}_3$  can form dimer and exists as  $\text{Al}_2\text{Cl}_6$ , aluminium has vacant d-orbitals which can accommodate electron from chlorine atom.

2.



Dimer      monomer

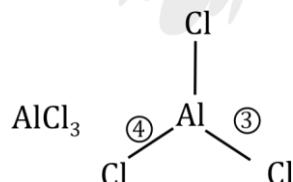
Structure



$\text{Al} \rightarrow$  incomplete

Hybridization = Number of s bond + number of lone pair.

$$= 4 + 0 = 4(\text{sp}^3)$$



$$\text{Hyb.} = 3 + 0 = 3$$

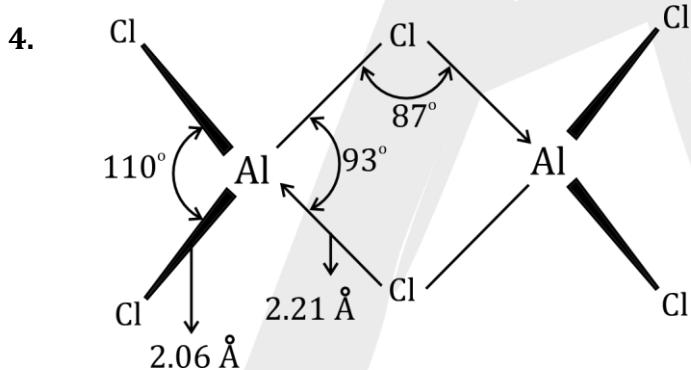
$$\text{Hyb.} = \text{sp}^2$$



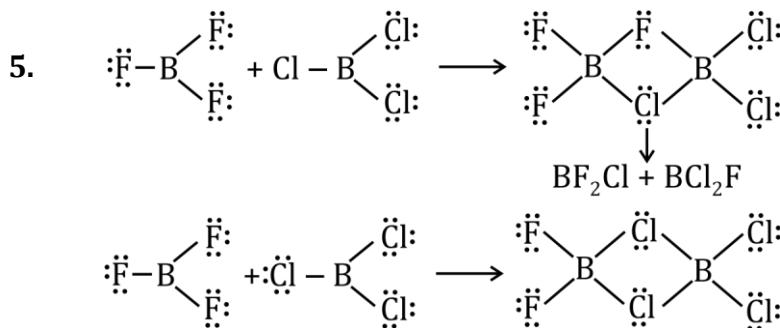
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3. The structure of diborane has  $D_{2h}$  symmetry. Four hydrides are terminal, while two bridge between the boron centers. The lengths of the  $B - H_{\text{bridge}}$  bonds and the  $B - H_{\text{terminal}}$  bonds are 1.33 and 1.19 Å respectively. This difference in bond lengths reflects the difference in their strengths, the  $B - H_{\text{bridge}}$  bonds being relatively weaker. The weakness of the  $B - H_{\text{bridge}}$  compared to  $B - H_{\text{terminal}}$  bonds is indicated by their vibrational signatures in the infrared spectrum, being  $\approx 2100$  and  $2500 \text{ cm}^{-1}$  respectively.<sup>[7]</sup>

The model determined by molecular orbital theory describes the bonds between boron and the terminal hydrogen atoms as conventional 2-center 2-electron covalent bonds. The bonding between the boron atoms and the bridging hydrogen atoms is, however, different from that in molecules such as hydrocarbons. Each boron uses two electrons in bonding to the terminal hydrogen atoms and has one valence electron remaining for additional bonding. The bridging hydrogen atoms provide one electron each. The  $B_2H_2$  ring is held together by four electrons forming two 3-center 2-electron bonds. This type of bond is sometimes called a "banana bond".

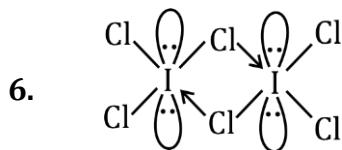


Boron nitride called inorganic graphite is colourless and insulator. Bridge bond order is 0.5 and terminal bond order is 1. Boron nitride is a 2-D crystalline form of the hexagonal boron nitride which has thickness of one to few atomic layer.



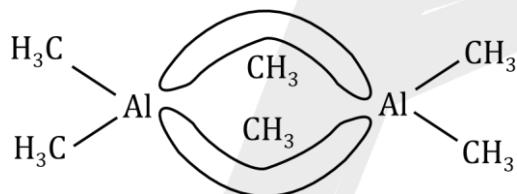


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7. The molecule  $\text{Al}_2(\text{CH}_3)_6$  can be divided into two  $\text{Al}(\text{CH}_3)_3$  groups which are connected by a covalent bond between the two Al atoms.

- Each  $\text{Al}(\text{CH}_3)_3$  group contains one Al atom, three  $\text{CH}_3$  groups, and three covalent bonds between the Al atom and the  $\text{CH}_3$  groups.
- Each covalent bond between the Al atom and a  $\text{CH}_3$  group is a 2-center-2-electron (2c-2e) bond, because it involves two atoms sharing two electrons.
- Therefore, each  $\text{Al}(\text{CH}_3)_3$  group contains  $3 \times 2 = 6$  2c - 2e bonds.
- The two  $\text{Al}(\text{CH}_3)_3$  groups are connected by a covalent bond between the two Al atoms, which is also a 2c - 2e bond.
- Therefore, the molecule  $\text{Al}_2(\text{CH}_3)_6$  contains a total of  $2 \times 6 + 1 = 13$  2c - 2e bonds



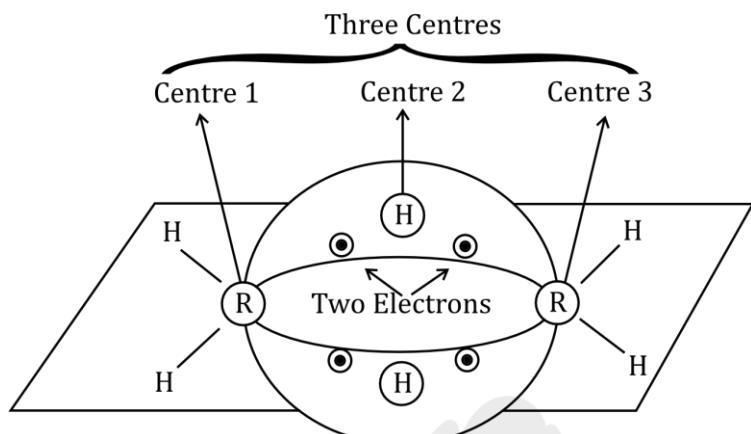
The  $3c - 4e^-$  bond is a model used to explain bonding in certain hypervalent molecules such as tetratomic & hexatomic interhalogen compounds, sulphur tetrafluoride, xenon fluoride and the fluoride ions.

In the above question, the correct answer is option 3.  $\text{I}_2\text{Cl}_6$  has  $3c - 4e^-$  bond and planner geometry.

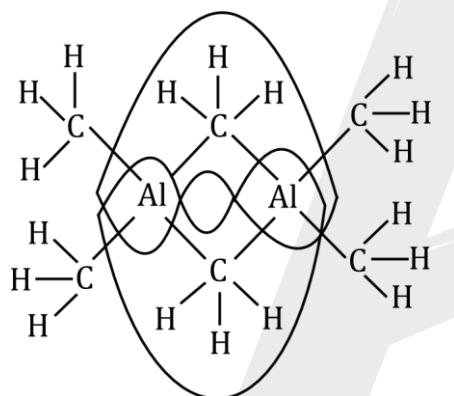


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8.



Three Centres - Two Electron Bond



$\therefore$  This is a  $3C - 2e^-$  bond.

$\therefore$  All the central atom have complete octet.

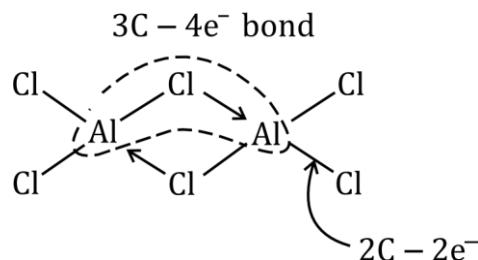
The octet of Aluminium is also complete and that of carbon is also complete.

9.  $\text{BeCl}_2$  is an electrophile and has polymeric structure in solid state.  $\text{BeH}_2$  is covalent and has polymeric structure involving multicentre bonds (three-centre two-electron bond). Each beryllium atom is bonded to two hydrogen atoms and each hydrogen atom to two beryllium atoms.



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10. A → P, R, S; B → Q, S; C → P, R; D → Q, S, T

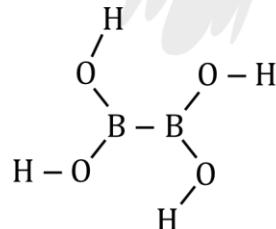
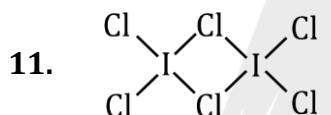


Terminal Al – Cl are  $2C - 2e^-$  bonds.

Total: 4

The molecule  $\text{Al}_2(\text{CH}_3)_6$  can be divided into two  $\text{Al}(\text{CH}_3)_3$  groups which are connected by a covalent bond between the two Al atoms.

- Each  $\text{Al}(\text{CH}_3)_3$  group contains one Al atom, three  $\text{CH}_3$  groups, and three covalent bonds between the Al atom and the  $\text{CH}_3$  groups.
- Each covalent bond between the Al atom and a  $\text{CH}_3$  group is a 2-center-2-electron (2c-2e) bond, because it involves two atoms sharing two electrons.
- Therefore, each  $\text{Al}(\text{CH}_3)_3$  group contains  $3 \times 2 = 6$  2c – 2e bonds.
- The two  $\text{Al}(\text{CH}_3)_3$  groups are connected by a covalent bond between the two Al atoms, which is also a 2c – 2e bond.
- Therefore, the molecule  $\text{Al}_2(\text{CH}_3)_6$  contains a total of  $2 \times 6 + 1 = 13$  2c – 2e bonds



1

2

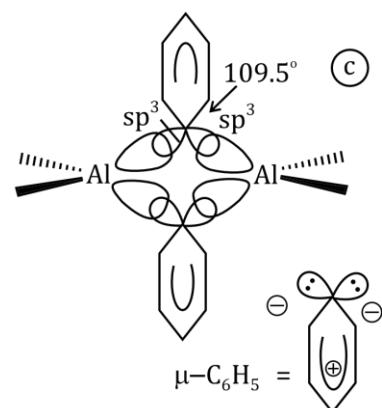
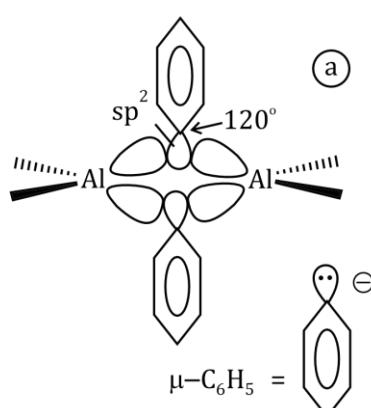
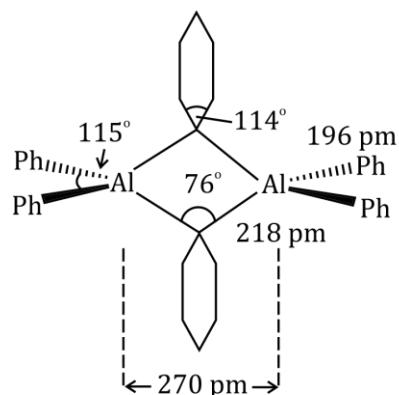


The internal angle of the phenyl ring and the orientation suggests that the bond between the ring and the two aluminium is more complex (e.g. 3c – 2e bond and a 3c – 4e bond).

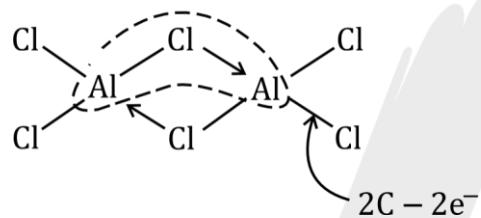
The 3c – 4e bond destroys the aromaticity at the bonding carbon by incorporating the  $\pi$ -system p orbital in an  $\text{sp}^3$  hybridization:



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$3C - 4e^-$  bond



Terminal  $\text{Al} - \text{Cl}$  are  $2\text{C} - 2\text{e}^-$  bonds.

Total: 4

