Hybridisation

41. (d)

Explanation:

Hydrogen peroxide (**H_2O_2**) has a **non-planar** structure.

- Each oxygen is **sp^3 hybridized**, forming a **bent geometry**.
- The molecule has a **dihedral angle of ~101°** between the two O–H planes.
- $\angle$H–O–O = $\angle$O–O–H′ ≈ **97°**.

Thus, H_2O_2 has a **skew (non-planar)** shape, correctly described in **option (d)**

42. (b) 4

Explanation:

In **ethylene (C_2H_4)**, the two carbon atoms are connected by a **double bond (C=C)**.

- A double bond consists of **one sigma (σ)** and **one pi (π)** bond.
- Each bond involves **two shared electrons**, so total = 2 (σ) + 2 (π) = **4 shared electrons** between the two carbons.

43. (c) sp^3, sp^2, sp, sp^2

Explanation:

Let's analyze each carbon:

1. **C_1 (CH_3–)** → single bonds only → **sp^3**
2. **C_2 (–CH=)** → part of a double bond → **sp^2**
3. **C_3 (=C=)** → part of two double bonds → **sp**
4. **C_4 (=CH_2)** → part of a double bond → **sp^2**

Hence, hybridization sequence = **sp^3, sp^2, sp, sp^2**

44. (a) Acetate ion is $CH_3-C\begin{matrix}\nearrow O \\ \searrow O^-\end{matrix}$ *i.e.* one $C-O$ single bond and one $C=O$ double bond.

45. (c) **sp hybridized**

Explanation:

In **acetylene (C_2H_2)**, each carbon atom forms:

- One **sigma** (σ) bond with the other carbon atom
- One **sigma** (σ) bond with a hydrogen atom
- Two **pi** (π) bonds** between the two carbons**

Thus, each carbon is **sp hybridized**, forming a **linear molecule** with a bond angle of **180°**

46. (c) Benzene has all carbons sp^2 hybridised and planar in shape.

47. (d) In methane C is sp^3 hybridized and bond angle is 109^o.

48. (b) 120°

Explanation: sp^2 hybrid orbitals are arranged trigonal-planar at 120°

49. (c) H_3C^+

Explanation: The carbocation (CH_3^+) has three σ-bonds/positions and an empty p orbital → sp^2.

50. (a) Tetrahedral

Explanation: Each C is sp^3 hybridized and bonded to four other C atoms in a tetrahedral network.

51. (b) BCl_3

Explanation: B in BCl_3 has three σ-bonds and no lone pair → sp^2, trigonal planar.

52. (a) dsp^2

Explanation: The Cu(II) in the tetraammine complex is commonly square-planar (dsp^2 hybridisation).

53. (c) $sp–sp^2$

Explanation: The C–C single bond connects an sp-hybridized carbon (from the ≡) to an sp^2-hybridized carbon (from the =).

54. (d) CH_3–C–H O (i.e., the CH_3 carbon is sp^3)

Explanation: A methyl carbon (CH_3) is bonded by single bonds (four σ) and is sp^3 hybridized. *(Interpreted the options so the CH_3-containing choice is the one with sp^3 carbon.)*

55. (b) sp^2

Explanation: The 120° angle and trigonal arrangement around B indicate sp^2 hybridisation for boron.

56. (d)

$$\begin{array}{ccccccc} & & H & & H & & H & \\ & & | & & | & & | & \\ H & - & C & - & C & - & C & - & H \\ & & | & & | & & | & \\ & & H & & H & & H & \end{array}$$

There are 10 shared pairs of electrons.

57. (b) 1/2

Explanation:

In sp hybridisation, one s orbital mixes with one p orbital, forming two equivalent hybrid orbitals.

Therefore,

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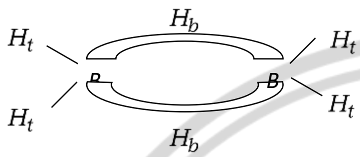
s−character = 1/2

p−character = 1/2

58. (a) The diborane molecule has two types of $B - H$ bond :

(i) $B-H_t$ − It is a normal covalent bond.

(ii) $B-H_b$ − It is a three centred bond.



59. (a) sp³

Explanation: The circled carbon in CH_3–OCl is bonded to three hydrogen atoms and one oxygen atom through single (σ) bonds. Hence, it uses **sp³ hybrid orbitals** in bond formation.

60. (c) $H_2O_2 > O_3 > O_2$

Explanation:

- In O_2, the bond order = 2 → shortest bond.
- In O_3, the bond order = 1.5 → intermediate bond length.
- In H_2O_2, the bond order = 1 → longest bond.

Therefore, bond length order is **$H_2O_2 > O_3 > O_2$**.