

Haloalkanes and Haloarenes

Nature of C-X Bond in Haloalkanes and Haloarenes

The nature of the carbon-halogen (C-X) bond plays a crucial role in determining the physical and chemical properties of haloalkanes and haloarenes.

Bond Polarity

1. Electronegativity Difference

- Halogen atoms (X) are more electronegative than carbon (C).
- This creates a polar covalent bond with a partial positive charge (δ^+) on carbon and a partial negative charge (δ^-) on the halogen.

Trend of Electronegativity:

F > Cl > Br > I

The bond polarity decreases in the same order.

2. Dipole Moment

- Due to the polarity of the C-X bond, haloalkanes and haloarenes exhibit dipole moments.
 - The dipole moment depends on the electronegativity of the halogen and the bond length.
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Bond Strength (Bond Dissociation Enthalpy)

1. Bond Length

- The size of the halogen atom increases from fluorine to iodine, leading to an increase in bond length.

Trend of Bond Length:

C-F < C-Cl < C-Br < C-I

2. Bond Strength

- The strength of the C-X bond decreases as the bond length increases.

Trend of Bond Strength:

C-F > C-Cl > C-Br > C-I

- The C-F bond is the strongest due to its short length and high bond dissociation energy.
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Nature of C-X Bond in Haloalkanes

1. sp^3 Hybridized Carbon

- In haloalkanes, the carbon atom bonded to the halogen is sp^3 -hybridized, leading to a tetrahedral geometry around the carbon.

2. Reactivity

- The polar nature of the C-X bond makes haloalkanes susceptible to nucleophilic substitution and elimination reactions.
- Reactivity depends on the bond strength, with weaker bonds (e.g., C-I) being more reactive.

Nature of C-X Bond in Haloarenes

1. sp^2 Hybridized Carbon

- In haloarenes, the carbon atom bonded to the halogen is sp^2 -hybridized as part of the aromatic ring.

2. Resonance Effect

- The lone pairs on the halogen atom can interact with the π -electrons of the aromatic ring, leading to partial double bond character in the C-X bond due to resonance.
- This makes the C-X bond in haloarenes stronger and less reactive towards nucleophilic substitution reactions.

3. Polarity

- The C-X bond in haloarenes is less polar than in haloalkanes due to resonance stabilization, which reduces the partial positive charge on the carbon atom.
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Key Differences in Haloalkanes and Haloarenes

Property	Haloalkanes	Haloarenes
Hybridization of Carbon	sp^3	sp^2
Resonance Effect	Absent	Present
Bond Strength	Relatively weaker	Relatively stronger
Reactivity	More reactive ($SN1/SN2$)	Less reactive (requires specific conditions)

The nature of the C-X bond influences the physical properties (e.g., boiling points, solubility) and chemical reactivity of haloalkanes and haloarenes.