

CLASS 11 CHEMISTRY — HYDROCARBONS

Structure of of Benzene

Resonance & Delocalisation

TopAll

WHY DOES BENZENE REFUSE TO BEHAVE LIKE A NORMAL TRIENE?

Expected Behavior



Highly Reactive

Readily undergoes Addition

VS

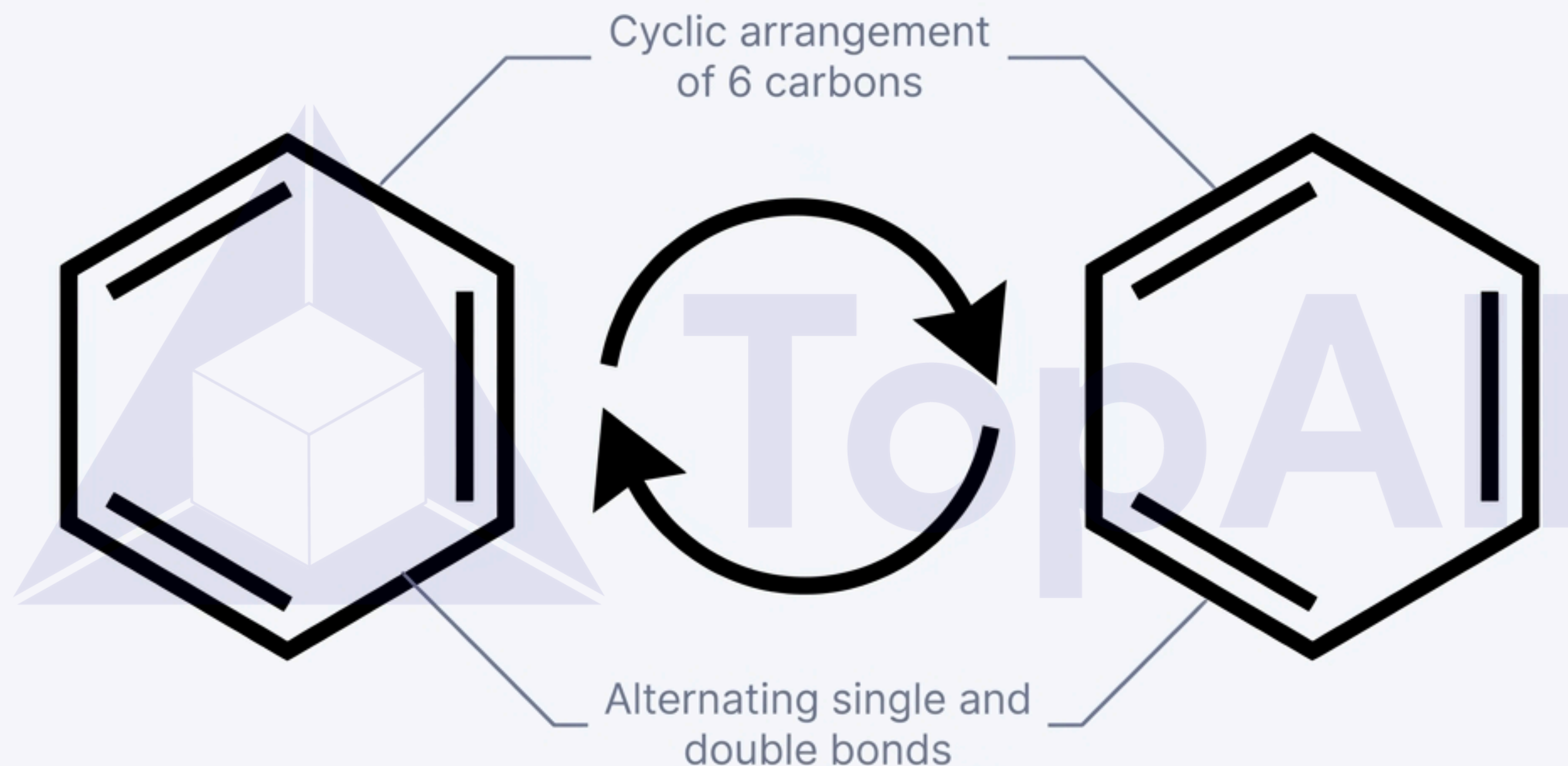
The Anomaly: Benzene (C_6H_6)



Unusually Stable

Stubbornly resists Addition

The Historical Blueprint: Kekulé's Oscillating Model



Proposed in 1865, Kekulé suggested the double bonds rapidly oscillate back and forth to explain why benzene yields only one ortho-disubstituted product instead of two.



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$$E=mc^2$$



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The Empirical Evidence: Why Kekulé's Model Fails

Reactivity

Expected: Readily undergoes addition.

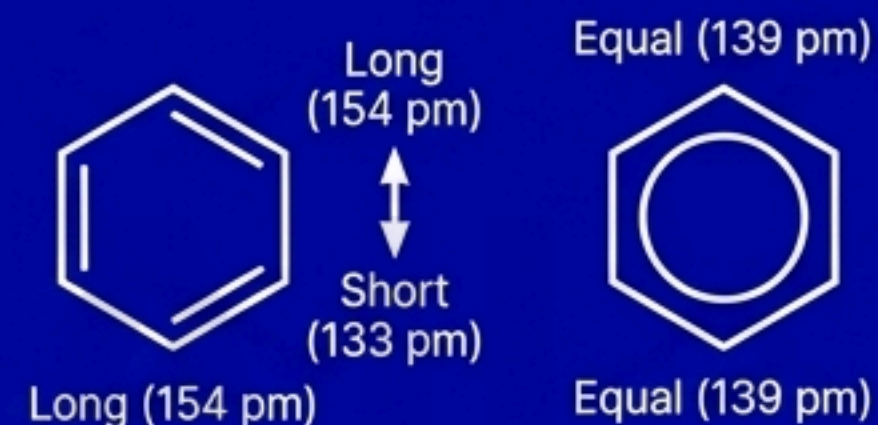
✗ **Actual:** Addition is highly unfavorable; strongly prefers substitution reactions.

Disubstitution

Expected: Two distinct ortho isomers.

✗ **Actual:** All 6 carbon positions are perfectly equivalent (only one ortho product exists).

The X-Ray Data

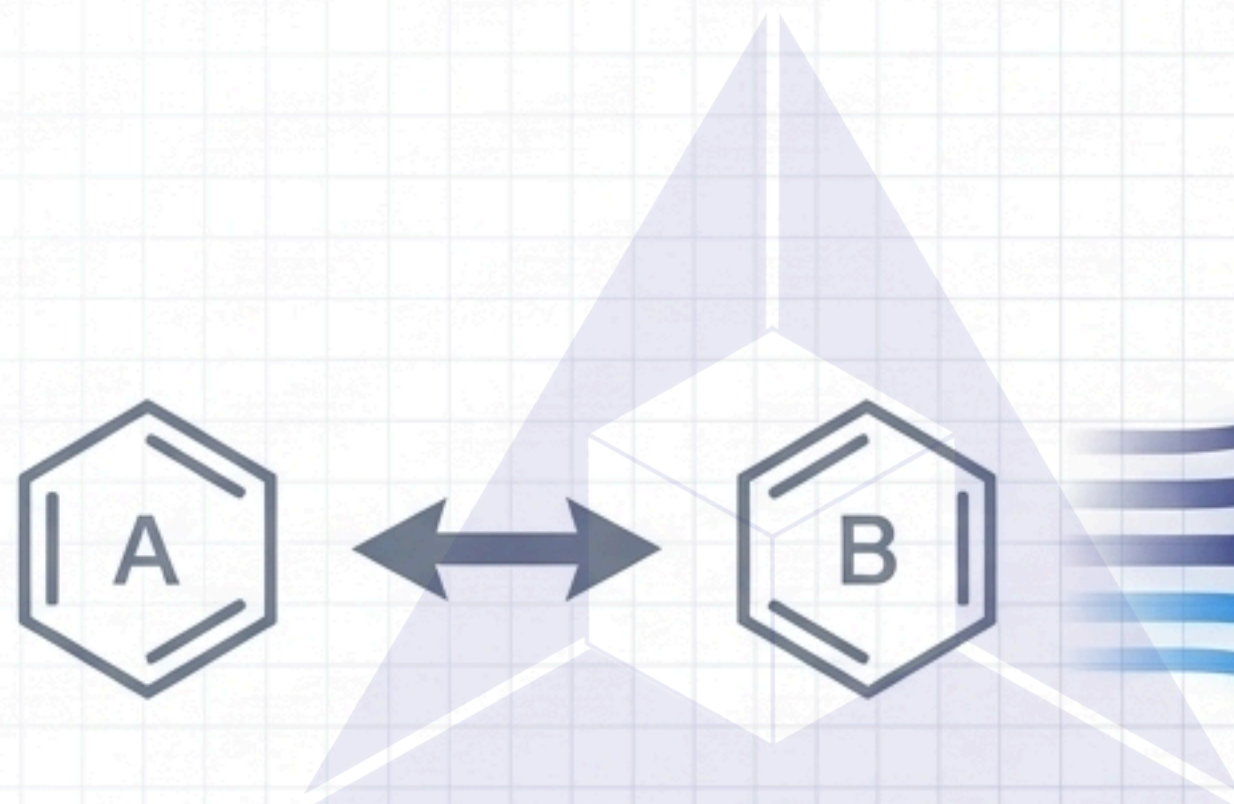


Expected: C-C single bonds = 154 pm | C=C double bonds = 133 pm.

✓ **Actual:** ALL carbon-carbon bonds are exactly 139 pm.

Synthesis: The equal 139 pm bond lengths physically prove there are no "pure" single or double bonds in the ring

The Modern Solution: Resonance Hybrid

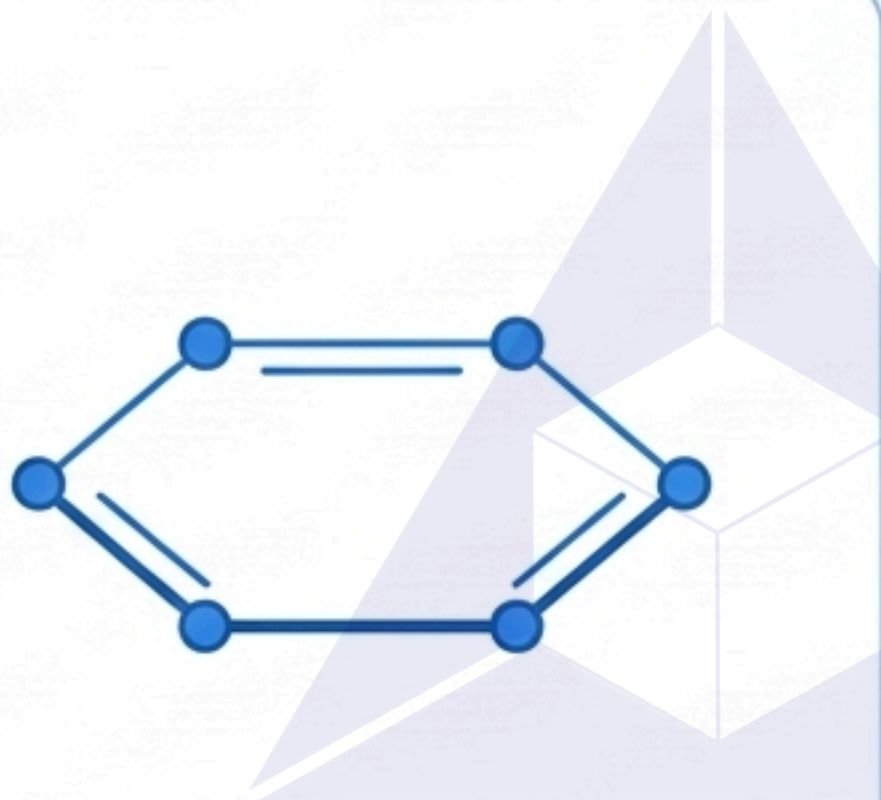


6 delocalised
 π electrons



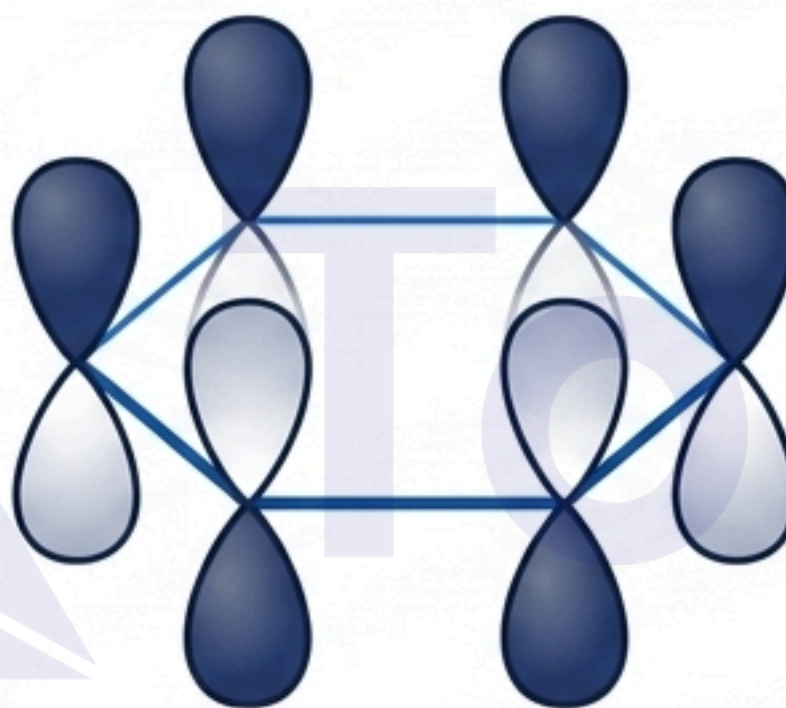
A single state of lower energy
and maximum stability.

The Physical Reality: The Orbital Picture



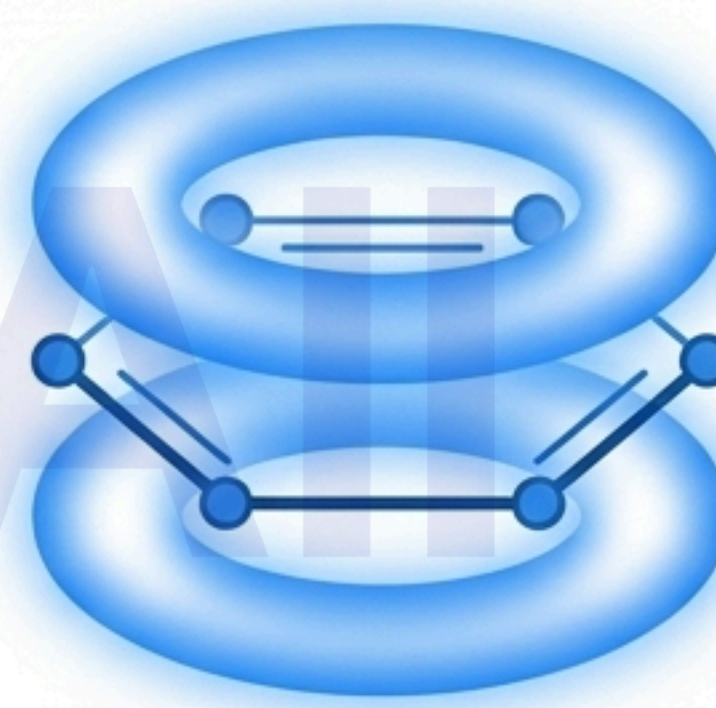
Step 1

All C atoms sp^2 hybridized.
Planar hexagonal ring (σ bonds).



Step 2

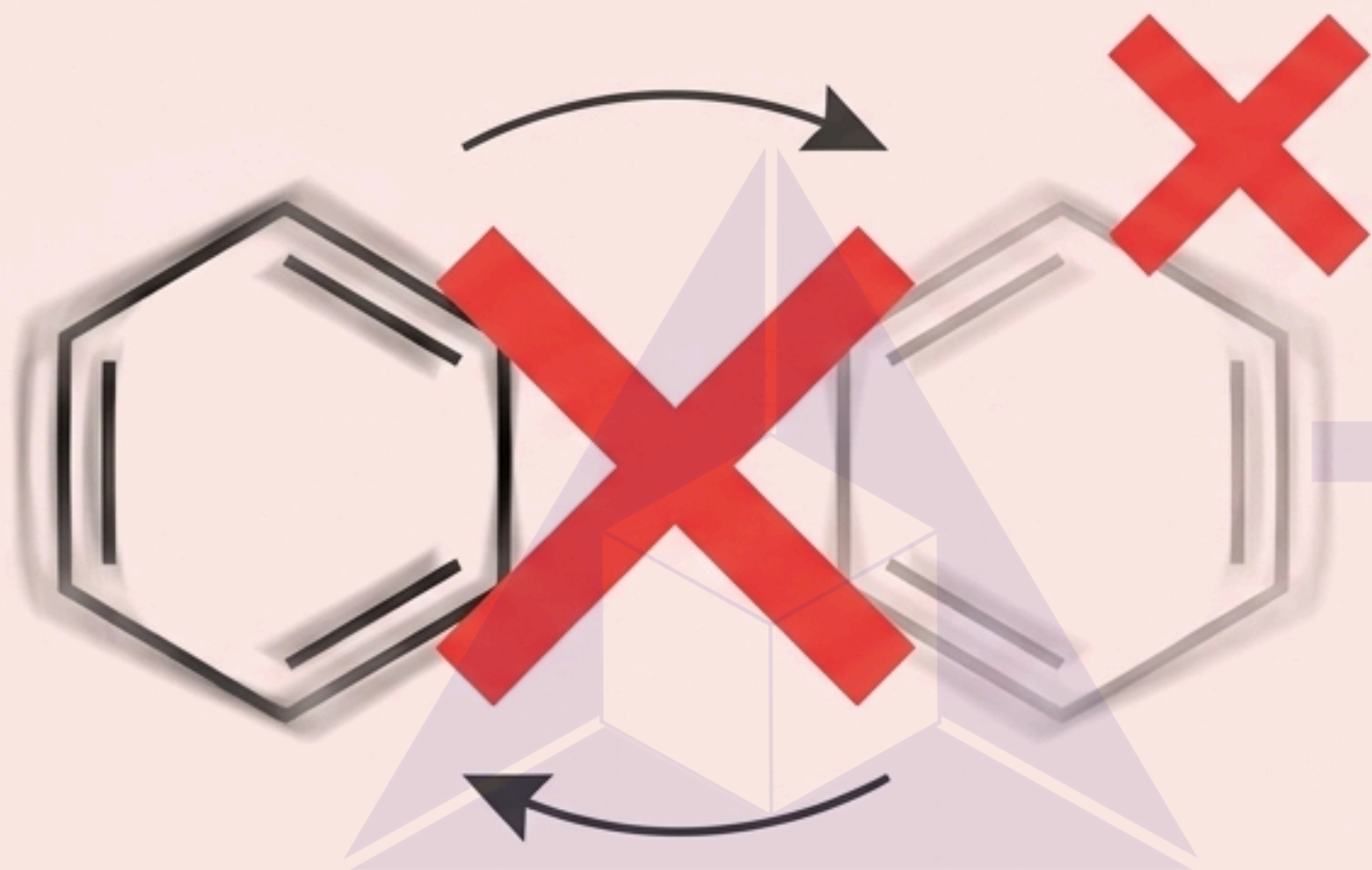
Six parallel p orbitals.



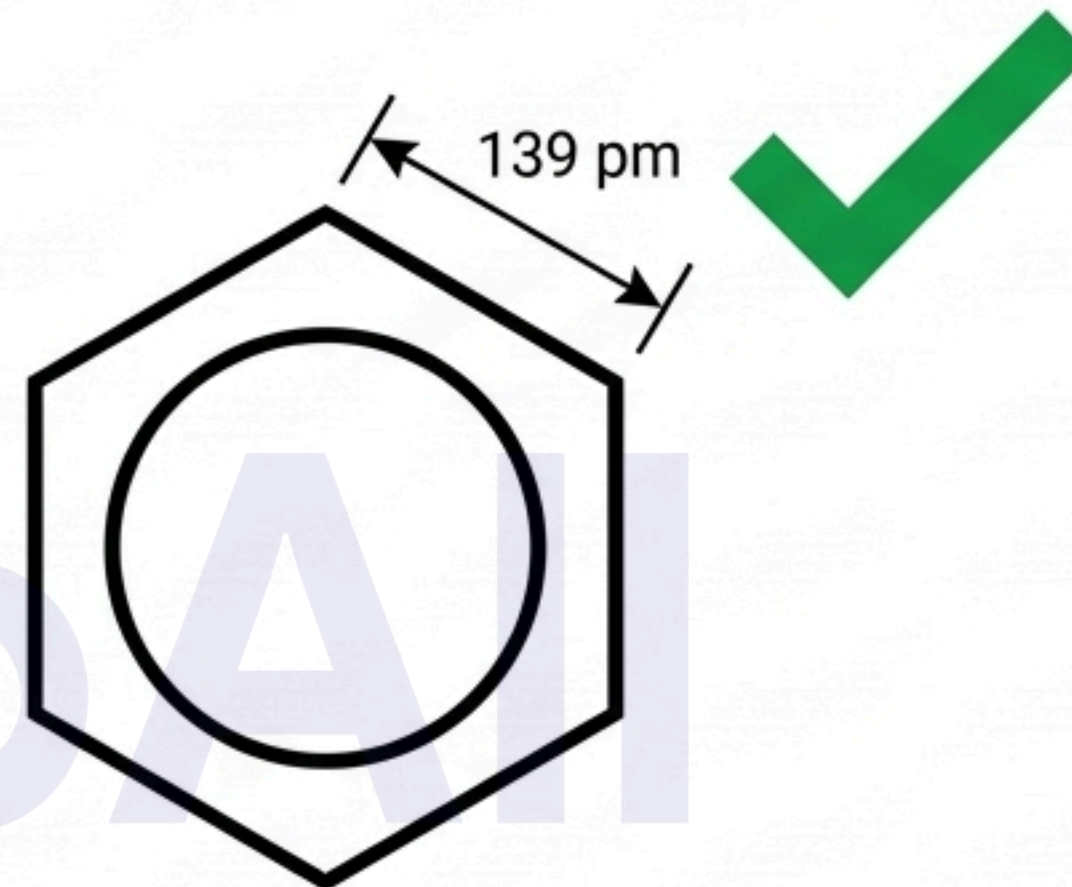
Step 3

Lateral overlap creates a
continuous delocalised π cloud.

JEE Trap Alert



Benzene rapidly oscillates back and forth between two real Kekulé molecules.



Benzene does not oscillate. It is a single, permanent resonance hybrid. All C–C bonds are perfectly equivalent (139 pm) at all times.

Key Takeaway: Resonance is a mathematical hybrid, not a physical toggle. The individual Kekulé structures do not actually exist.



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