

A Level Organic Chemistry

A-Level Chemistry ■ Topic 29

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What we will cover

- 1 Naming aromatics
- 2 Two new mechanisms
- 3 The shape of benzene
- 4 Evidence for delocalisation
- 5 Optical isomerism

1 Benzene

Two new mechanisms

electrophilic substitution 亲电取代

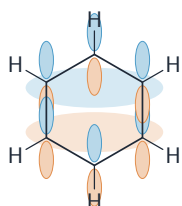
an electrophile replaces a H on benzene

addition-elimination 加成消去

a molecule adds on, then a small one leaves

New families: the **amide** 酰胺 group and **aromatic** 芳香 compounds (built on a **benzene** 苯 ring).

The shape of benzene

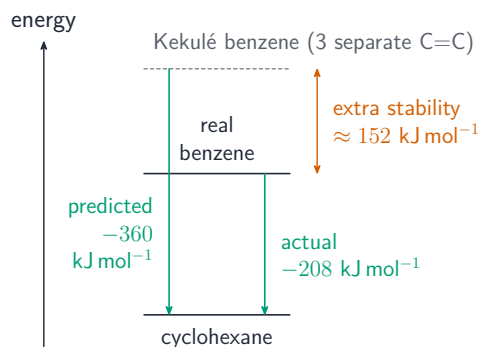


one **delocalised** π system above and below the ring
 sp^2 σ framework;
all six C–C bonds equal

Each carbon is **sp^2** sp^2 杂化: σ bonds make the flat hexagon, and the leftover p orbitals overlap into one **delocalised** 离域 π system.

All six C–C bonds are the **same length**, and benzene is very stable.

Evidence for delocalisation



The **enthalpy of hydrogenation** 氢化焓变 is the proof:

- Kekulé model predicts -360 kJ mol^{-1}
- real benzene releases only -208

So benzene is $\sim 152 \text{ kJ mol}^{-1}$ **more stable** than the model.

2 Isomerism

Optical isomerism



enantiomer 2 (mirror image)



a 50:50 **racemic mixture** gives no net rotation (the two cancel)

Two **enantiomers** 对映体 are identical except:

- they rotate **plane-polarised light** 平面偏振光 in opposite directions (**optically active** 旋光活性)
- a **racemic mixture** 外消旋混合物 (50:50) gives no net rotation

Chirality 手性 matters in drugs.

3 Recap

Worked example – spotting a chiral centre

Explain why lactic acid $\text{CH}_3\text{CH}(\text{OH})\text{COOH}$ is optically active but propanoic acid is not.

- Look for one carbon carrying **four different groups**.
- In lactic acid the middle C has CH_3 , OH, COOH and H – all different $\Rightarrow$ a **chiral centre** 手性中心.
- Its mirror image cannot be superimposed $\Rightarrow$ two **enantiomers**, rotating polarised light oppositely.
- $\text{CH}_3\text{CH}_2\text{COOH}$ has no such carbon (the middle C has two H) $\Rightarrow$ not chiral.

One carbon, **four different groups**. Enantiomers are identical in every physical and chemical property *except* optical rotation and reactions with other chiral molecules.

Topic 29 – key takeaways

1 Mechanisms

electrophilic substitution;
addition–elimination

2 Benzene

sp^2 σ frame + delocalised π ring

3 Delocalisation

more stable than the Kekulé model

4 Enantiomers

rotate polarised light oppositely

Check yourself

- How does benzene react with an electrophile?
- What hybridisation is each benzene carbon?
- What proves benzene is delocalised?
- What does a racemic mixture do to polarised light?



Answers 1. by electrophilic substitution 2. sp^2 3. its enthalpy of hydrogenation
4. no net rotation