A Level Organic Chemistry

A-Level Chemistry ▪ Topic 29

A-Level Chemistry

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

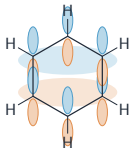
Two new mechanisms

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

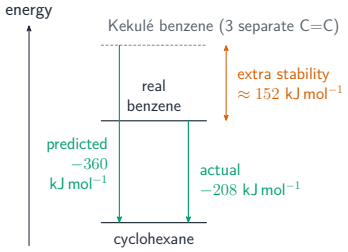


one **delocalised** π system above and below the ring
sp^2 σ framework;
all six C–C bonds equal

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



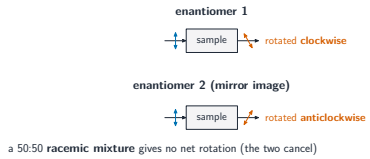
The **enthalpy of hydrogenation** 氢化焓变 is the proof:

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

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

2 Isomerism

Optical isomerism



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 $CH_3CH(OH)COOH$ 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 ⇒ a **chiral centre** 手性中心.
- Its mirror image cannot be superimposed ⇒ two enantiomers, rotating polarised light oppositely.
- CH_3CH_2COOH has no such carbon (the middle C has two H) ⇒ 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

1. How does benzene react with an electrophile?
2. What hybridisation is each benzene carbon?
3. What proves benzene is delocalised?
4. 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