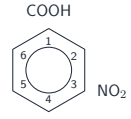
A Level Organic Chemistry

A-Level Chemistry ▪ Topic 29

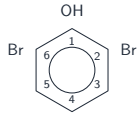
A-Level Chemistry

What we will cover

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



3-nitrobenzoic acid



2,4,6-tribromophenol

number the ring

Two new mechanisms

electrophilic substitution 亲电取代

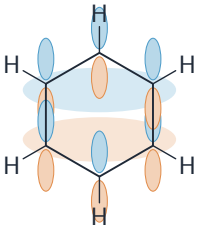
an electrophile replaces a H on benzene

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

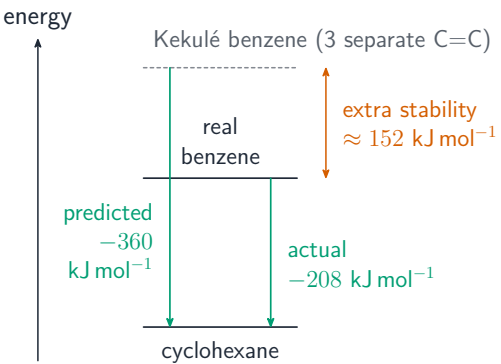


one **delocalised** π system above and below the ring
sp^2 σ framework;
all six C–C bonds equal

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

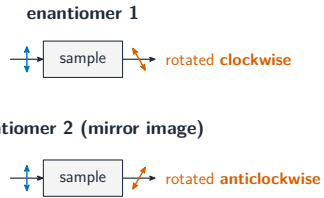


The **enthalpy of hydrogenation** 氢化焓变 is the proof:

- 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.

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.

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 $\Rightarrow$ a **chiral centre** 手性中心.
- Its mirror image cannot be superimposed $\Rightarrow$ two enantiomers, rotating polarised light oppositely.
- CH_3CH_2COOH 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

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