

Preparation of Benzene

Commercial isolation and three fundamental laboratory synthesis routes.



Commercial Isolation

Primary commercial source is coal tar.
Process involves fractional distillation.

Step 1

Fractional Distillation of Coal Tar

Coal Tar → Light Oil Fraction (80-170°C)

Step 2

Purification and Rectification

Light Oil → Pure Benzene (b.p. 80°C)

Exam Recap

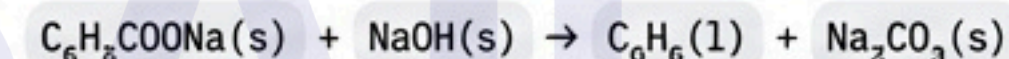
- Commercial: Coal Tar Distillation.
- Lab 1: Decarboxylation (Soda-lime).
- Lab 2: Phenol Reduction (Zn dust).
- Lab 3: Ethyne Polymerization (Red-hot Fe).

Laboratory Synthesis Routes

1. Decarboxylation of Sodium Benzoate

Condition: Heat with Soda-lime (NaOH + CaO)

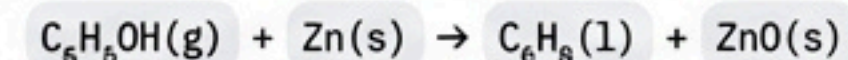
Heating sodium benzoate with soda-lime removes CO₂.



2. Reduction of Phenol

Condition: Heat with Zinc Dust (Zn)

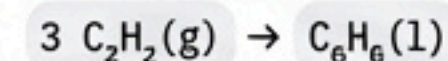
Passing phenol vapor over heated zinc dust.



3. Polymerization of Ethyne (Acetylene)

Condition: Red-hot Fe tube at 873 K

Passing ethyne through a red-hot iron tube.



SOURCE

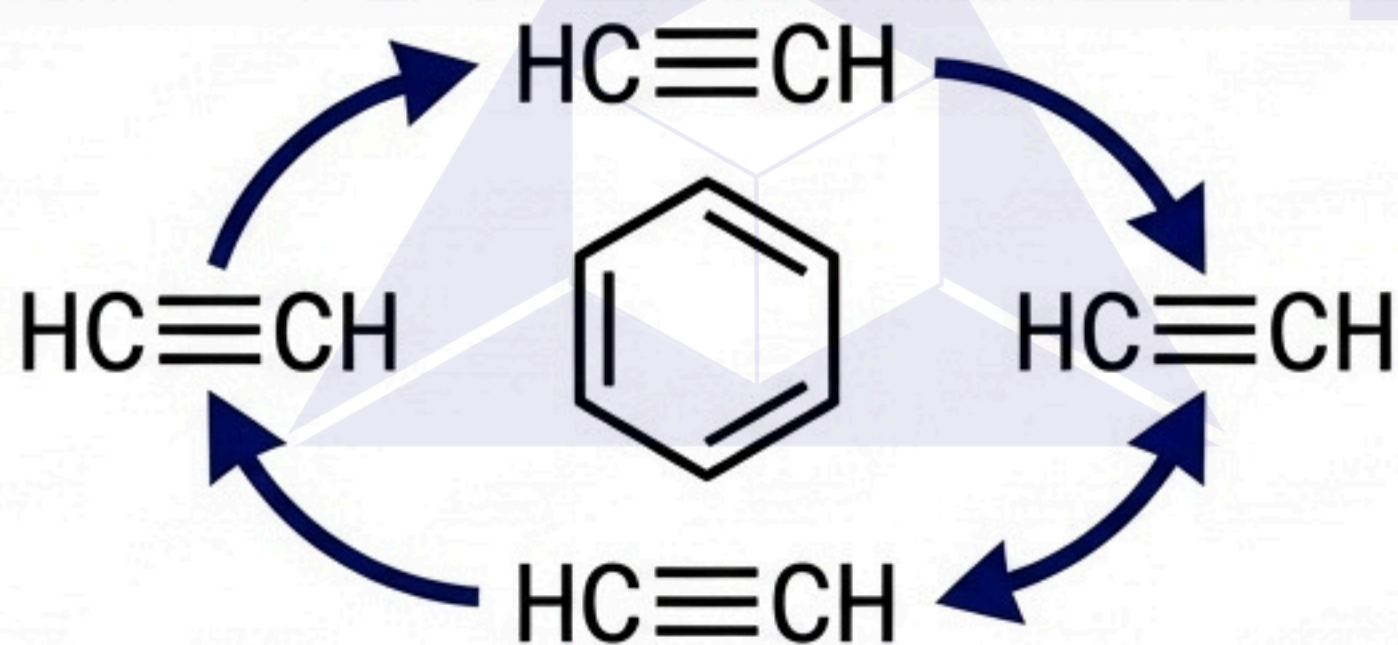
Isolation From Coal Tar

While benzene can be synthesized in the laboratory, its primary commercial isolation historically and practically begins with the massive-scale destructive distillation of coal.



Exam Note: Commercial isolation (macro-scale extraction from natural resources) is distinct from laboratory preparation (micro-scale targeted chemical transformations).

Cyclic Polymerisation of Ethyne



Reactants

Three molecules of ethyne (acetylene).

Transformation

Aliphatic (linear) to Aromatic (cyclic) ring closure.

Exam Recap Panel: Key Insight: This reaction is the classic 'aliphatic to aromatic' bridge in organic synthesis—the best route for entering aromatic chemistry from open-chain hydrocarbons.



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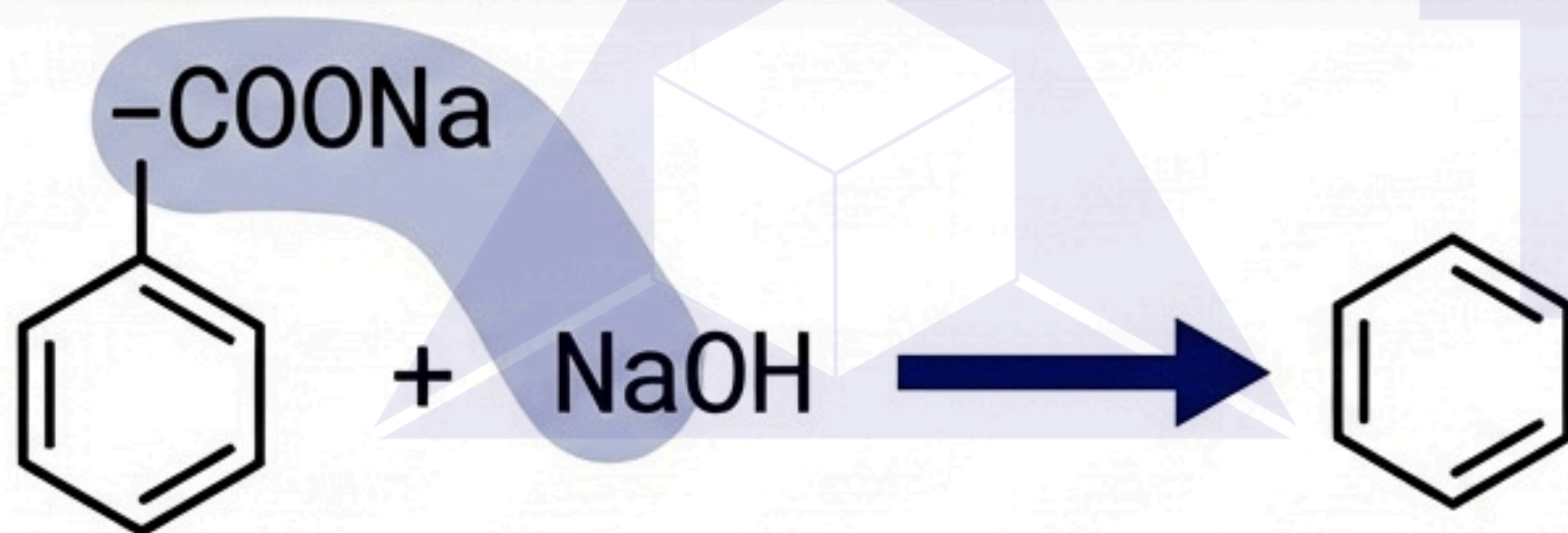
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Decarboxylation of Sodium Benzoate



The Sodalime Route

Heating the sodium salt of benzoic acid with sodalime.

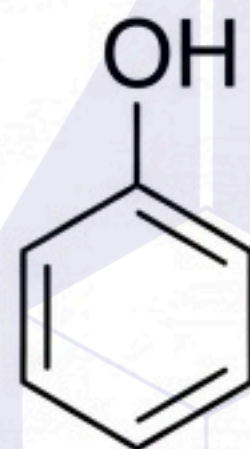
Decarboxylation

The chemical elimination of a carboxyl group (removed as CO_2 , which forms sodium carbonate).

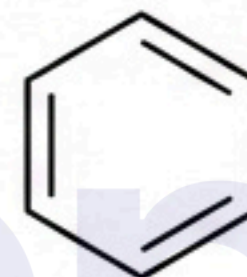
Exam Check: Why CaO? Calcium oxide keeps the sodium hydroxide dry and facilitates the solid-state decarboxylation reaction.

METHOD 3

Reduction of Phenol



Zn



ZnO
Byproduct

1. The Process

Phenol vapours are passed over heated zinc dust.

2. The Transformation

Direct removal of oxygen (reduction) from the aromatic ring.

Mechanism Note: Zinc dust acts as a strong reducing agent. It oxidizes to Zinc Oxide (ZnO) while simultaneously reducing the phenol ring to bare benzene.

Three Routes, One Product

Premium Diagnostic Comparison Matrix

Route	Starting Material	Key Reagents	Byproducts
Polymerisation	Ethyne ($\text{HC}\equiv\text{CH}$)	Red Hot Fe, 873K	None
Decarboxylation	Sodium Benzoate	Sodalime, Δ	Na_2CO_3
Reduction	Phenol ($\text{C}_6\text{H}_5\text{OH}$)	Zn Dust, Δ	ZnO

All three laboratory routes yield the identical aromatic C_6H_6 structure despite vastly different starting materials—bridging aliphatic chains, carboxylic salts, and alcohols directly to the benzene ring.



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