

Four Routes to Phenol

Haloarenes

Diazonium Salts

Retrosynthetic mapping of the primary laboratory and industrial preparation methods.

Benzenesulphonic Acid

Cumene

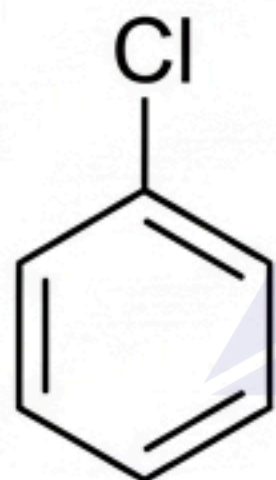


Route 1: From Haloarenes



Chlorobenzene is fused with NaOH under extreme heat and atmospheric pressure, followed by acidification to yield the final product.

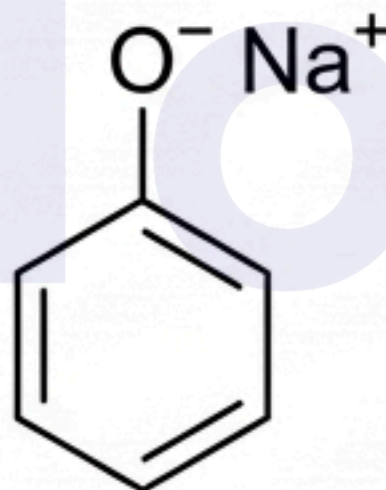
⚠ **Extreme Conditions**



Chlorobenzene
 $\text{C}_6\text{H}_5\text{Cl}$

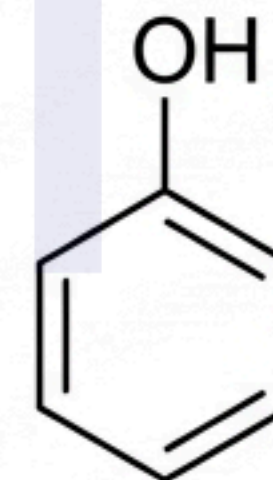
NaOH

623 K, 320 atm



Sodium phenoxide
 $\text{C}_6\text{H}_5\text{ONa}$

HCl

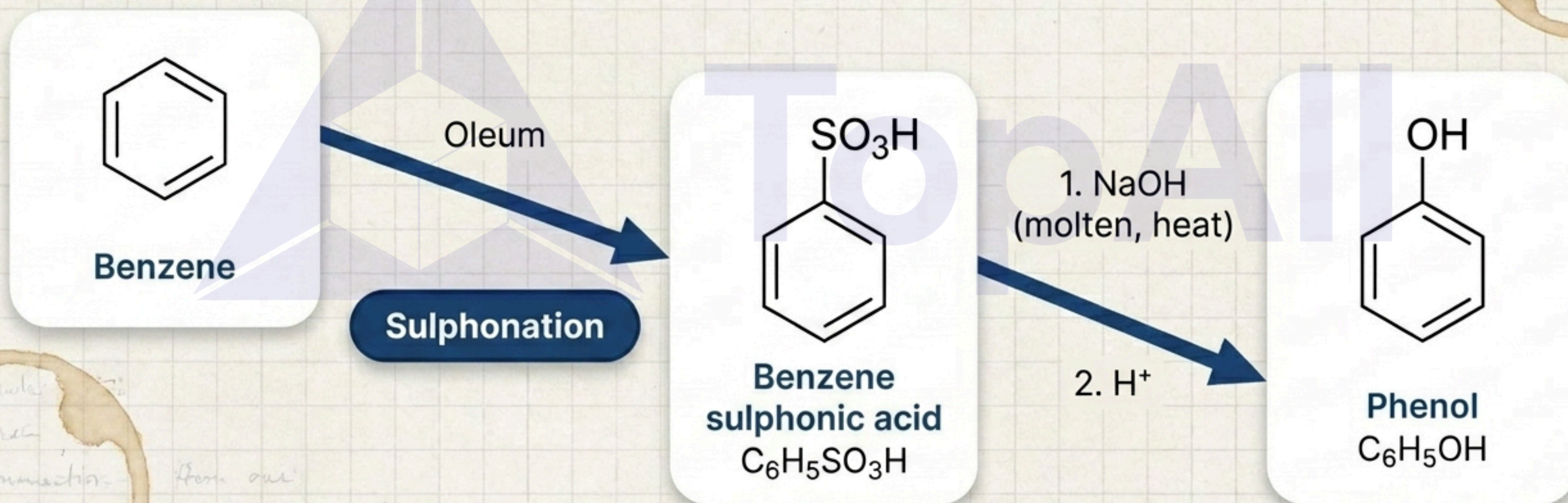


Phenol
 $\text{C}_6\text{H}_5\text{OH}$

Route 2: From Benzenesulphonic Acid



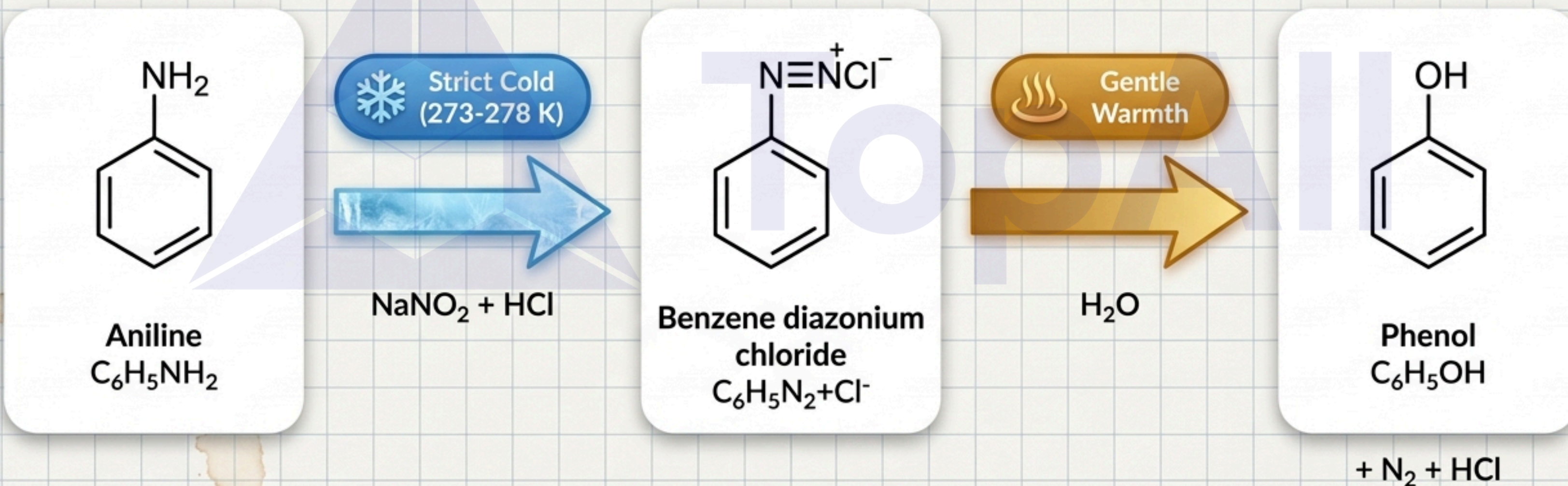
Benzene is sulphonated with oleum. The resulting benzene sulphonic acid is converted to sodium phenoxide via heating with molten sodium hydroxide, before final acidification.



Route 3: From Diazonium Salts

A delicate two-step process:

First, an amine is treated with nitrous acid under strictly cold conditions to form a **diazonium salt**. This intermediate is then easily hydrolysed to phenol by simply warming with water.





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$$E=mc^2$$



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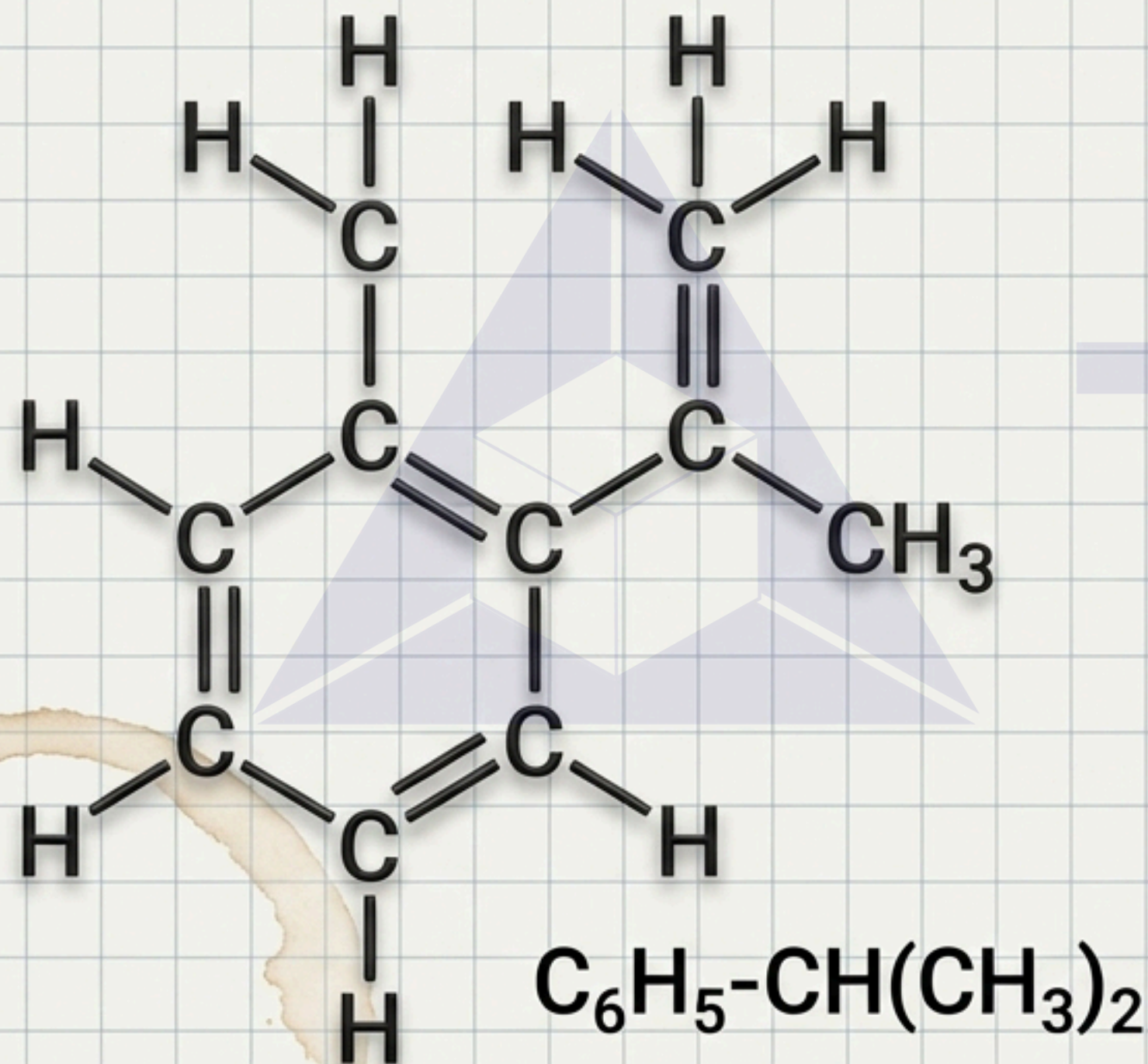
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Route 4: From Cumene



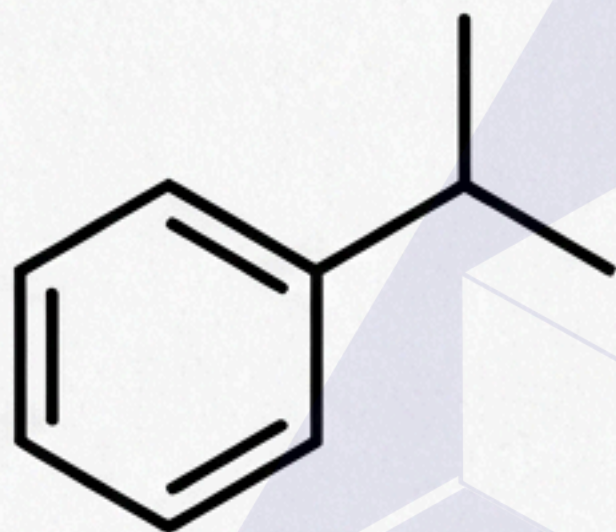
Isopropylbenzene

Industrial Champion

“Most of the worldwide production of phenol is from cumene.”

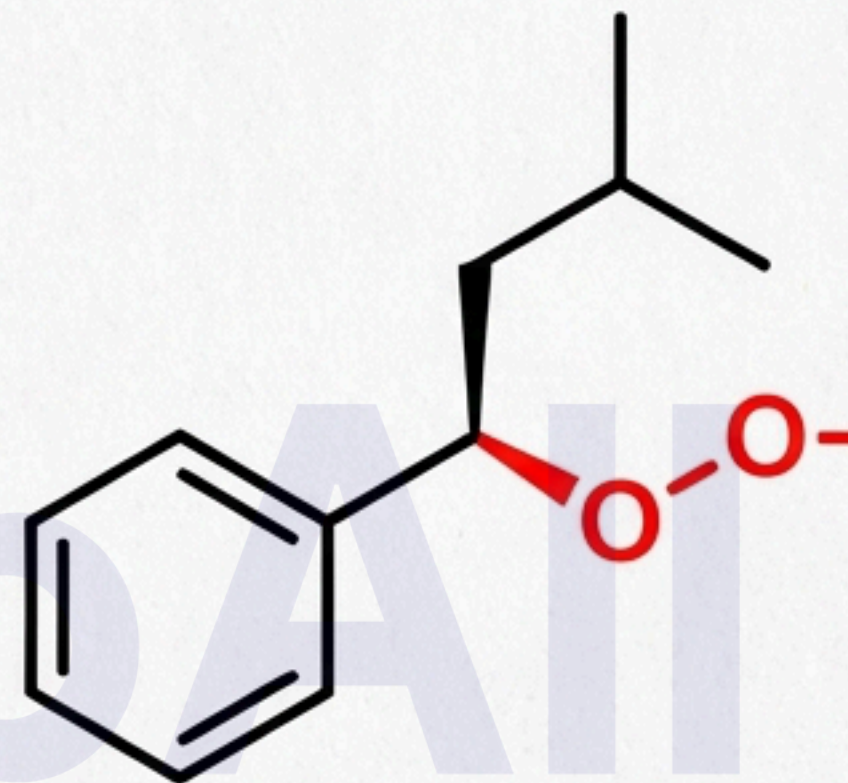
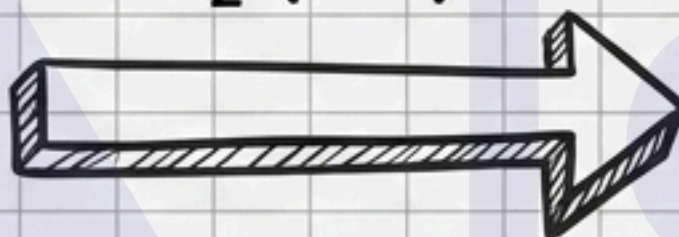
Step 1: Aerial Oxidation

The Cumene Hydroperoxide Intermediate



Cumene

O_2 (Air)

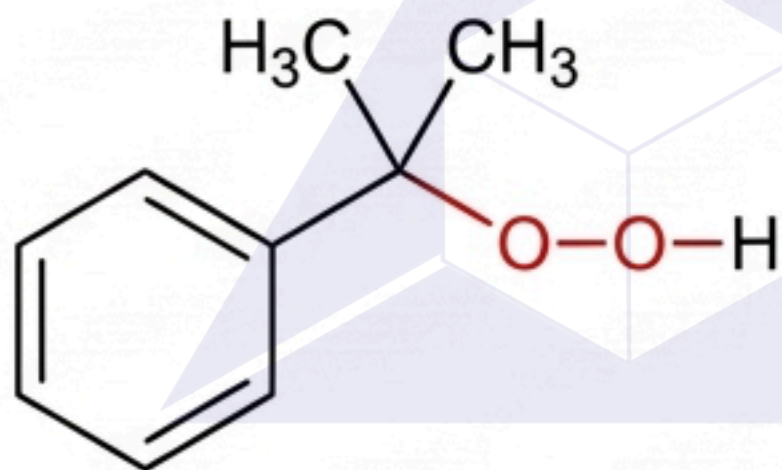


Cumene Hydroperoxide

$-\text{O}-\text{O}-$

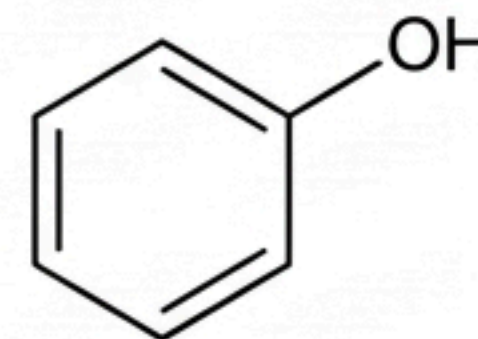
The Cleavage: Phenol + Acetone

Treating the hydroperoxide intermediate with dilute acid cleanly cleaves the molecule. Acetone is generated in massive quantities alongside phenol, making this route globally dominant and financially viable.

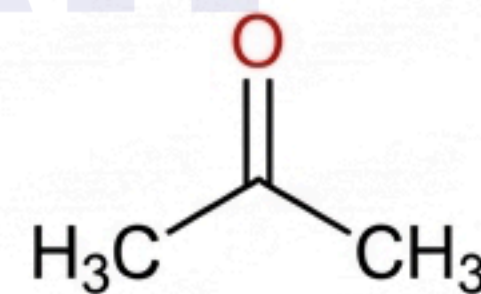


Cumene Hydroperoxide

Dilute Acid (H⁺), H₂O



Phenol



Acetone



High-Yield
Economic Byproduct

Exam Summary: The Synthetic Matrix

Route Name	Starting Material	Intermediate	Key Conditions	Byproducts
From Haloarenes	Chlorobenzene ($\text{C}_6\text{H}_5\text{Cl}$)	Sodium phenoxide	Extreme (623 K, 320 atm)	—
From Benzenesulphonic Acid	Benzene	Benzene sulphonic acid	Molten NaOH heating	—
From Diazonium Salts	Aniline ($\text{C}_6\text{H}_5\text{NH}_2$)	Benzene diazonium chloride	273-278 K -> Warm H_2O	N_2 , HCl
From Cumene	Isopropylbenzene	Cumene hydroperoxide	Air oxidation -> Dilute Acid	Acetone (Massive scale)



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