

Properties of Aromatic Hydrocarbons

A Mechanistic Blueprint of Benzene and Electrophilic Substitution



The Physical Reality of Arenes

Solubility & State



- Non-polar nature
- Colorless liquids or solids
- Immiscible with water (hydrophobic)
- Characteristic pleasant aroma

Combustion



- Burns with a characteristic sooty flame
- Driven by a high carbon-to-hydrogen ratio

Exam Recap: A sooty flame during combustion is a primary diagnostic indicator of aromaticity.

Why Aromatics Protect Their Stability



Addition destroys the delocalized pi electron cloud, breaking the highly stable aromatic ring and violating Hückel's Rule.

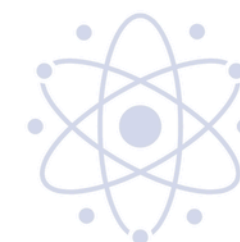
Substitution temporarily disrupts the ring, but ultimately restores the sp² planar framework and resonance energy.

Exam Recap: Benzene's unsaturation is retained. It strongly prefers Electrophilic Substitution (SE) over addition to preserve resonance stability.



You've Learned the Theory. Let's Test Them Now.

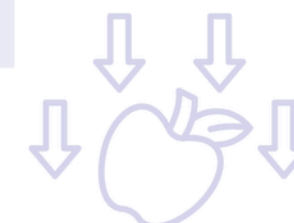
$$E=mc^2$$



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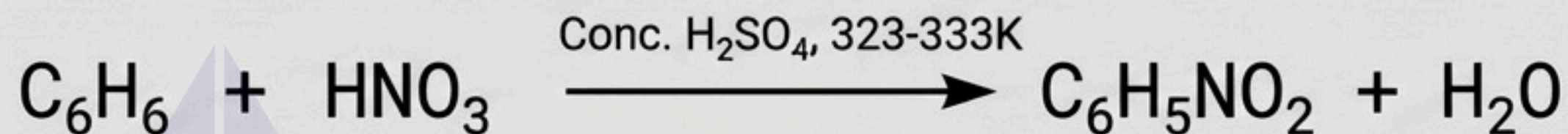
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Key Highlights

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Nitration: Introducing the Nitro Group

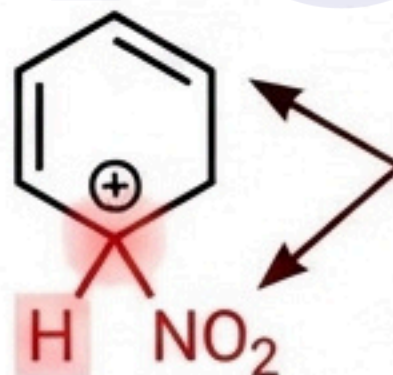


Reactant:
[Benzene]

Attacking Electrophile:
[Nitronium Ion: NO_2^+]

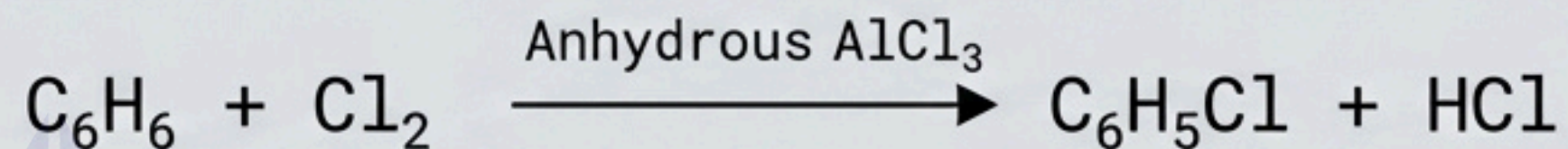
Catalyst:
[Conc. HNO_3 + Conc. H_2SO_4]

Intermediate Formation



Exam Recap: Sulphuric acid acts as an acid and nitric acid as a base to generate the NO_2^+ electrophile.

Halogenation: The Role of Lewis Acids

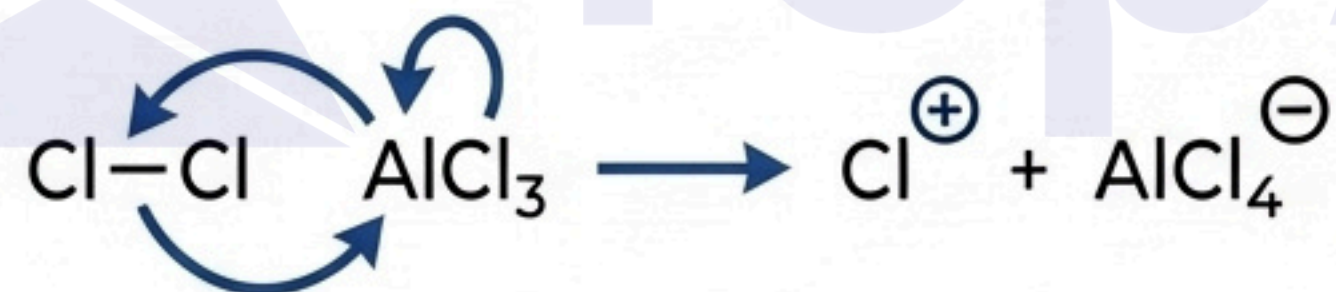


Reactant:
[Benzene]

Attacking Electrophile:
[Chloronium Ion: Cl^+]

Catalyst: [Lewis
Acid: Anhydrous AlCl_3 or FeCl_3]

Electrophile Generation



Exam Recap: Without the anhydrous Lewis acid, the halogen bond will not polarize enough to produce the necessary electrophile.

Sulphonation: Reaction with Oleum

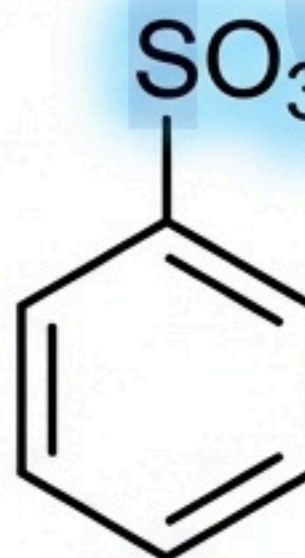


Reactant: [Benzene]

Attacking Electrophile: [SO_3]

Catalyst: [Fuming Sulphuric Acid (Oleum)]

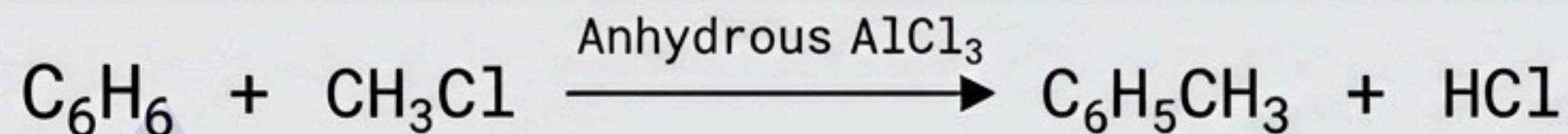
Product Substitution



Requires heating to drive the substitution of the bulky sulphonic acid group.

Exam Recap: Oleum ($\text{H}_2\text{S}_2\text{O}_7$) is effectively a solution of SO_3 gas in concentrated H_2SO_4 , providing a powerful electrophile.

Friedel-Crafts Alkylation: Expanding the Carbon Framework

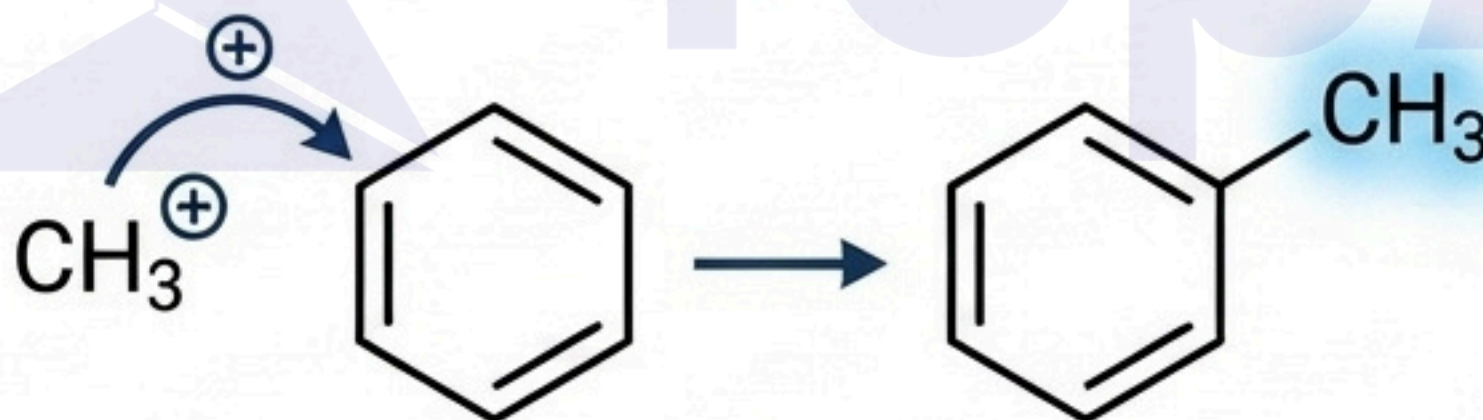


Reactant:
[Benzene]

Attacking Electrophile:
[Alkyl Carbocation: R^+]

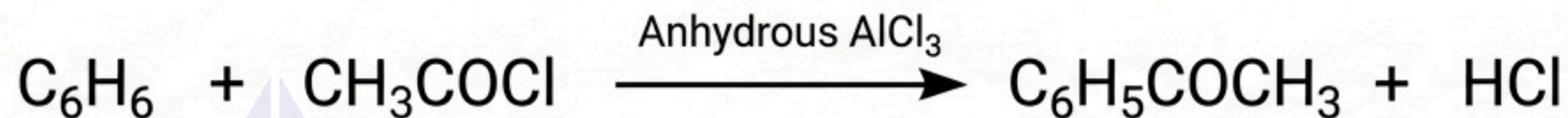
Catalyst:
[Lewis Acid: Anhydrous AlCl_3]

Chain Attachment



Exam Recap: Friedel-Crafts Alkylation is the primary synthetic route for attaching alkyl chains directly to an aromatic ring.

Friedel-Crafts Acylation: Forming Aromatic Ketones

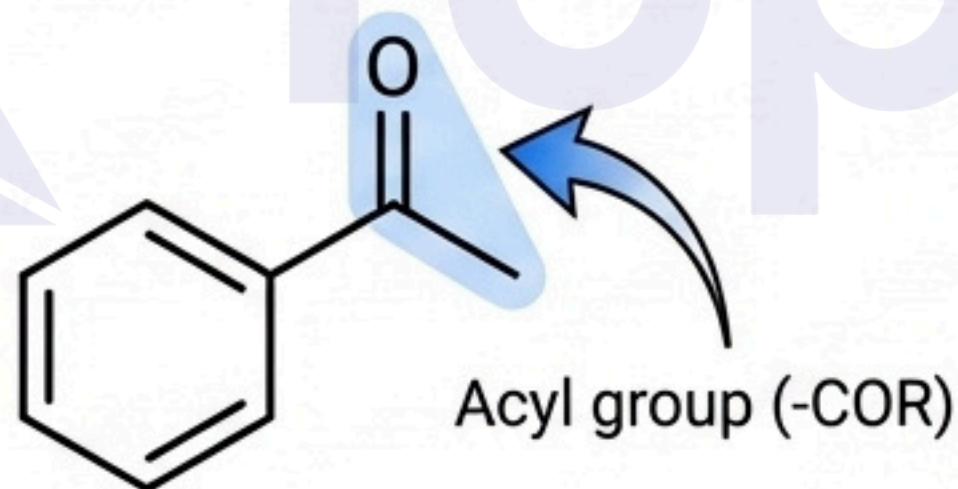


Reactant: [Benzene]

Attacking Electrophile: [Acylium Ion: $\text{R}-\text{C}^+=\text{O}$]

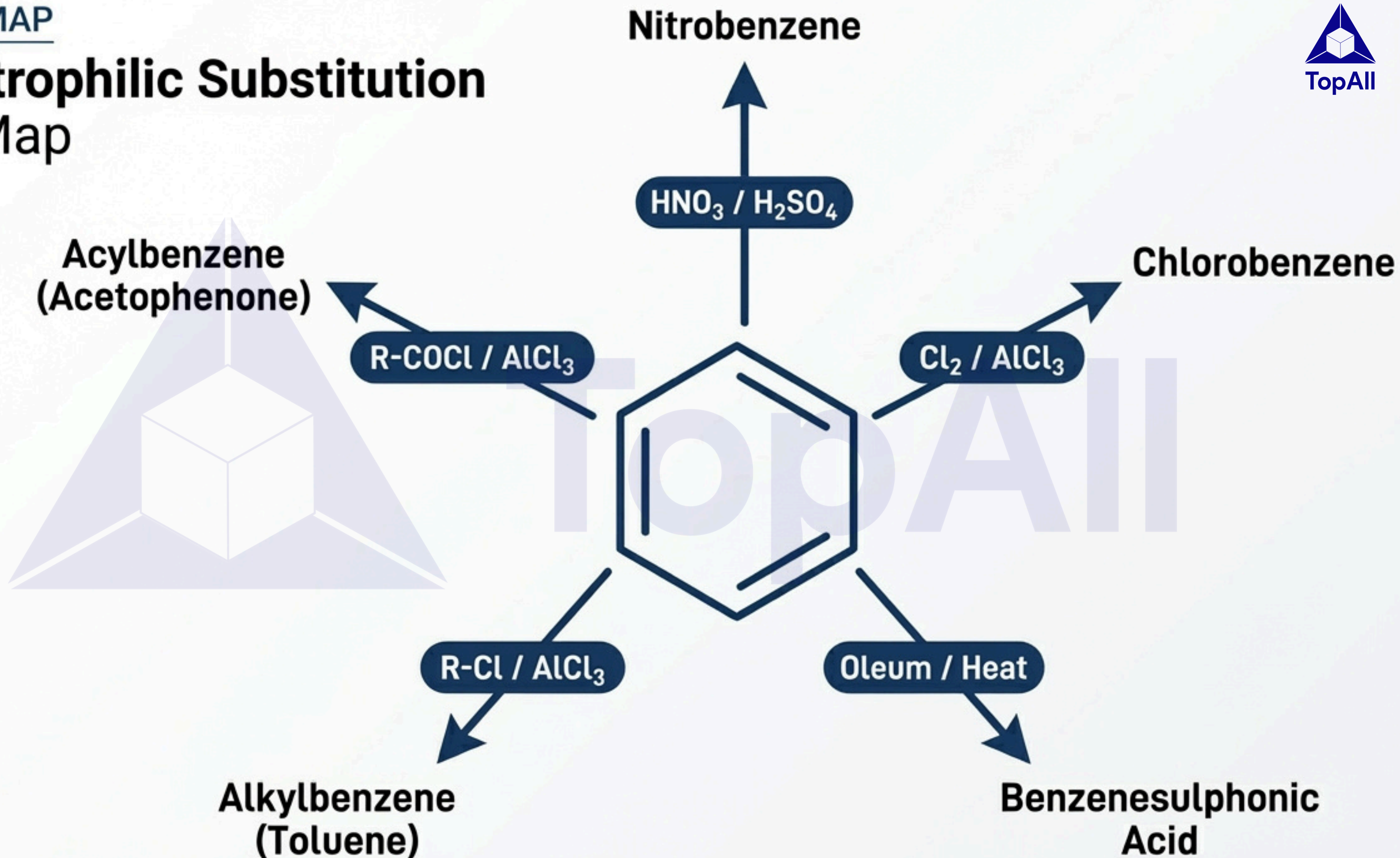
Catalyst: [Lewis Acid: Anhydrous AlCl_3]

Ketone Formation



Exam Recap: Acylation introduces an acyl group forming a ketone. Unlike alkylation, it is highly stable and less prone to carbocation rearrangements.

The Electrophilic Substitution Master Map





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