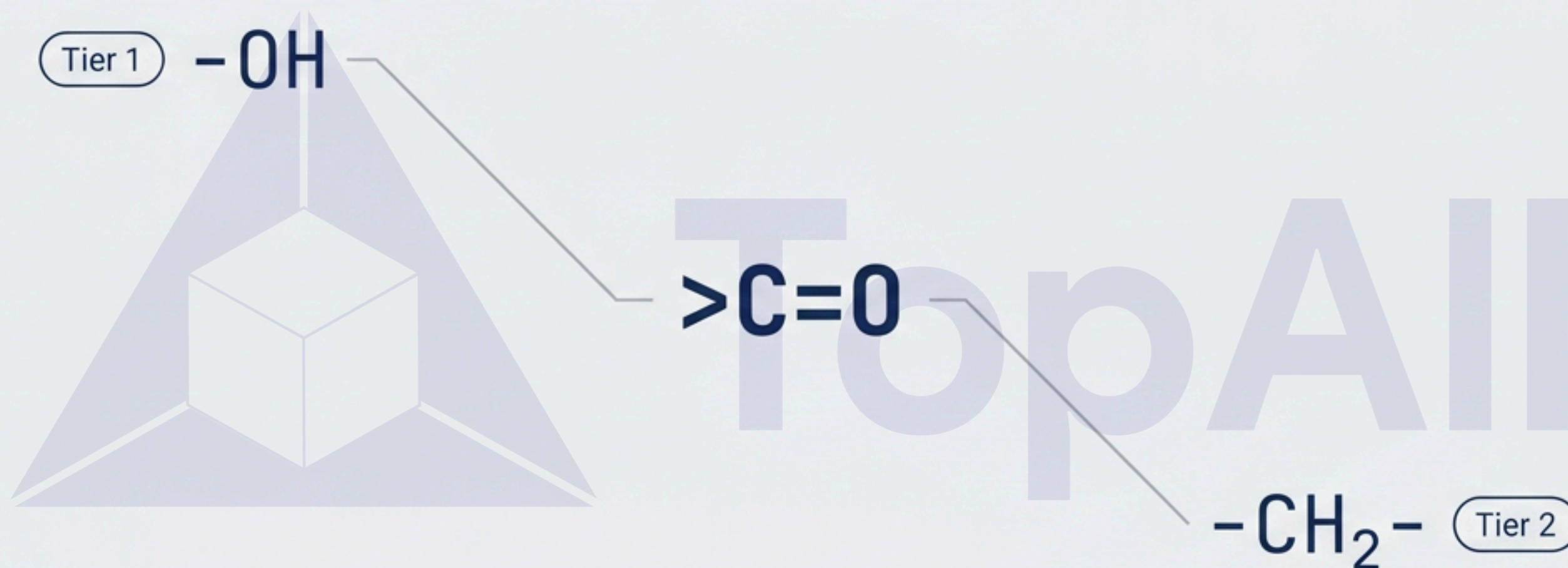


8.4.5 Reduction of Aldehydes and Ketones



Carbonyls are highly versatile. The $>C=O$ double bond is primed for reduction, but the final product depends entirely on your choice of reagent and reaction conditions.

TIER 1 REDUCTION

Synthesizing Alcohols from Carbonyls

Primary (1°) Alcohol

The Aldehyde Path



Secondary (2°) Alcohol

The Ketone Path



Key Takeaway: The degree of the resulting alcohol is strictly determined by the starting material. Aldehydes yield primary alcohols; ketones yield secondary alcohols.

REDUCING AGENTS

Complex Metal Hydrides

Mild

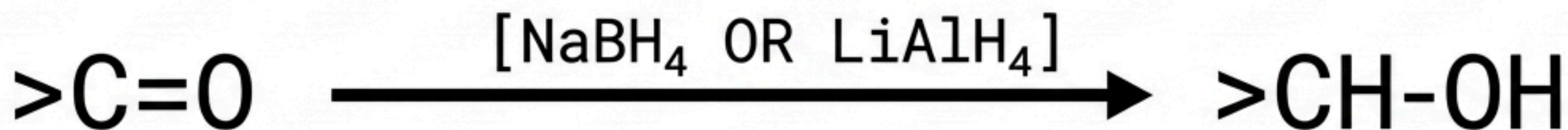


(Sodium borohydride)

Strong



(Lithium aluminium hydride)



Both reagents act as hydride donors, effectively reducing aldehydes and ketones to their respective alcohols. (Note: LiAlH_4 is highly reactive, while NaBH_4 is more selective).



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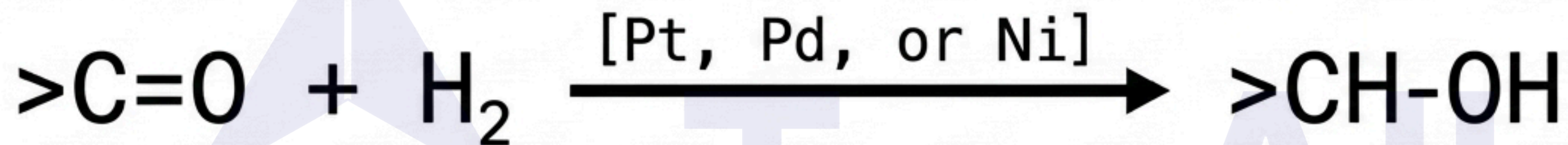
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ALTERNATIVE ROUTE

Catalytic Hydrogenation



The Reagents

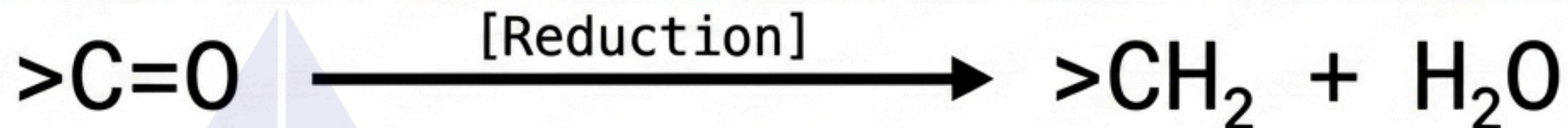
Uses molecular hydrogen gas (H_2) passed over finely divided heavy metal catalysts like Platinum (Pt), Palladium (Pd), or Nickel (Ni).

Exam Integration

Unlike complex metal hydrides ($\text{NaBH}_4/\text{LiAlH}_4$) which donate H^- ions, catalytic hydrogenation relies on the adsorption of both the H_2 gas and the carbonyl molecule onto the metallic surface to break the pi bond.

TIER 2 REDUCTION

Cleaving Oxygen: Reduction to Hydrocarbons



(Carbonyl to Methylene)

Clemmensen Reduction

Acidic

Zn–Hg (Zinc-amalgam) + conc. HCl

Wolff-Kishner Reduction

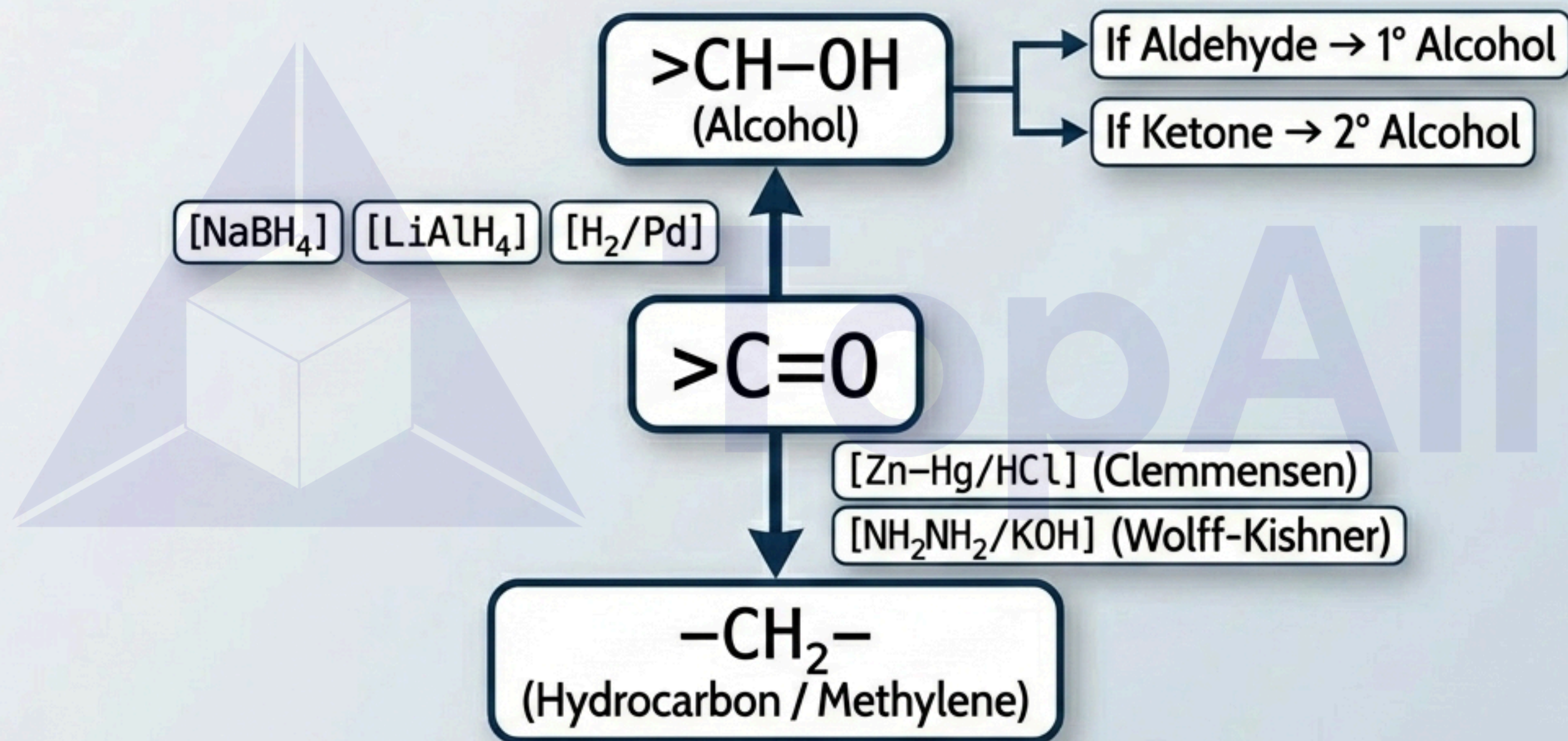
Basic

1. NH_2NH_2 (Hydrazine)
2. KOH or NaOH + heat in Ethylene Glycol

Both reactions strip oxygen entirely to yield a hydrocarbon. The choice of method depends purely on whether the rest of the target molecule can better tolerate strongly acidic or strongly basic conditions.

MASTER SYNTHESIS

The Carbonyl Reduction Map



Exam Rule: Always match your target functional group (alcohol vs. alkane) to the correct reagent tier, and ensure the reaction conditions (acidic vs. basic) tolerate your specific molecule.



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