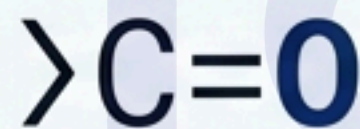


Reduction Reactions of Aldehydes and Ketones

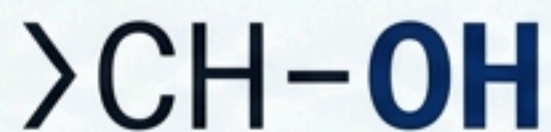
Navigating reaction depths: from alcohols to alkanes.



Shallow Path



Deep Path



The Reagent Toolkit

NaBH₄ / LiAlH₄

The mild/strong hydride donors

Clemmensen

The acidic route

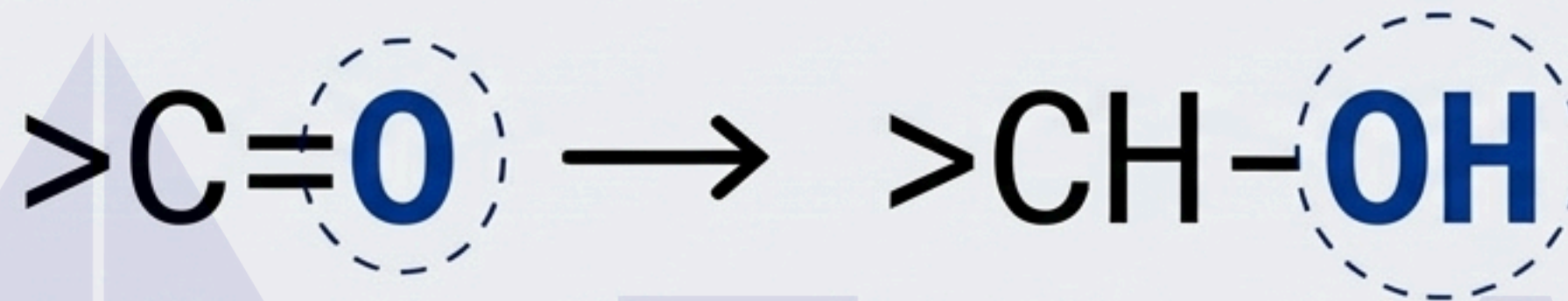
Wolff-Kishner

The basic route

Hydrazine

The WK intermediate former

Depth 1: To-Alcohol (Oxygen Retained)



Reagents:

- **NaBH₄** (Sodium borohydride)
- **LiAlH₄** (Lithium aluminium hydride)
- **Catalytic H₂**

Aldehydes yield 1° alcohols. Ketones yield 2° alcohols.



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Depth 2: Clemmensen Spotlight



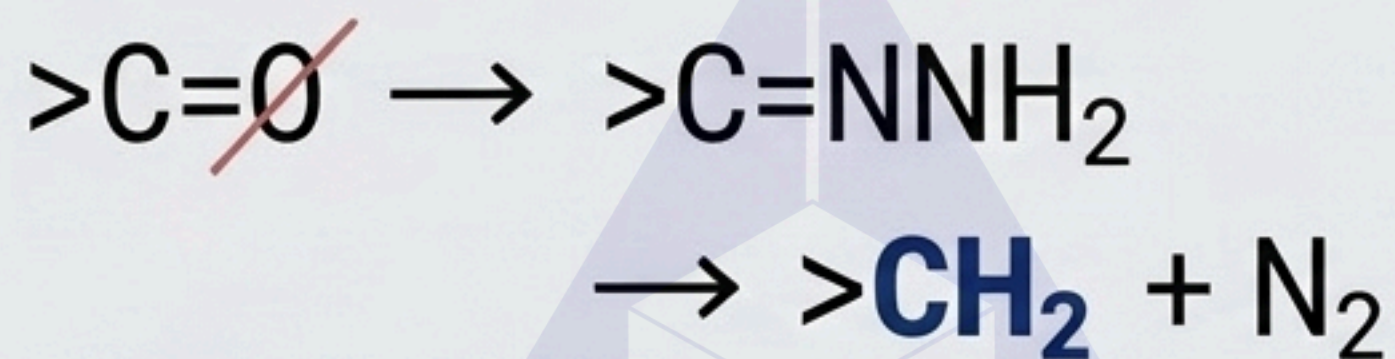
Reagents: Zn-Hg
(Zinc amalgam) and conc. HCl

Route A: The Acidic Path

This reduction **completely erases the oxygen**, bringing the molecule down to an alkane.

The defining feature here is the use of strictly **acidic conditions** (HCl).

Depth 2: Wolff-Kishner Spotlight



Reagents:

Step 1: NH_2NH_2 (Hydrazine)

Step 2: Heat with KOH or NaOH in ethylene glycol

Route B: The Basic Path

Achieves the **exact same depth** as Clemmensen (total oxygen removal to form a methylene group), but utilizes strictly **basic** conditions.

The Condition-Choice Matrix

Why two reactions for the exact same transformation? Look at the rest of the molecule.

Clemmensen (Acidic)	Wolff-Kishner (Basic)
 Best for: Molecules stable in acid.  AVOID if: The molecule has acid-sensitive groups elsewhere (e.g., acetals, or alcohols prone to dehydration).	 Best for: Molecules stable in base.  AVOID if: The molecule has base-sensitive groups elsewhere (e.g., halogens prone to base-catalyzed elimination).

Watch for this: Conflating Depths

Examiners frequently offer NaBH_4 as a distractor to convert a ketone to an alkane, or Zn-Hg/HCl to form an alcohol.

NaBH_4 / LiAlH_4 = **ALWAYS** stop at $-\text{OH}$ (C-O single bond remains).

Zn-Hg / NH_2NH_2 = **ALWAYS** erase oxygen entirely ($-\text{CH}_2-$).

Key Takeaways

- **Depth matters:** Hydride donors ($\text{NaBH}_4/\text{LiAlH}_4$) perform a shallow reduction, retaining the oxygen to form alcohols.
- **Environment matters:** Clemmensen ($\text{Zn-Hg}/\text{HCl}$) and Wolff-Kishner (Hydrazine/ KOH) both perform a deep reduction to yield alkanes ($-\text{CH}_2$), but your choice depends entirely on the acid/base sensitivity of the target molecule.



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