

UNIT 8 • ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

Reduction and Decarboxylation of Carboxylic Acids

Mastering functional group transformations,
reagent selectivity, and carbon-counting traps
for competitive exams.

The Core Lexicon

Diborane (B_2H_6)

A highly selective reducing agent for carboxylic acids.

Sodalime

A specific 3:1 mixture of NaOH and CaO used to strip CO_2 .

Decarboxylation

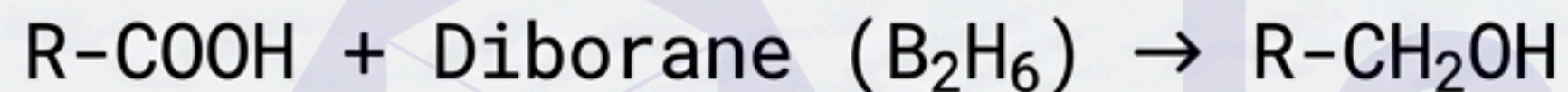
The chemical loss of a carbon dioxide (CO_2) molecule.

Kolbe Electrolysis

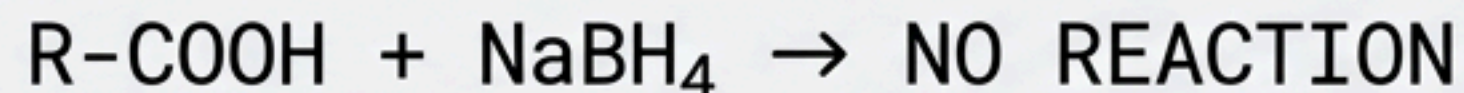
An electrolytic pathway that breaks acid salts to form symmetric alkanes.

Pathway A: Reduction & Reagent Selectivity

Carboxylic acids can be reduced to primary alcohols, but you must choose your reagent carefully.



- ✓ Diborane is highly selective! It perfectly reduces -COOH while safely sparing ester, nitro, and halo groups. (LiAlH₄ also works, but is less selective).



- ✗ NaBH₄ is too mild. It fails entirely to reduce carboxylic acids.



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$$E=mc^2$$



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Pathway B: Sodalime Decarboxylation

Heating a sodium salt of a carboxylic acid with sodalime strips away the carboxyl group entirely, replacing it with a hydrogen atom.

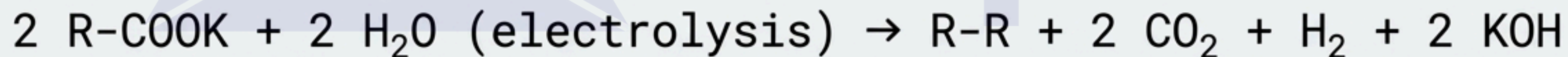
FACT: Sodalime is exactly NaOH and CaO in a **3:1 ratio**.



- i** Notice the product R-H. The final hydrocarbon retains the exact same carbon count as the original alkyl group (R).

Pathway B: Kolbe Electrolysis

Electrolysis of aqueous sodium or potassium salts of carboxylic acids follows a radical mechanism, forcing two alkyl fragments to combine.



Notice the product R-R. Two alkyl fragments bond together. This **DOUBLES** the carbon count of the original alkyl group.

The Carbon-Count Trap

Sodalime Route	Yields R-H. Alkyl carbon count stays the SAME.
Kolbe Route	Yields R-R. Alkyl carbon count DOUBLES.

Watch for this trap! An examiner asks you to synthesize butane (C_4H_{10}) starting from an ethyl group (C_2H_5). Which decarboxylation method is required?

Sodalime Decarboxylation

Sodalime keeps the count the same ($n \rightarrow n$). This would yield ethane!

Kolbe Electrolysis

Correct! Kolbe doubles the alkyl carbons ($2n$), perfectly converting an ethyl radical into butane.

Synthesis Complete

- **Reduction Selectivity:** Use Diborane (B_2H_6) to selectively reduce $-\text{COOH}$ to an alcohol without touching **esters or nitro groups**. Remember that NaBH_4 fails entirely here.
- **Decarboxylation Math:** To keep your alkyl carbon count the same, use Sodalime (3:1 $\text{NaOH}:\text{CaO}$). To double your alkyl carbon count, use Kolbe Electrolysis.



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