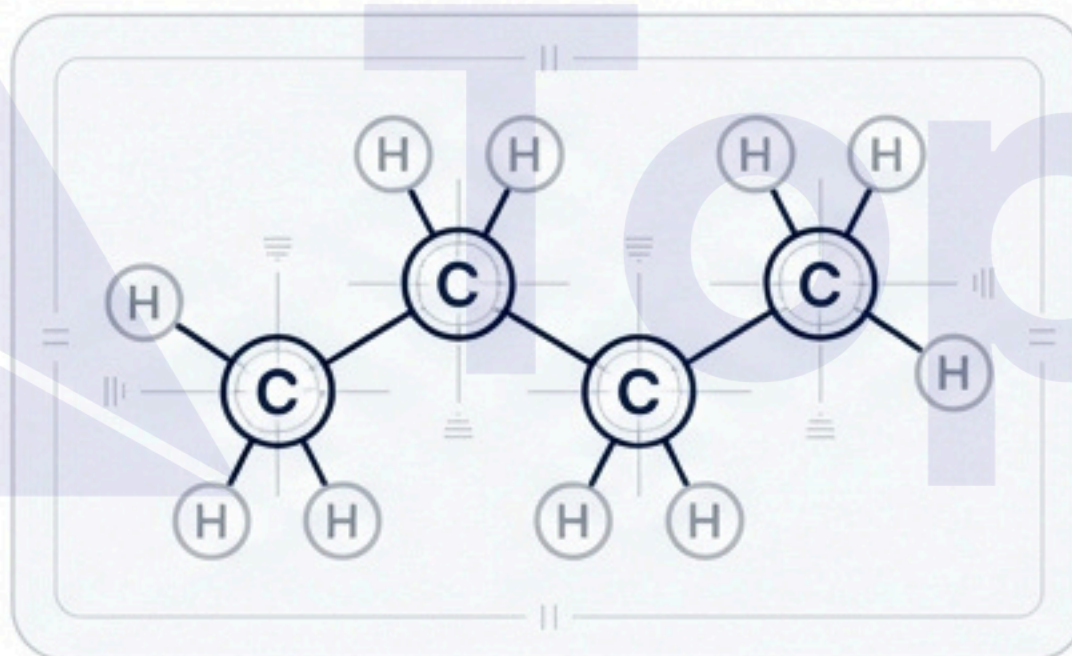


UNIT 9.2.2 • HYDROCARBONS

Preparation of Alkanes

The Synthesis Toolkit: Pathways from natural extraction to strategic laboratory preparation.



Exam-Smart Revision Deck

Petroleum and Natural Gas



The Primary Natural Sources

Petroleum and natural gas are the main natural reservoirs of alkanes. They are obtained via extraction and fractional distillation rather than chemical synthesis.



The Synthetic Toolkit

When specific, pure alkanes are required, chemists rely on targeted synthetic pathways utilizing precursor molecules.

[Unsaturated Hydrocarbons]

[Alkyl Halides]

[Carboxylic Acids]

While nature provides complex mixtures, laboratory preparation allows us to architect specific alkane structures on demand.

Catalytic Hydrogenation



Dihydrogen gas adds to alkenes and alkynes in the presence of a finely divided metal catalyst. The metal surface adsorbs H₂ gas and activates the H-H bond.



Carbon Count: $n \rightarrow n$

Key Condition: Platinum (Pt) and Palladium (Pd) work at room temperature. Nickel (Ni) requires higher temperature and pressure to catalyze the reaction.



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$$E=mc^2$$



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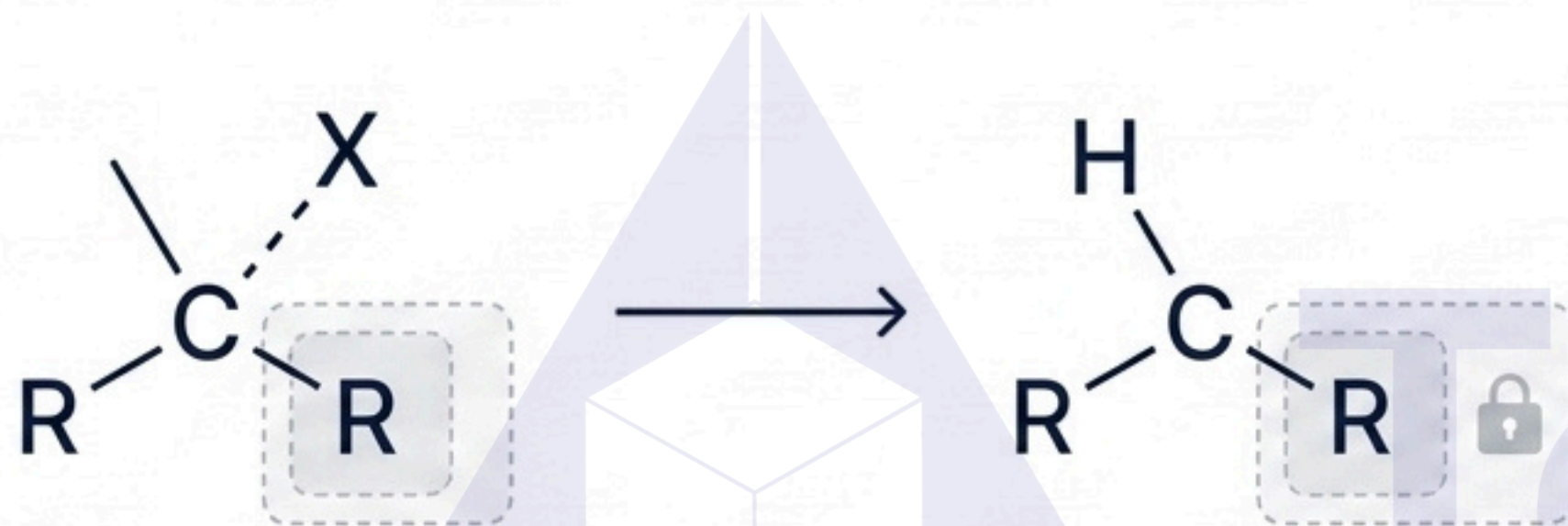
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Reduction with Zinc



Substitution
Schematic

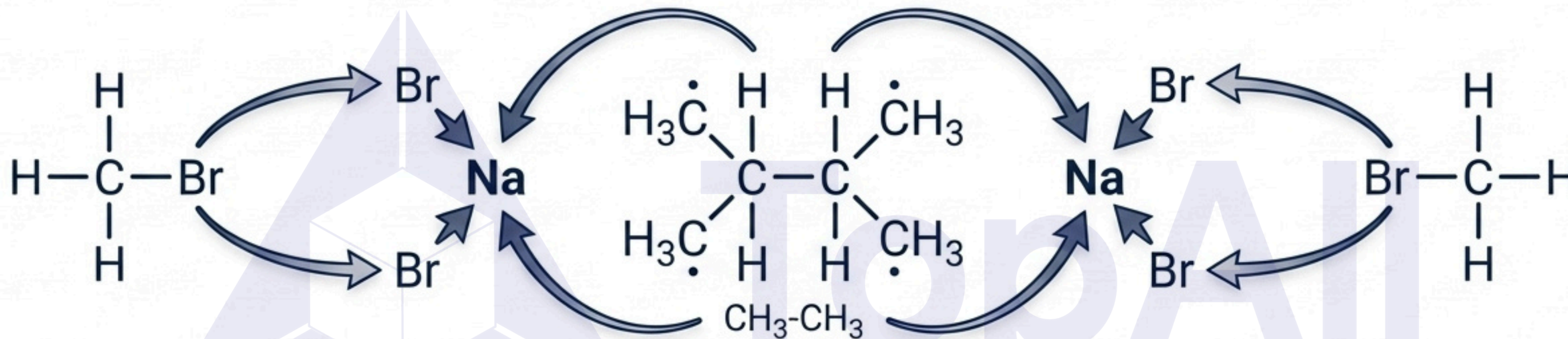
Alkyl halides are reduced to their corresponding alkanes using zinc metal and dilute hydrochloric acid, replacing the halogen atom with a hydrogen atom.



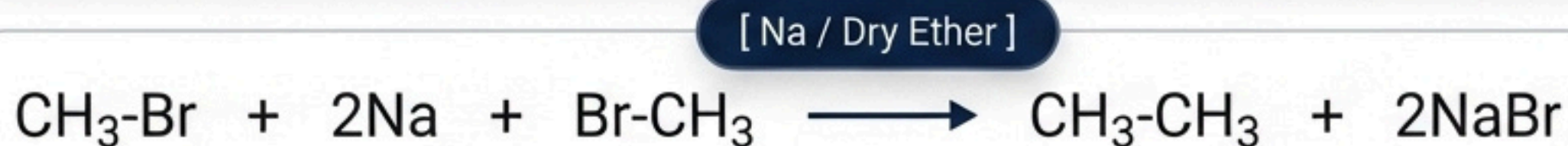
Carbon Count: $n \rightarrow n$

Critical Exception: This reaction works for chlorides, bromides, and iodides, but fluorides do not undergo this reduction.

The Wurtz Reaction



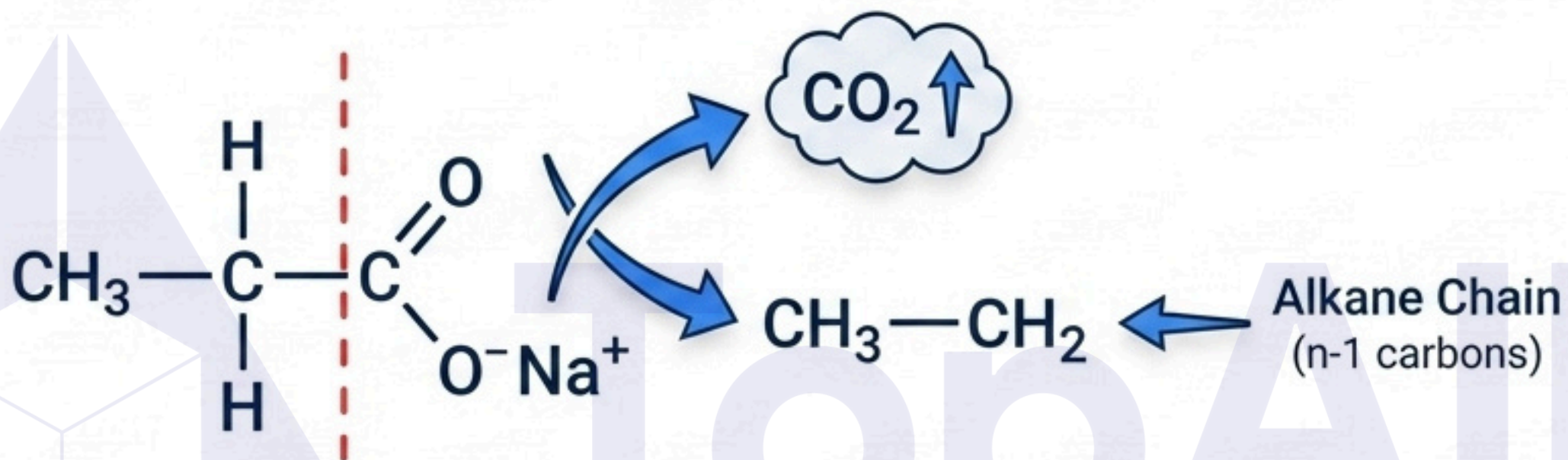
Alkyl halides treated with sodium metal in dry ethereal solution couple together. This is the primary method for synthesizing higher alkanes with an even number of carbon atoms.



Carbon Count: $n \rightarrow 2n$

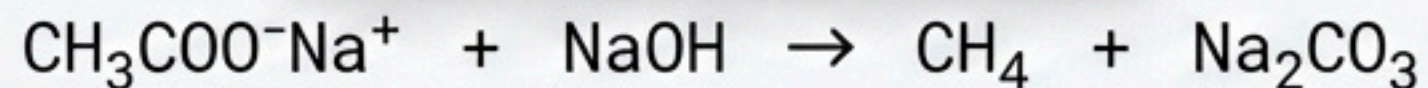
Exam Trap: Wurtz is strictly used for symmetrical alkanes (even number of carbons). It is ineffective for synthesizing alkanes with an odd number of carbon atoms (like propane) due to mixed product formation.

Decarboxylation



Heating a sodium salt of a carboxylic acid with sodalime eliminates carbon dioxide, yielding an alkane.

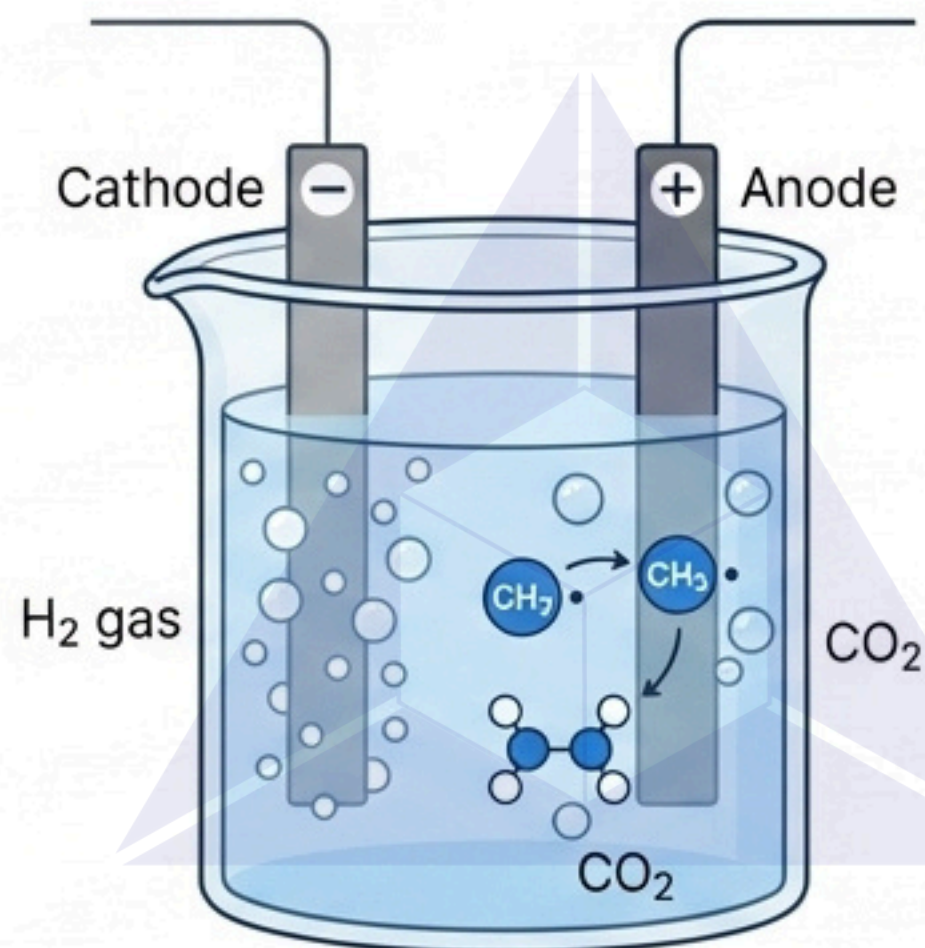
[Sodalime ($\text{NaOH} + \text{CaO}$) / Heat (Δ)]



Carbon Count: $n \rightarrow n-1$

Strategic Use: This is a step-down reaction. The resulting alkane will always contain exactly one less carbon atom than the starting carboxylic acid.

Kolbe's Electrolytic Method

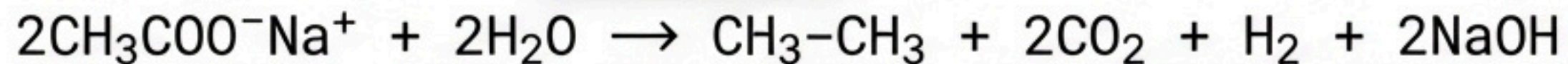


1. **Ionization:** $2\text{CH}_3\text{COO}^-\text{Na}^+ \rightarrow 2\text{CH}_3\text{COO}^- + 2\text{Na}^+$

2. **Anode (Oxidation):** Acetate loses electrons to form methyl free radicals, which couple to form the alkane.

3. **Cathode (Reduction):** Water is reduced, releasing H_2 gas.

[Electrolysis]



Carbon Count: $2n$ (symmetrical)

Exam Trap: Methane (CH_4) cannot be prepared by this method, as the coupling requires joining two alkyl radicals.

The Alkane Preparation Matrix

Select your synthetic pathway based on your starting material and your target carbon chain length.

Starting Precursor	Reagent & Conditions	Carbon Outcome	Reaction Name
Unsaturated Hydrocarbon	H ₂ , [Pt/Pd/Ni]	n → n (Same)	Hydrogenation
Alkyl Halide	H ₂ , [Zn/dil. HCl]	n → n (Same)	Reduction
Alkyl Halide	Na, [Dry Ether]	n → 2n (Doubles)	Wurtz Reaction
Carboxylic Acid Salt	[Sodalime / Heat]	n → n-1 (Steps Down)	Decarboxylation
Carboxylic Acid Salt	[Electrolysis]	n → 2n (Couples)	Kolbe's Method

When designing a synthesis on an exam, first identify the Delta (the change in carbon count). If you need to step down, use Decarboxylation. If you need to double, use Wurtz or Kolbe.



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