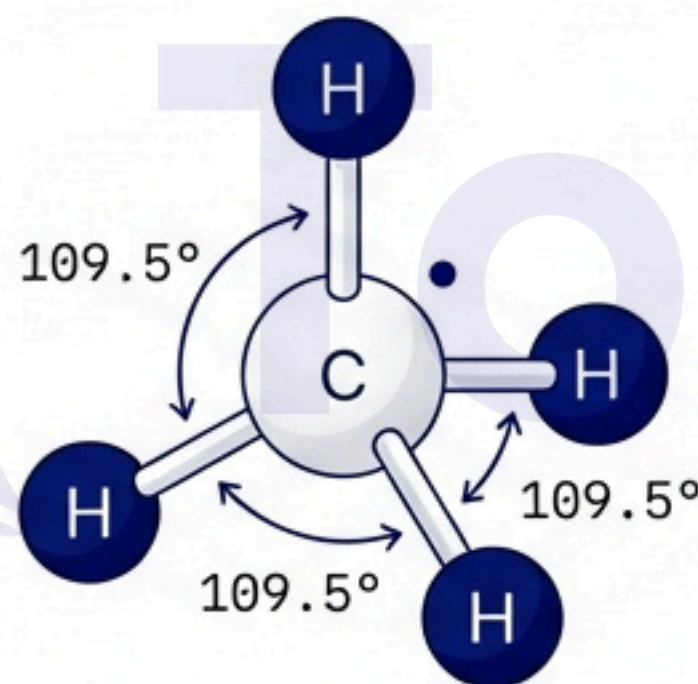
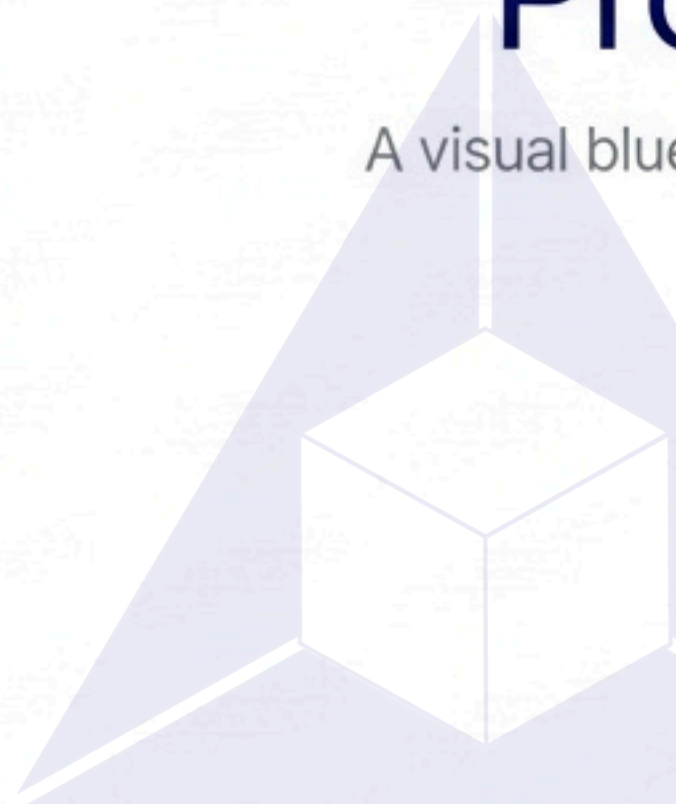


UNIT 9 • HYDROCARBONS

Properties of Alkanes

A visual blueprint of physical characteristics and chemical reactivity.



Physical Properties

Chemical Reactions

Mechanisms

Physical Properties Overview

Bonding

Non-polar molecules (C-C and C-H have very little electronegativity difference).

Intermolecular Forces

Weak van der Waals forces (Due to covalent, non-polar nature).

Sensory

Colorless & Odorless.

C1 to C4

C5 to C17

C18+

Gases

(e.g., Methane)

Liquids

(e.g., Petrol)

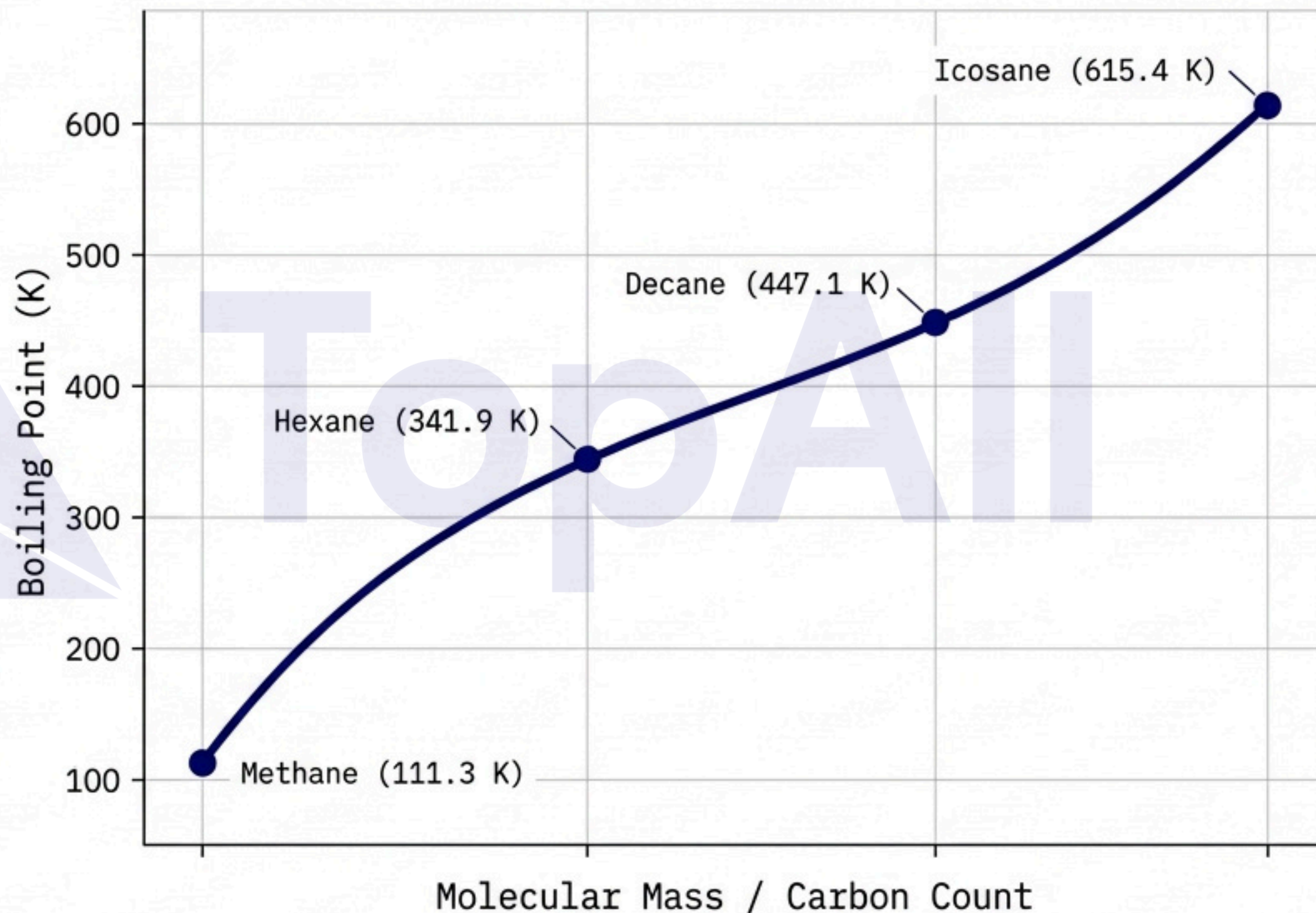
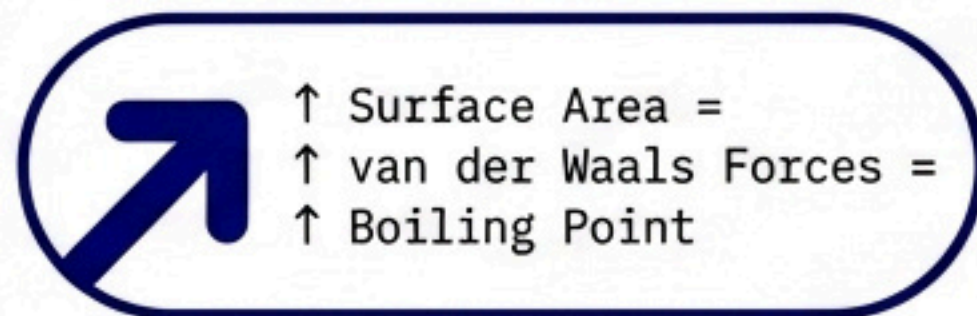
Solids

(e.g., Wax)

The Boiling Point Trend

As molecular mass increases, the molecular size and surface area expand.

This strengthens the intermolecular van der Waals forces, requiring higher temperatures to overcome.



The Effect of Branching on Isomers



Straight Chain

Molecule: Pentane
(n-pentane)

Shape: Elongated chain
(Large contact area)

Boiling Point: 309.1 K

Ato. = 10, 8PS



Single Branch

Molecule: 2-Methylbutane
(isopentane)

Shape: Slightly compact
(Reduced contact area)

Boiling Point: 301.3 K

Ato. = 10, 1B4



Double Branch

Molecule: 2,2-Dimethylpropane
(neopentane)

Shape: Spherical
(Minimum contact area)

Boiling Point: 282.5 K

Ato. = 10, 6B5

More branching gives the molecule a spherical shape. This reduces the area of contact, weakening intermolecular forces and lowering the boiling point.



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

$$E=mc^2$$



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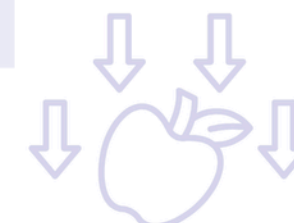
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- » Get Clear Explanations, Not Just Marks
- » Track Your Performance Smarter



Solubility Logic: "Like Dissolves Like"

Hydrophobic



Hydrophobic

Alkanes are non-polar and cannot dissolve in polar solvents like water.

vs

Miscible



Miscible

Non-polar alkanes dissolve easily in non-polar solvents.

Real-World Application Card

Petrol and lower petroleum fractions are used in dry cleaning because they effectively dissolve grease stains, which are mixtures of higher alkanes.

Chemical Reactivity: Substitution Reactions



Alkanes are generally inert toward acids, bases, and oxidizers (historically named paraffins—little affinity). However, they undergo substitution under specific conditions.

$h\nu$ (Diffused sunlight / UV light)

OR

High Temperature (573-773 K)



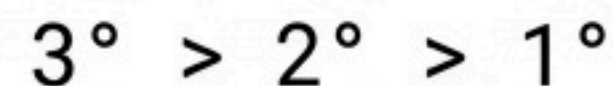
(Methane + Chlorine $\rightarrow$ Chloromethane + Hydrogen Chloride)

Halogen Reactivity



(Fluorination is too violent; Iodination is reversible).

Hydrogen Replacement



(Tertiary hydrogens are substituted fastest).

Free Radical Halogenation Mechanism

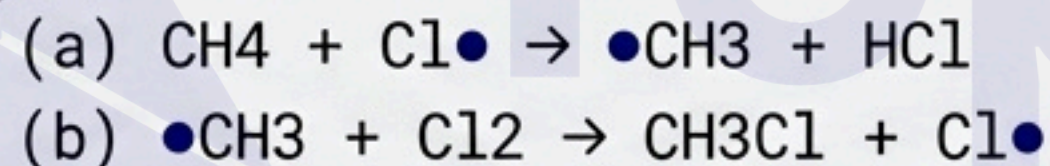
Step 1: Initiation

Homolysis of the Cl-Cl bond is triggered by UV light/heat.



Step 2: Propagation

A chain reaction cycle. The chlorine radical attacks methane, generating a methyl radical, which then attacks a new chlorine molecule.



Step 3: Termination

Radicals consume each other, stopping the chain. Notably, methyl radicals can combine to form ethane as a byproduct.



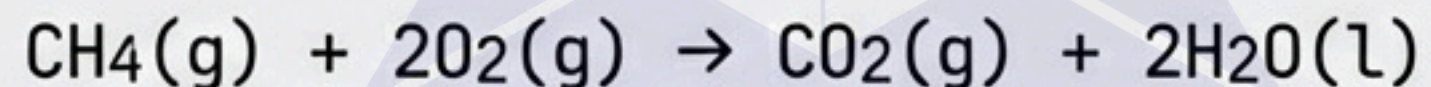
Combustion: Complete vs. Incomplete



General Equation: $C_nH_{2n+2} + (3n+1)/2 O_2 \rightarrow nCO_2 + (n+1)H_2O + \text{Heat}$

Complete Combustion

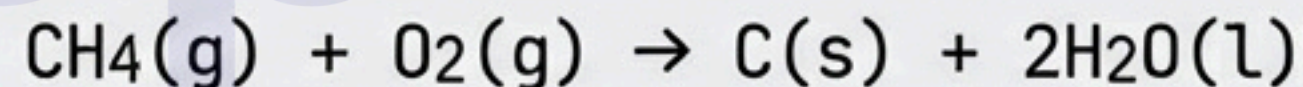
Excess Oxygen / Air



Result: Completely oxidized to carbon dioxide and water. Evolves large amounts of heat. Excellent fuel.

Incomplete Combustion

Insufficient Oxygen



Result: Produces Carbon Black (soot). Used industrially for printer ink, black pigments, and filters.

Other Important Reactions

Controlled Oxidation



Oxidation of 3° Alkanes



2-Methylpropane $\rightarrow$
2-Methylpropan-2-ol (Unique
exception to oxidation
resistance).

Isomerisation



n-Hexane $\rightarrow$ 2-Methylpentane
+ 3-Methylpentane.

Aromatisation (Reforming)



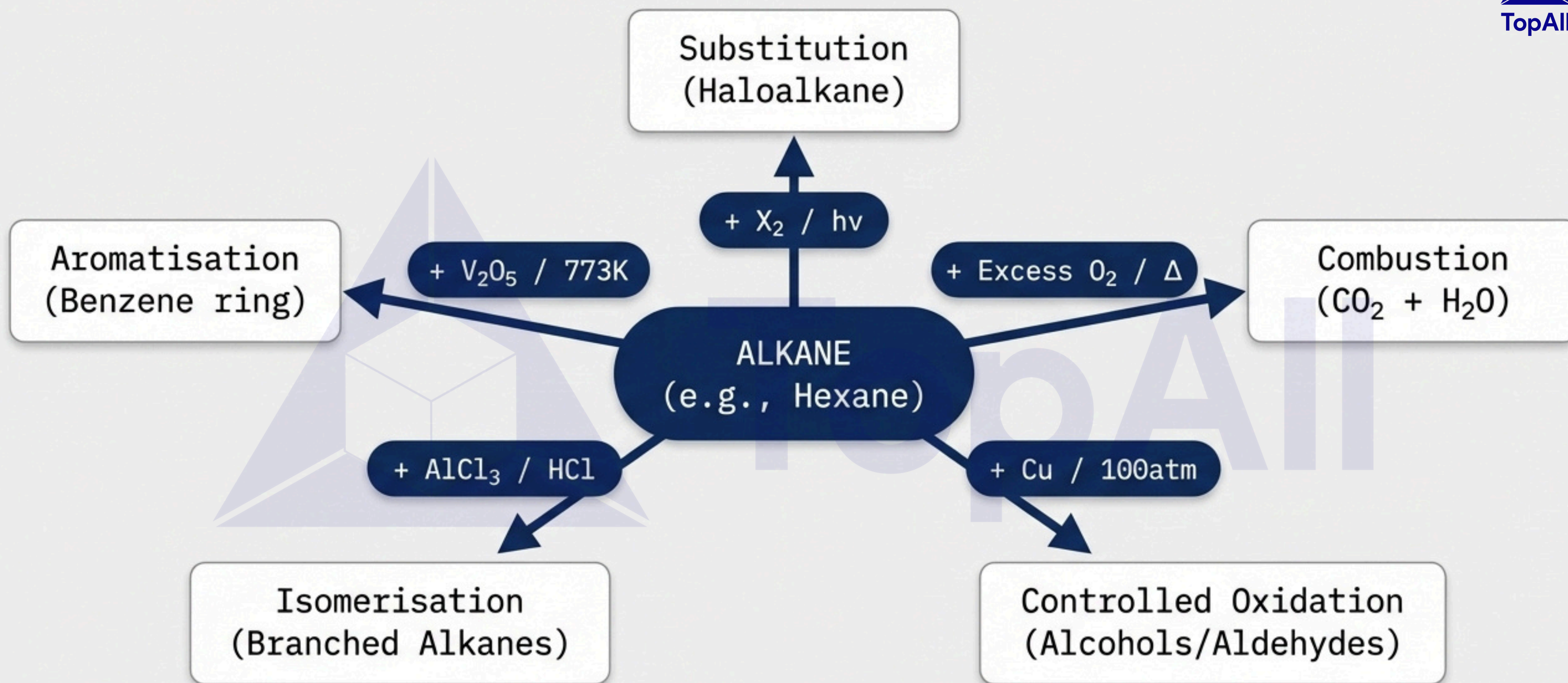
n-Hexane cyclizes and dehydrogenates to
form **Benzene**.

Pyrolysis & Steam

Higher alkanes break down into smaller
alkanes/alkenes upon heating (Pyrolysis).

Reaction with steam over **Ni** produces syngas
($\text{CO} + \text{H}_2$).

Final Exam Summary: Alkane Reaction Wheel



Alkanes (C_nH_{2n+2}) are non-polar, generally inert hydrocarbons whose physical properties scale with mass and whose chemical properties require specific, energetic catalysts.



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