# 14 Alkanes – Part 1

Name: _____ Class: _____ Date: _____

## Vocabulary

*Write each word three times.*

| **English** | **Write it 3 times** (English) | | |
|---|---|---|---|
| alkanes | | | |
| complete combustion | | | |
| incomplete combustion | | | |
| carbon monoxide | | | |
| ultraviolet light | | | |
| free-radical substitution | | | |
| initiation | | | |
| propagation | | | |
| termination | | | |
| polarity | | | |

## Recall

At IGCSE you learned that **alkanes** are saturated hydrocarbons that **burn** as fuels. Now we look at their combustion and their one important reaction with halogens.

- Alkanes have only single bonds (general formula $C_nH_{2n+2}$).
- They are fairly **unreactive** because their bonds are strong and non-polar.

Nothing here is harder than IGCSE – it just adds a mechanism.

## New ideas

Read these first, then do the Practice.

### 1 Combustion

- **complete combustion** (plenty of oxygen) → carbon dioxide + water.
- **incomplete combustion** (too little oxygen) → water + toxic **carbon monoxide** (CO) + soot.

$$\text{complete: alkane} + O_2 \rightarrow CO_2 + H_2O$$

$$\text{incomplete: alkane} + \text{less } O_2 \rightarrow CO + \text{soot} + H_2O$$

### 2 Free-radical substitution

Alkanes react with chlorine (or bromine) in **ultraviolet light** by **free-radical substitution**, in three steps:

- **initiation** – UV splits the halogen into **radicals**: $Cl_2 \rightarrow 2\,Cl\cdot$
- **propagation** – radicals react and make new radicals: $Cl\cdot + CH_4 \rightarrow CH_3\cdot + HCl$, then $CH_3\cdot + Cl_2 \rightarrow CH_3Cl + Cl\cdot$
- **termination** – two radicals join, ending the chain.

$$\begin{aligned}
&\text{initiation:} && Cl_2 \rightarrow 2\,Cl\cdot \\
&\text{propagation:} && Cl\cdot + CH_4 \rightarrow CH_3\cdot + HCl \\
& && CH_3\cdot + Cl_2 \rightarrow CH_3Cl + Cl\cdot \\
&\text{termination:} && Cl\cdot + CH_3\cdot \rightarrow CH_3Cl
\end{aligned}$$

### 3 Why alkanes are unreactive

Their C–H and C–C bonds are strong and have little **polarity**, so there is no charge to attract an attacking species.

**Watch out:** free-radical substitution needs UV light and gives a *mixture* of products (mono-, di-, tri-substituted). The dot in Cl· marks an unpaired electron – a radical, not an ion.

## Practice

Try these in order.

**14.1** Give the general formula of the alkanes. [1]

**14.2** Name the products of (a) complete, (b) incomplete combustion of an alkane. [2]

**14.3** Why is carbon monoxide dangerous? (one reason) [1]

**14.4** Name the three steps of free-radical substitution, in order. [3]

**14.5** Write the initiation step for the reaction of chlorine in UV light. [1]

**14.6** Explain why alkanes are unreactive towards polar reagents. [2]

**14.7 Challenge.** When methane reacts with chlorine in UV light, the product is a mixture, not just chloromethane. Explain why. [2]