

# 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.

complete:  $\text{alkane} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

incomplete:  $\text{alkane} + \text{less O}_2 \rightarrow \text{CO} + \text{soot} + \text{H}_2\text{O}$

### ■ 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**:  $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$
- propagation** – radicals react and make new radicals:  $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{CH}_3\cdot + \text{HCl}$ , then  $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$
- termination** – two radicals join, ending the chain.

initiation:  $\text{Cl}_2 \rightarrow 2\text{Cl}\cdot$

propagation:  $\text{Cl}\cdot + \text{CH}_4 \rightarrow \text{CH}_3\cdot + \text{HCl}$   
 $\text{CH}_3\cdot + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}\cdot$

termination:  $\text{Cl}\cdot + \text{CH}_3\cdot \rightarrow \text{CH}_3\text{Cl}$

### ■ 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  $\text{Cl}\cdot$  marks an unpaired electron – a radical, not an ion.

## Practice

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Try these in order.

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

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

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

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

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

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**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]

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