

11.4 Alkanes

Name: _____ Class: _____ Date: _____

Total: 21 marks

KEY WORDS ultraviolet light • substitution • alkanes • combustion
• hydrogen

Objective

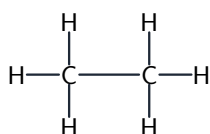
Build the skills to answer exam questions on **alkanes** – saturated hydrocarbons, **combustion**, and **substitution** with chlorine.

You must be able to:

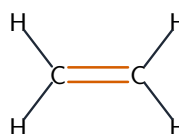
- describe alkanes as saturated and generally unreactive
- write combustion equations (complete/incomplete)
- describe the photochemical substitution with chlorine

1 Key knowledge and worked examples

■ Alkane reactions

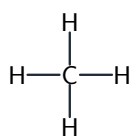


ethane C₂H₆
saturated: single C–C bond

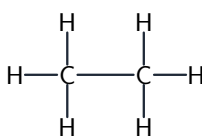


ethene C₂H₄
unsaturated: C=C double bond

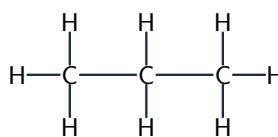
Alkanes are saturated (single bonds only), so they are generally unreactive



methane
CH₄



ethane
C₂H₆



propane
C₃H₈

each step adds a CH₂ unit general formula C_nH_{2n+2}

Alkanes form a homologous series

- **combustion (complete):** alkane + O₂ → CO₂ + H₂O.
- **substitution:** CH₄ + Cl₂ $\xrightarrow{\text{UV}}$ CH₃Cl + HCl (needs UV light).

2 Practice

2.1 State why alkanes are described as saturated. [1]

2.2 Name the products of the complete combustion of an alkane. [2]

3 Exam-style questions

3.1 The reaction of methane with chlorine requires: [1]

☐

- A a nickel catalyst
- B ultraviolet light
- C steam
- D high pressure only

3.2 Methane reacts with chlorine in ultraviolet light.

(a) Write the equation for the reaction. [2]

(b) Name this type of reaction. [1]

3.3 Write a balanced equation for the complete combustion of ethane, C_2H_6 . [2]

3.4 Methane, CH_4 , is the first member of the alkanes.

(a) State what is meant by a *saturated hydrocarbon*, and give the general formula of the alkanes. [3]

(b) Write the balanced equation for the complete combustion of methane, and state one danger of **in**complete combustion. [3]

(c) Methane reacts with chlorine in ultraviolet light. Name the type of reaction, write the equation for the first step, and state why light is needed. [3]

(d) Draw the displayed formula of ethane, and explain why alkanes are generally unreactive. [3]

Solutions

Each answer shows the steps, then the **result**.

2.1

- alkanes are saturated because they have **only single C–C bonds**

2.2

- complete combustion: **carbon dioxide** and **water**

3.1 B

- the substitution needs **ultraviolet light**
- A is hydrogenation; C is hydration; D is not enough

3.2

(a)

- $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$

(b)

- substitution**

3.3

- $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$

3.4

(a)

- a hydrocarbon: **only C and H**
- only single C–C bonds**
- general formula $\text{C}_n\text{H}_{2n+2}$

(b)

- $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- incomplete combustion produces **toxic, colourless, odourless carbon monoxide**

(c)

- substitution**
- $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$
- UV light supplies the energy to **break the Cl–Cl bond**

(d)

- two carbons joined by a single bond, each with three hydrogens, all bonds drawn
- C–C and C–H bonds are **strong and not polar**, so a great deal of energy is needed to react