

11.4 Alkanes

Name: _____ Class: _____ Date: _____

Total: 21 marks

KEY WORDS ultraviolet light 紫外线 • substitution 取代 • alkanes 烷烃 • combustion 燃烧
• hydrogen 氢气

Objective

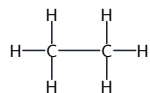
Build the skills to answer exam questions on **alkanes** 烷烃 — saturated hydrocarbons, **combustion** 燃烧, and **substitution** 取代 with chlorine.

You must be able to:

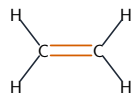
- describe alkanes as saturated and generally unreactive
- write combustion equations (complete/incomplete)
- describe the photochemical substitution with chlorine

1 Worked examples

■ Alkane reactions



ethane C₂H₆
saturated: single C–C bond

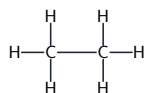


ethene C₂H₄
unsaturated: C=C double bond

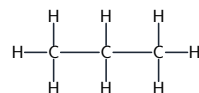
Alkanes are saturated (single bonds only), so they are generally unreactive



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, C₂H₆. [2]

3.4 Methane, CH₄, 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

2.1 they have only single carbon–carbon bonds.

2.2 carbon dioxide; water.

3.1 B. The substitution needs ultraviolet light.

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) It contains only carbon and hydrogen (a hydrocarbon), with only **single** bonds between the carbon atoms — no double bonds; the general formula is C_nH_{2n+2}.

(b) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$; incomplete combustion produces **carbon monoxide**, a toxic gas that is colourless and has no smell, so it cannot be detected without an alarm.

(c) **Substitution**; $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$; ultraviolet light supplies the energy to break the Cl–Cl bond and start the reaction.

(d) Two carbons joined by a single bond, each with three hydrogens, all bonds drawn. The C–C and C–H bonds are strong and are not polar, so there is no partial charge to attract an attacking particle — a great deal of energy is needed before anything reacts.