

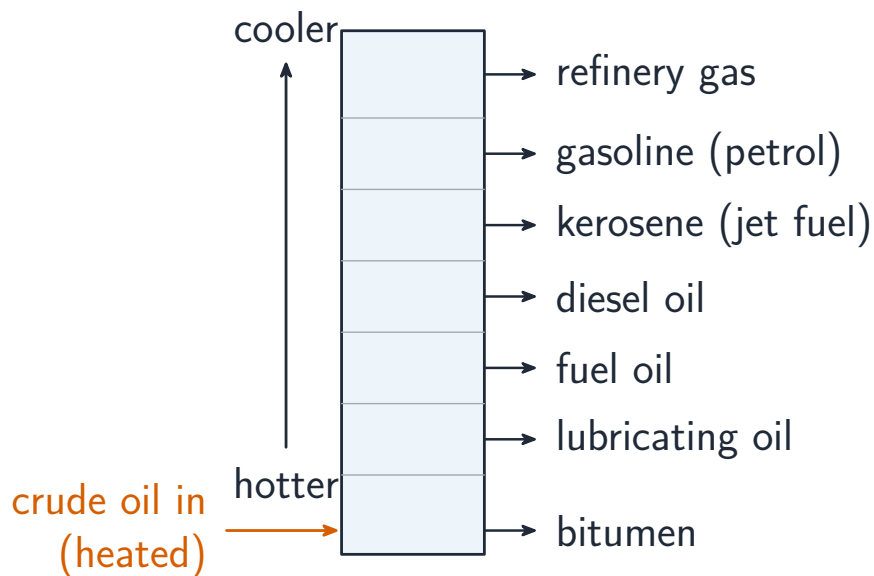
Exercise walk-through

11.4

Alkanes

IGCSE Chemistry

Fuels: fractional distillation



up the column: smaller molecules,
lower boiling points, more volatile

Petroleum fractions is split into by boiling point in a tall column.

Top (cool): short chains, more **volatile**, low **viscosity**. Bottom (hot): long chains, **bitumen**.

Separating crude oil

The fractionating column

Crude oil is heated and fed into a **fractionating column** that is hot at the bottom and cool at the top.

Why it works

Longer molecules have stronger forces between them, so a longer **chain length** means a higher boiling point – and it condenses lower down.

Top to bottom

Refinery gases, petrol, naphtha, kerosene, diesel, fuel oil, bitumen.

Cracking

Long fractions in surplus are cracked into short ones in demand, giving alkenes for plastics as well as petrol.

One property – chain length – explains the order, the boiling points, the viscosity and how easily each fraction burns.

The fractions, top to bottom

Fraction	What it is used for
refinery gas	gas for heating and cooking
gasoline (petrol)	fuel for cars
naphtha	raw material for making chemicals
kerosene (paraffin)	fuel for aircraft
diesel oil	fuel for lorries and some cars
fuel oil	fuel for ships and home heating
bitumen	surfacing roads and roofs

Going **up** the column the chains get shorter: lower boiling point, higher **volatility** , lower **viscosity** , and they burn more easily.

Alkanes

combustion

burn in $\text{O}_2 \rightarrow \text{CO}_2 + \text{water}$

substitution

+ Cl_2 in **UV light**

Alkanes are **saturated** & generally unreactive. $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl}$ (a photochemical reaction).

Cracking

large alkane molecule



heat + catalyst



smaller alkane + alkene (C=C)

Cracking breaks a big alkane into a smaller alkane + an **alkene**, using heat & a catalyst. It makes useful small molecules & alkenes for plastics.

Exercises 2.1·2.2

2.1 State why alkanes are described as saturated.

[1]

2.2 Name the products of the complete combustion of an alkane.

[2]

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2.1 State why alkanes are described as saturated.

[1]

2.1

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

2.2 Name the products of the complete combustion of an alkane.

[2]

2.2

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

Exercise 3.1

3.1 The reaction of methane with chlorine requires:

[1]

☐

A a nickel catalyst

B ultraviolet light

C steam

D high pressure only

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[1]

☐

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3.1 B

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

Exercise 3.2 (a)

3.2 Methane reacts with chlorine in ultraviolet light.

(a) Write the equation for the reaction.

[2]

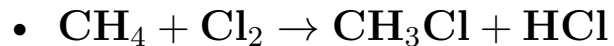
Exercise 3.2 (a)

3.2 Methane reacts with chlorine in ultraviolet light.

(a) Write the equation for the reaction.

[2]

(a)



Exercise 3.2 (b)

3.2 Methane reacts with chlorine in ultraviolet light.

(b) Name this type of reaction.

[1]

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(b)

- **substitution**

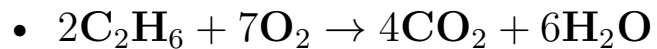
Exercise 3.3

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

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Exercise 3.4 (a)

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]

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(a)

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

Exercise 3.4 (b)

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

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(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**

Exercise 3.4 (c)

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

(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]

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(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**

Exercise 3.4 (d)

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(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