Alkanes Summary Map

Edexcel A Level Chemistry · Topic 6B

1 Crude oil

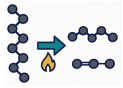
6B.8–6B.10

- A mixture of hydrocarbons, mostly alkanes
- **Fractional distillation**: separates by boiling point
- Column: hot at the bottom, cool at the top
- Longer chains: stronger London forces, higher boiling point, condense lower
- Fractions: gases, petrol, naphtha, kerosene, diesel, fuel oil, bitumen

2 Cracking

6B.10

- Long chains → shorter alkanes + alkenes
- Why: more demand for petrol and for alkenes (polymers)
- **Catalytic**: zeolite catalyst, about 450 °C
- e.g. $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$
- Balance C and H: the alkene is C_nH_{2n}

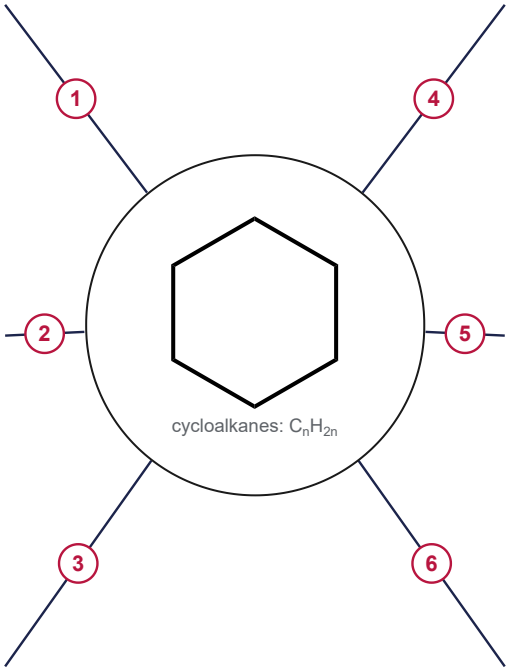


3 Reforming

6B.10

- Straight chains → branched and cyclic hydrocarbons
- Platinum catalyst
- They burn more smoothly in engines (less knocking)
- e.g. $C_6H_{14} \rightarrow C_6H_{12} + H_2$ (cyclohexane)
- Also arenes: $C_6H_{12} \rightarrow C_6H_6 + 3H_2$





4 Combustion

6B.16

- **Complete** (excess O_2): $CO_2 + H_2O$
- **Incomplete** (limited O_2): CO or C + H_2O
- Very exothermic: alkanes are fuels
- Balance C, then H, then O last (halves allowed)
- Incomplete burning releases less energy



5 Pollutants

6B.11–6B.13

- **CO**: toxic, binds to haemoglobin, less O_2 carried
- **NO_x**: $N_2 + O_2$ from the air at high engine temperatures
- **SO_2**: sulfur impurities in the fuel
- NO_x and SO_2 dissolve in rain: acid rain
- Soot (lungs), unburned hydrocarbons (smog)
- Catalytic converter: $2CO + 2NO \rightarrow 2CO_2 + N_2$

6 Alternative fuels

6B.14

- Why: crude oil is non-renewable; CO_2 causes climate change
- **Carbon neutral**: no net CO_2 added to the air
- Bioethanol: crop takes in $6CO_2$; fermentation 2 + burning 4 give it back
- Not fully neutral: fossil fuels for farming and distilling
- Biodiesel from vegetable oils: renewable, nearly carbon neutral

Free radical substitution: methane and chlorine

UV light; a dot marks the unpaired electron (Cl•, $\bullet CH_3$)

Stage	What happens	Equation
initiation	UV light breaks Cl–Cl (homolytic fission)	$Cl_2 \rightarrow 2Cl\bullet$
propagation 1	Cl• takes an H atom	$Cl\bullet + CH_4 \rightarrow HCl + \bullet CH_3$
propagation 2	$\bullet CH_3$ takes a Cl atom; Cl• is remade	$\bullet CH_3 + Cl_2 \rightarrow CH_3Cl + Cl\bullet$
termination	two radicals pair their electrons	$Cl\bullet + Cl\bullet \rightarrow Cl_2$; $\bullet CH_3 + Cl\bullet \rightarrow CH_3Cl$; $2\bullet CH_3 \rightarrow C_2H_6$
overall	Cl replaces H: substitution	$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
further substitution	the products are attacked too	$CH_3Cl \rightarrow CH_2Cl_2 \rightarrow CHCl_3 \rightarrow CCl_4$

Worked examples

Limited use in synthesis

- Further substitution: a mixture of products
- Larger alkanes: isomers (1- and 2-chloropropane)
- Must be separated; low yield of any one product
- Excess alkane: mostly the monosubstituted product

Balancing: a worked example

- Octane, complete: $C_8H_{18} + O_2 \rightarrow 8CO_2 + 9H_2O$
- O atoms: 16 + 9 = 25
- → **$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O$**
- To CO: $C_8H_{18} + 8½O_2 \rightarrow 8CO + 9H_2O$

Fuels compared

- **Petrol**: non-renewable; all its CO_2 is extra
- **Bioethanol**: renewable; nearly carbon neutral
- **Biodiesel**: renewable; needs farmland
- Always ask where the carbon came from

Ethane among the products of chlorinating methane is evidence for methyl radicals ($2\bullet CH_3 \rightarrow C_2H_6$).

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