# Alkanes Summary Map

Edexcel International A Level Chemistry · Unit 1 · Topic 4B

## 1 Crude oil

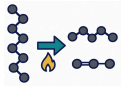
4.9, 4.12

- 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

4.12

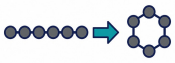
- Long chains → shorter alkanes + alkenes
- Why: more demand for petrol and for alkenes (polymers)
- **Catalytic**: zeolite catalyst, about 450 °C
- e.g. $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$
- Balance C and H: the alkene is $C_nH_{2n}$

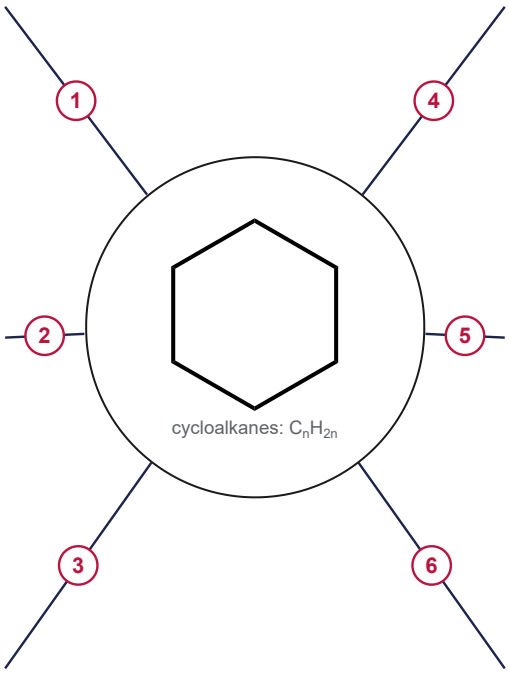


## 3 Reforming

4.12

- 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

4.17

- **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

4.13–4.14

- **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

4.15–4.16

- 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
- Hydrogen: water only; neutral only with renewable electricity

## Free radical substitution: methane and chlorine

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

| Stage | What happens | Equation |
|---|---|---|
| initiation | UV light breaks Cl–Cl (homolytic fission) | $Cl_2 \rightarrow 2Cl•$ |
| propagation 1 | Cl• takes an H atom | $Cl• + CH_4 \rightarrow HCl + •CH_3$ |
| propagation 2 | $•CH_3$ takes a Cl atom; Cl• is remade | $•CH_3 + Cl_2 \rightarrow CH_3Cl + Cl•$ |
| termination | two radicals pair their electrons | $Cl• + Cl• \rightarrow Cl_2$; $•CH_3 + Cl• \rightarrow CH_3Cl$; $2•CH_3 \rightarrow C_2H_6$ |
| 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
- **Hydrogen**: no $CO_2$ when burned; hard to store
- Always ask where the carbon or the energy came from

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

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