Alkanes Summary Map

OCR A Level Chemistry A · 4.1.2 Alkanes

1 σ-bonds 4.1.2(a)

- Every C–C and C–H bond is a **σ-bond**
- σ: orbitals overlap directly between the nuclei
- Overlap the same all round the bond axis
- **Free rotation** about a σ-bond
- Saturated: single bonds only



2 Shape 4.1.2(b)

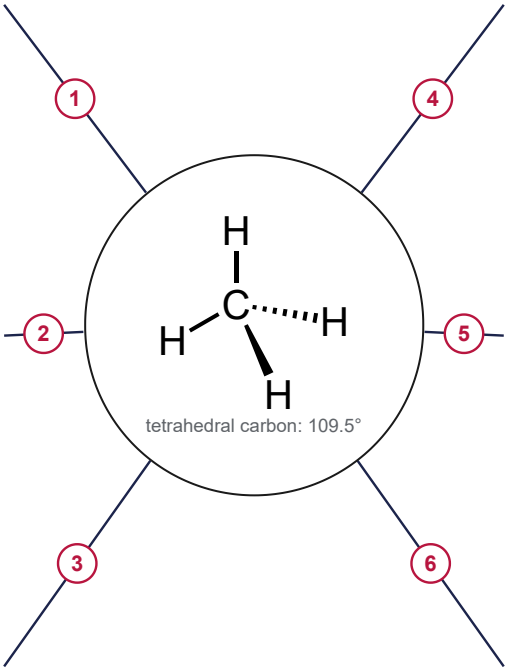
- Four bonding pairs around each carbon
- Electron pairs repel as far apart as possible
- **Tetrahedral**: bond angle **109.5°**
- Chains are zig-zags, not straight lines
- Cyclohexane rings are puckered, not flat



3 Boiling points 4.1.2(c)

- Between molecules: **London forces** (induced dipole–dipole)
- Longer chain: more electrons, more contact
- Stronger London forces: higher boiling point
- **Branching**: compact, less surface contact
- More branched isomers boil lower





4 Low reactivity 4.1.2(d)

- Alkanes react with few reagents
- C–C and C–H: **high bond enthalpy**
- σ-bonds of **very low polarity**
- No δ+ or δ− site for ions to attack
- They do burn, and react with halogens in UV light



5 Combustion 4.1.2(e)

- **Complete** (plenty of 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



6 Carbon monoxide 4.1.2(e)

- Made in a limited supply of oxygen
- **Toxic**: binds to haemoglobin more strongly than O_2
- Less oxygen carried round the body
- Colourless and odourless: cannot be noticed
- Detectors, servicing and ventilation reduce the risk



Radical substitution: methane and chlorine

UV light; a dot marks the unpaired electron (Cl•, •CH_3); bromine reacts in the same way

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	$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$
limitations	further substitution; different positions in a chain	a mixture: CH_2Cl_2, $CHCl_3$, CCl_4; 1- and 2-chloropropane

Worked examples

Combustion calculations

- n = m ÷ M; then the equation's ratio
- Gas at RTP: V = n × 24.0 $dm^3\ mol^{-1}$
- Gas volumes react in the mole ratio
- Water is a liquid at RTP: no gas volume

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: $C_8H_{18} + 8½O_2 \rightarrow 8CO + 9H_2O$

Why the mixture?

- CH_3Cl still has C–H bonds for Cl• to attack
- Excess methane favours CH_3Cl
- Propane: H on C1 or C2 can be replaced
- Poor for making one pure product

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

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