Topic 4: Organic chemistry

Edexcel International GCSE Chemistry 4CH1 · Section 4 · statements 4.1–4.50C · sheets 4.1–4.3

From crude oil to plastic

Your turn

Petrol, candle wax, vinegar, nail-varnish remover and a plastic bag are all carbon compounds.

A. Which of them are made from crude oil?

B. What do two members of the same family have in common?

C. Why does a plastic bag last for decades in a landfill?

Homologous series

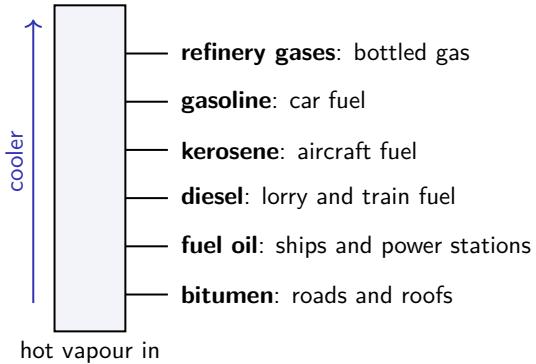
Series	**General formula**	**Functional group**	**First member**
alkanes	$\mathrm{C}_n\mathrm{H}_{2n+2}$	single bonds only	methane
alkenes	$\mathrm{C}_n\mathrm{H}_{2n}$	C=C	ethene
(C) alcohols	$\mathrm{C}_n\mathrm{H}_{2n+1}\mathrm{OH}$	–OH	methanol
(C) carboxylic acids	$\mathrm{C}_n\mathrm{H}_{2n+1}\mathrm{COOH}$	–COOH	methanoic acid
(C) esters		–COO–	**ethyl ethanoate**

Use the evidence

Isomers: same molecular formula, different structures (butane, methylpropane).

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Fractional distillation of crude oil



Down the column, boiling point and viscosity rise.

- Hot at the bottom, cool at the top.
- Small molecules with low boiling points rise highest.

Burning fuels and pollution

Pollutant	Source	Effect
carbon monoxide	**incomplete combustion**	poisonous; blood carries less oxygen
sulfur dioxide	sulfur impurities burning	acid rain
oxides of nitrogen	N_2 and O_2 combining in hot engines	acid rain

Use the evidence

Complete combustion gives only $CO_2 + H_2O$. Acid rain damages leaves, lakes and buildings.

Cracking

1. **Problem** The refinery makes more long-chain fractions than are wanted.
2. **Conditions** Heat the vapour over silica or alumina at 600–700 °C.
3. **Example** $C_{10}H_{22} \rightarrow C_8H_{18} + C_2H_4$
4. **Products** Petrol-sized alkanes, plus alkenes for polymers.

Decision

Cracking matches supply to demand.

Alkanes and alkenes compared

Alkanes, C_nH_{2n+2}

Saturated, single bonds only; fairly unreactive.

Substitution with halogens in UV light: $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$.

Bromine water stays orange.

Alkenes, C_nH_{2n}

Unsaturated, with a C=C double bond.

Addition across the double bond: $C_2H_4 + Br_2 \rightarrow C_2H_4Br_2$.

Bromine water turns from orange to colourless.

(C) Two ways to make ethanol

Ethene + steam

Phosphoric acid catalyst, about 300 °C, 60–70 atm.

Fast, continuous, pure product; ethene comes from crude oil.

Fermentation

Glucose with yeast, about 30 °C, no air.

30 °C suits the enzymes; without oxygen the yeast makes ethanol.

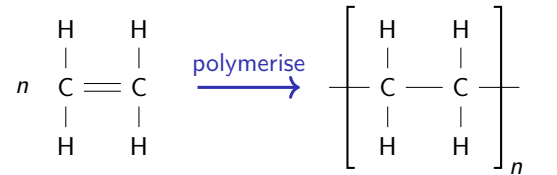
(C) Acids and esters

1. **Acid** Ethanoic acid (–COOH) fizzes with metals (H_2) and carbonates (CO_2).
2. **Mix** Ethanol + ethanoic acid with an acid catalyst.
3. **Join** The acid's –COOH links to the **alcohol**'s –O–, losing water.
4. **Product Ethyl ethanoate** (–COO–) + water.

Decision

Esters are volatile and sweet-smelling, used in flavourings and perfumes.

Addition polymers



Hard to dispose of: they do not biodegrade, and burning can release toxic gases.

- Open the C=C to join monomers.
- Close the two bonds to recover the **monomer**.

Polymers and the environment

Addition polymers

Resist chemical reactions and do not readily biodegrade.

Burning can release toxic gases.

(C) Condensation polymers

Dicarboxylic acid + diol $\rightarrow$ **polyester**, releasing water at each **ester** link.

Some biopolyesters biodegrade.

Check yourself

Your turn

Answer without notes, then check.

A. Name the six fractions of crude oil in boiling-point order.
B. Why is cracking necessary?
C. How does bromine water distinguish an alkene from an alkane?
D. (C) Which alcohol and acid make ethyl ethanoate?
E. (C) What monomers make a polyester, and what is released?