Chapter: 12 Organic Chemistry 1
Book/PDF: Chapter-12.pdf
Pages: 188–205
Exam level: Cambridge IGCSE (0610)

1) Big-picture overview (100–150 words)

This chapter introduces **organic chemistry**, the study of carbon compounds. It focuses on **hydrocarbons**, which are molecules made only of carbon and hydrogen. You'll learn about two key families, or **homologous series**: the **alkanes** and the **alkenes**. Alkanes are "saturated" with single bonds, making them quite unreactive, and are mainly used as fuels. Alkenes are "unsaturated" because they have a double bond, which makes them much more reactive. This reactivity allows them to undergo addition reactions to make other useful chemicals and, most importantly, to join together to form long chains called **polymers**. These polymers are the basis of plastics. The chapter concludes by looking at how plastics are made (polymerisation) and the serious environmental problems caused by their disposal.

2) Syllabus mapping

Outcome description	Where covered (page)
Define a homologous series.	188, 190
State the general formulae for alkanes and alkenes.	189, 194
Describe alkanes as saturated hydrocarbons.	188
Describe alkenes as unsaturated hydrocarbons.	194
Name and draw the displayed formulae for C1 to C4 alkanes and alkenes.	189, 195
Describe the properties of alkanes (combustion and substitution).	191
Describe the properties of alkenes (addition reactions).	196–197
Describe the manufacture of alkenes by cracking.	195

Outcome description	Where covered (page)
Distinguish between saturated and unsaturated hydrocarbons using aqueous bromine.	197
Define polymers, monomers, and (addition) polymerisation.	198
Deduce the structure of an addition polymer from its monomer, and vice versa.	198–200
Describe the environmental challenges of plastics.	201

3) Key terms and definitions

Term	One-sentence definition	First appears (page)	Example/application
Organic compounds	Compounds containing carbon atoms, often bonded to hydrogen and other elements.	188	Methane (CH_4), ethanol (C_2H_5OH).
Hydrocarbons	Compounds containing only hydrogen and carbon atoms.	188	Alkanes and alkenes are hydrocarbons.
Homologous series	A family of similar compounds with the same functional group and similar chemical properties.	188, 190	Alkanes, alkenes.
Displayed formula	A diagram that shows how all the atoms in a molecule are bonded, with individual lines for each bond.	188	The displayed formula for methane shows one C atom bonded to four H atoms.

Term	One-sentence definition	First appears (page)	Example/application
Saturated hydrocarbon	A hydrocarbon in which all the carbon-carbon bonds are single covalent bonds.	188	Ethane (C_2H_6).
General formula	An algebraic formula that represents all members of a homologous series.	189	Alkanes: C_nH_{2n+2}.
Functional group	An atom or group of atoms that determine the chemical properties of a homologous series.	189, 190	The $C=C$ double bond is the functional group of alkenes.
Structural isomers	Compounds with the same molecular formula but different structural formulae.	191	Butane and 2-methylpropane both have the formula C_4H_{10}.
Structural formula	An unambiguous description of the way atoms are arranged in a molecule.	191	Butane: $CH_3CH_2CH_2CH_3$.
Substitution reaction	A reaction where one atom or group of atoms is replaced by another.	192	Methane reacting with chlorine to form chloromethane.
Unsaturated hydrocarbon	A hydrocarbon containing at least one carbon-carbon double or triple bond.	194	Ethene (C_2H_4).

Term	One-sentence definition	First appears (page)	Example/application
Cracking	The process of breaking down large alkane molecules into smaller, more useful alkanes and alkenes.	195	Dodecane (C_12H_26) cracking to form octane (C_8H_18) and butene (C_4H_8).
Addition reaction	A reaction in which atoms are added across a double bond, forming a single product.	196	Ethene reacting with hydrogen to form ethane.
Polymers	Large molecules (macromolecules) built up from many small repeating units called monomers.	198	Poly(ethene).
Monomers	Small molecules that join together to form a polymer.	198	Ethene is the monomer for poly(ethene).
Polymerisation	The process where small monomer molecules join together to form a long polymer chain.	198	The formation of poly(ethene) from ethene.
Addition polymerisation	Polymerisation where monomer units add to each other in such a way that the polymer is the only product formed.	198	The formation of poly(propene) from propene.

4) Core concepts explained

Alkanes (p. 188)

- Alkanes are a **homologous series** of **saturated hydrocarbons** (p. 188). This means they only contain carbon-carbon **single covalent bonds**.
- Their names end in **-ane** (e.g., methane, ethane) (p. 190).
- The general formula for alkanes is $C_nH_2n + 2$ (p. 189).
- As the number of carbon atoms increases, the boiling points increase due to stronger intermolecular forces (p. 189). The first four alkanes (methane to butane) are gases at room temperature (p. 190).
- Alkanes are generally **unreactive** but undergo two important reactions: **combustion** and **substitution** (p. 191).

Chemical Reactions of Alkanes (p. 191)

- **Combustion:** Alkanes burn easily in a good supply of air (oxygen) to produce carbon dioxide, water, and heat energy. This makes them excellent fuels (p. 191).
  - *Word equation:* methane + oxygen → carbon dioxide + water (p. 191)
  - *Balanced equation:* $CH_4(g) + 2O_2(g) rightarrow CO_2(g) + 2H_2O(g)$ (p. 191)
- **Substitution:** Alkanes react with halogens (like chlorine) in the presence of ultraviolet (UV) light. One hydrogen atom is replaced by a halogen atom (p. 192). This is called a photochemical reaction.
  - *Word equation:* methane + chlorine → chloromethane + hydrogen chloride (p. 192)
  - *Balanced equation:* $CH_4(g) + Cl_2(g) rightarrow CH_3Cl(g) + HCl(g)$ (p. 192)

Alkenes (p. 194)

- Alkenes are a **homologous series** of **unsaturated hydrocarbons** (p. 194).
- They are unsaturated because their molecules contain at least one **carbon-carbon double covalent bond** ($C = C$) (p. 194). This double bond is their **functional group**.
- Their names end in **-ene** (e.g., ethene, propene) (p. 194).
- The general formula for alkenes is C_nH_2n (p. 194).
- The double bond makes alkenes **more reactive** than alkanes (p. 194, 196).

Comparison: Alkanes vs. Alkenes

Feature	Alkanes	Alkenes	Exam Note
Bonding	C-C single bonds only	At least one C=C double bond	Saturated vs. Unsaturated is a key distinction.
General Formula	$C_nH_2n + 2$	C_nH_2n	Memorise these formulae.
Reactivity	Generally unreactive	Reactive	Due to the C=C double bond.
Main Reaction Type	Combustion, Substitution	Addition	Addition reactions break the double bond.
Test with Bromine Water	No reaction, colour remains brown/orange	Decolourises bromine water	This is the standard test for unsaturation.

Chemical Reactions of Alkenes (Addition Reactions) (p. 196)

- In an **addition reaction**, the carbon-carbon double bond breaks, and atoms are added to the molecule. Only **one product** is formed (p. 196).
- **Hydrogenation:** Addition of hydrogen (H_2) across the double bond to form an alkane. Requires a nickel catalyst and $200^{circ}C$ (p. 196).
  - $C_2H_4(g) + H_2(g)$ $rightarrowC_2H_6(g)$ (ethene → ethane) (p. 196)
- **Hydration:** Addition of steam (H_2O) across the double bond to form an alcohol. Requires a phosphoric(V) acid catalyst, $300^{circ}C$, and 6000 kPa pressure (p. 196–197).
  - $C_2H_4(g) + H_2O(g)$ $rightleftharpoonsC_2H_5OH(g)$ (ethene → ethanol) (p. 197)
- **Halogenation:** Addition of a halogen (e.g., bromine, Br_2). This reaction happens at room temperature and is used to test for unsaturation (p. 197).
  - $C_2H_4(g) + Br_2(aq)$ $rightarrowC_2H_4Br_2(aq)$ (ethene → dibromoethane) (p. 197)

Polymers (p. 198)

- **Polymers** are very large molecules made from many small repeating units called **monomers** (p. 198).

- **Addition polymerisation** is the process where alkene monomers join together. The double bond in each monomer breaks, allowing them to link up into a long chain (p. 198).
- The polymer is the only product. The name of the polymer is formed by putting 'poly' in front of the monomer name, e.g., ethene polymerises to form poly(ethene) (p. 198).
- A **repeat unit** is the part of the polymer chain that comes from one monomer molecule. It is shown in square brackets with 'n' outside to represent a large number (p. 198).

Environmental challenges of plastics (p. 201)

- Plastics are useful because they are light, cheap, and unreactive. However, this unreactivity means they are **non-biodegradable** and difficult to dispose of (p. 201).
- **Landfill:** Takes up space and can release greenhouse gases like methane as they very slowly break down (p. 201).
- **Incineration (Burning):** Can release energy for heating, but may also produce **toxic gases** if not burned at very high temperatures (p. 201).
- **Ocean Accumulation:** Non-biodegradable plastics build up in oceans, harming and killing aquatic life (p. 201).
- **Solutions** include recycling, and developing biodegradable or photodegradable plastics, but these are not yet widespread (p. 201).

5) Diagrams and micrographs (figures)

- **Displayed formulae of alkanes (Figure 12.2, p. 189):** Shows the structures of methane (CH_4), ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}). To redraw, remember that each carbon atom must form 4 covalent bonds and each hydrogen atom must form 1.
- **Covalent bonding in methane (Figure 12.3, p. 189):** A 'dot and cross' diagram showing one carbon atom sharing one pair of electrons with each of four hydrogen atoms.
- **Apparatus for cracking an alkane (Figure 12.12, p. 196):**
  - **What it shows:** Laboratory setup for thermal cracking of a long-chain alkane (like paraffin) into smaller molecules.
  - **Labels:**
    - **Boiling tube (horizontal):** Contains paraffin soaked into absorbent wool at one end and a catalyst (broken porcelain or aluminium oxide) in the middle.
    - **Bunsen burner (heating):** One heats the wool gently ('Warm') to vaporise the paraffin, another heats the catalyst strongly ('Strong heat').
    - **Delivery tube:** Leads from the boiling tube to a test tube in a cold water bath.

    - **Test tube in cold water bath:** To condense any liquid products.
    - **Second delivery tube:** Leads from the first test tube to an inverted test tube/measuring cylinder in a crystallising dish of water to collect the gaseous products (alkenes).
- **Addition of hydrogen to ethene (Figure 12.13, p. 196):** Uses molecular models to show an ethene molecule (C_2H_4) and a hydrogen molecule (H_2) reacting to form one ethane molecule (C_2H_6).
- **Formation of poly(ethene) (Figure 12.17, p. 199):** Shows how the double bond in an ethene monomer breaks, allowing it to form single bonds with other monomers, creating a long saturated polymer chain. The diagram illustrates how to derive the 'repeat unit' from the monomer.

6) Processes and cycles

Catalytic Cracking (p. 195)

- **Aim:** To break down large, less useful alkane molecules into smaller, more useful alkanes and alkenes, which are in higher demand (p. 195).
- **Inputs → Outputs:**
    - **Input:** A large alkane molecule (e.g., from the kerosene or fuel oil fraction).
    - **Outputs:** A smaller alkane molecule + one or more alkene molecules (+ possibly hydrogen).
- **Conditions:** High temperature (e.g., $550^{circ}C$) and a catalyst (e.g., aluminium oxide and chromium oxide) (p. 195).
- **Example Word Equation:** Not explicitly given.
- **Example Balanced Equation:**
    - $C_12H_26(g)$ $rightarrowC_8H_18(g) + C_4H_8(g)$ (dodecane → octane + butene) (p. 195)
    - $C_10H_22(g)$ $rightarrowC_8H_18(g) + C_2H_4(g)$ (decane → octane + ethene) - *Note: The text has a typo in this equation (C_10H_22 should crack to a C_8 alkane and ethene, not be a product). A correct version would be: C_10H_22 $rightarrowC_8H_18 + C_2H_4$.*

Addition Polymerisation of Ethene (p. 198)

- **Aim:** To produce the polymer poly(ethene) from the monomer ethene.
- **Step-by-step sequence:**

i. A large number ('n') of ethene monomers are subjected to high temperature and high pressure with a catalyst.
ii. The double bond ($C = C$) in each ethene molecule breaks open.
iii. The monomers link together via new single covalent bonds to form a very long saturated chain, the poly(ethene) polymer.

- **Inputs → Outputs:**
  - **Input:** Ethene monomers ($CH_2 = CH_2$).
  - **Output:** Poly(ethene) polymer ($-[CH_2 - CH_2]_n-$).
- **Conditions:** High temperature, high pressure, catalyst (p. 198).

7) Formulae and calculations

Quantity	Formula	Units	Typical values	Worked example
General Formula of Alkanes	C_nH_{2n+2}	n/a	n = 1, 2, 3...	**Q:** What is the molecular formula for an alkane with 6 carbon atoms? **A:** n = 6. H = (2 × 6) + 2 = 14. Formula is C_6H_{14} (Hexane) (p. 190).
General Formula of Alkenes	C_nH_{2n}	n/a	n = 2, 3, 4...	**Q:** What is the molecular formula for an alkene with 4 carbon atoms? **A:** n = 4. H = 2 × 4 = 8. Formula is C_4H_8 (Butene) (p. 194).

8) Required practicals / experiments

Test to distinguish between an Alkane and an Alkene (p. 197)

- **Aim:** To use aqueous bromine to identify which of two hydrocarbons is saturated (alkane) and which is unsaturated (alkene).
- **Apparatus:** Test tubes, dropping pipette, stoppers.
- **Method:**
  i. Place a small amount of the first hydrocarbon (e.g., hexane) into a test tube.
  ii. Place the same amount of the second hydrocarbon (e.g., hexene) into another test tube.

iii. Using a dropping pipette, add a few drops of aqueous bromine (which is orange/brown) to each test tube (p. 197, 495).
iv. Stopper the test tubes and shake them (p. 496).
v. Observe any colour change.

- **Variables:**
  - **IV:** Type of hydrocarbon (alkane vs. alkene).
  - **DV:** Colour change of the bromine water.
  - **Controls:** Volume of hydrocarbon, volume of bromine water added, temperature.
- **Safety:** Wear eye protection. Hydrocarbons are flammable. Bromine is toxic and corrosive (p. 493).
- **Expected results:**
  - **Alkane (Hexane):** No reaction. The mixture remains orange/brown (p. 197).
  - **Alkene (Hexene):** An addition reaction occurs. The orange/brown bromine water will be decolourised and turn colourless (p. 197).

9) Data handling and graphing

- **Tables of Homologous Series:** Table 12.1 (p. 190) and Table 12.2 (p. 194) show data for alkanes and alkenes.
  - **Columns:** Name, Molecular Formula, Melting Point, Boiling Point, State at Room Temp.
  - **Trend to look for:** As the number of carbon atoms (and thus molecular mass) increases down the series, the boiling point generally increases (p. 189). This is because the intermolecular forces of attraction between molecules get stronger.
  - **Typical exam prompts:** "Estimate the boiling point of the next member of the series (e.g., heptane)." You would do this by observing the trend/difference between previous members (p. 190, Q1).
- **Tables of Petroleum Fractions:** Table 12.3 (p. 196) compares the percentage of fractions available in petroleum versus the percentage demanded by industry.
  - **Trend to look for:** There is a surplus of large-molecule fractions (like fuel oil) and a higher demand for smaller-molecule fractions (like gasoline).
  - **Typical exam prompts:** "Explain why cracking is economically important." The answer is that it converts the surplus large molecules into the more in-demand smaller molecules (p. 195).

10) Common misconceptions and exam tips

- **Misconception:** "Saturated" means a substance has dissolved as much as it can.
  - **Correct understanding:** In organic chemistry, **saturated** means a hydrocarbon has only C-C single bonds and can't add any more atoms to its carbon chain (p. 188). **Unsaturated** means it has C=C double bonds and *can* add more atoms via an addition reaction (p. 194).
  - **Quick tip:** Saturated = Single bonds.
- **Misconception:** In polymerisation, the monomer molecules themselves are the 'links' in the chain.
  - **Correct understanding:** The **double bond** in each monomer breaks open to form new single bonds that link the monomer units together. The polymer backbone is a chain of single-bonded carbon atoms (p. 198).
  - **Quick tip:** When drawing a polymer repeat unit, always change the C=C to a C-C and draw 'extension' bonds out of the sides of the square brackets.
- **Misconception:** Alkanes react with bromine.
  - **Correct understanding:** Alkanes only react with bromine (and other halogens) under specific conditions (UV light). They do **not** react with aqueous bromine in a test tube at room temperature (p. 197). This lack of reaction is the basis of the test for saturation.
  - **Quick tip:** Alk**a**ne = No reaction. Alk**e**ne = Decolourises bromine.

11) Exam-style practice

Multiple Choice Questions (MCQs)

1. Which of the following is the general formula for the alkanes?
   A) C_nH_n
   B) C_nH_2n
   C) $C\_nH\_2n + 1$
   D) $C\_nH\_2n + 2$
   (Answer: D. This is the definition for an alkane homologous series (p. 189).)
2. A hydrocarbon decolourises aqueous bromine. What can you deduce about the hydrocarbon?
   A) It is an alkane.
   B) It is saturated.
   C) It contains C=C double bonds.
   D) It is a polymer.
   (Answer: C. The decolourisation of bromine water is the test for an unsaturated hydrocarbon, which contains C=C double bonds (p. 197).)

3. What is the name of the process that breaks down large hydrocarbons into smaller ones?
   A) Polymerisation
   B) Cracking
   C) Combustion
   D) Substitution
   (Answer: B. Cracking uses heat and a catalyst to break large alkanes into smaller alkanes and alkenes (p. 195).)
4. Which substance is formed by the addition polymerisation of ethene?
   A) Ethanol
   B) Ethane
   C) Poly(ethene)
   D) Propene
   (Answer: C. The monomer ethene joins to form the polymer poly(ethene) (p. 198).)
5. Which reaction type is characteristic of alkanes?
   A) Addition
   B) Neutralisation
   C) Polymerisation
   D) Substitution
   (Answer: D. Alkanes undergo substitution reactions with halogens in the presence of UV light (p. 192).)
6. Which term describes molecules with the same molecular formula but different structural formulae?
   A) Homologues
   B) Monomers
   C) Polymers
   D) Structural Isomers
   (Answer: D. This is the definition of structural isomers (p. 191).)
7. Which conditions are required for the hydration of ethene to ethanol?
   A) Nickel catalyst, 200°C
   B) UV light
   C) Phosphoric(V) acid catalyst, 300°C, high pressure
   D) Room temperature, no catalyst
   (Answer: C. These are the specific conditions for adding steam to ethene to manufacture ethanol (p. 196-197).)
8. Which of these is a major environmental problem caused by the disposal of plastics?
   A) They are biodegradable and decompose too quickly.
   B) They release oxygen when they break down.
   C) They are non-biodegradable and accumulate in oceans.

D) They are made from renewable resources.

(Answer: C. Plastics persist in the environment for a very long time, causing pollution and harming wildlife (p. 201).)

9. What are the products of the complete combustion of propane (C_3H_8)?

   A) Carbon and water

   B) Carbon monoxide and water

   C) Carbon dioxide and hydrogen

   D) Carbon dioxide and water

   (Answer: D. Complete combustion of any hydrocarbon produces carbon dioxide and water (p. 191).)

10. Which molecule is a member of the alkene homologous series?

    A) C_2H_6

    B) C_3H_8

    C) C_4H_8

    D) C_5H_{12}

    *(Answer: C. Alkenes follow the general formula C_nH_{2n}. For C4, H = 2*4 = 8 (p. 194).)*

Short-Answer Questions

1. **Define** the term *homologous series*.
   - **Answer:** A family of similar compounds [1] with the same functional group and similar chemical properties [1].
2. **Draw** the displayed formula for propene (C_3H_6).
   - **Answer:** *Correct structure showing a C=C bond between two carbons and a C-C single bond [1]. All carbons have 4 bonds and all hydrogens have 1 bond [1].*

```
   H   H
   |   |
H–C – C = C–H
   |       |
   H       H
```

3. **Write** a balanced chemical equation for the reaction between ethene and hydrogen. **Name** the product.
   - **Answer:** $C_2H_4 + H_2$ $rightarrow C_2H_6$ [1]. The product is ethane [1].
4. **Describe** how you would dispose of waste plastic in a way that generates useful energy. **State** one problem with this method.

- **Answer:** The plastic can be burned / incinerated [1]. The heat generated can be used for heating or generating electricity [1]. A problem is that burning can produce toxic gases [1] (p. 201).

5. **Explain** why alkanes are described as saturated but alkenes are described as unsaturated.
   - **Answer:** Alkanes are saturated because their molecules contain only carbon-carbon single bonds [1]. Alkenes are unsaturated because their molecules contain at least one carbon-carbon double bond [1] (p. 188, 194).

Structured Questions

1. Butane has the molecular formula C_4H_{10}.

   a) **State** the general formula for the homologous series to which butane belongs. [1]

   b) Butane has two structural isomers. **Draw** the displayed formula for both isomers. [4]

   c) Butane undergoes complete combustion. **Write** a word equation for this reaction. [2]

   Model Answer:

   a) **State**: C_nH_{2n+2} [1] (p. 189).

   b) **Draw**:

   * Isomer 1 (butane): A straight chain of 4 carbon atoms, each saturated with hydrogen atoms.

   ```
    H   H   H   H |   |   |   | H–C – C – C – C–H |   |   |   | H   H   H   H
   ```

   [Correct C-C backbone [1], correct number of H atoms [1]]

   * Isomer 2 (2-methylpropane): A chain of 3 carbon atoms with a CH_3 branch on the central carbon, all saturated with hydrogen atoms.

   ```
    H | H–C–H H   |   H |   |   | H–C – C – C–H |   |   | H   H   H
   ```

   [Correct branched C-C backbone [1], correct number of H atoms [1]]

   c) **Write**: Butane + Oxygen → Carbon dioxide + Water [2] (*1 mark for correct reactants, 1 mark for correct products*) (p. 191).

2. Ethene (C_2H_4) is produced by cracking. It is a monomer used to make a common polymer.

   a) **Describe** the process of cracking, stating the necessary conditions. [3]

   b) **Describe** a chemical test to show that a gas is ethene and not ethane. **State** the expected observation. [3]

   c) The polymerisation of ethene is an example of addition polymerisation.

   i. **Draw** the repeat unit of the polymer formed from ethene. [2]

   ii. **State** the name of the polymer. [1]

   Model Answer:

   a) **Describe**: Cracking is the process of breaking large alkane molecules [1] into smaller alkanes and alkenes [1]. It requires a high temperature (e.g., $550^{circ}C$) and a catalyst (e.g., aluminium oxide) [1] (p. 195).

   b) **Describe**: Bubble the gas through aqueous bromine / bromine water [1]. **State**: With ethene,

the bromine water will turn from orange/brown to colourless [1]. With ethane, there will be no change [1] (p. 197).

c) **Draw**:

i. `H  H |  | –[C – C]– |  | H  H  n`

[Correct C-C single bond backbone with side bonds [1], correct atoms and brackets with 'n' [1]] (p. 198)

ii. **State**: Poly(ethene) [1] (p. 198).

12) Quick revision checklist

- ☐ I can define a homologous series, and give alkanes and alkenes as examples.
- ☐ I know the general formula for alkanes ($C\_nH\_2n + 2$) and alkenes (C_nH_2n).
- ☐ I can explain the difference between saturated (single C-C bonds) and unsaturated (at least one C=C bond).
- ☐ I can name and draw the displayed formulae for methane, ethane, propane, butane, ethene, propene, and butene.
- ☐ I can describe the complete combustion of alkanes to form CO_2 and H_2O.
- ☐ I can describe the substitution reaction of an alkane with chlorine (requires UV light).
- ☐ I can describe the cracking of large alkanes to make smaller alkanes and alkenes.
- ☐ I can describe the addition reactions of alkenes with bromine, hydrogen, and steam.
- ☐ I can describe the test to distinguish between an alkane and an alkene using bromine water.
- ☐ I can define monomer, polymer, and addition polymerisation.
- ☐ I can draw the repeat unit of poly(ethene).
- ☐ I can explain the environmental problems caused by non-biodegradable plastics (landfill, ocean pollution, toxic fumes on burning).

13) Flashcards (ready-to-use)

Q1: What is a hydrocarbon?

A1: A compound containing only carbon and hydrogen atoms (p. 188).

Q2: What is the general formula for alkanes?

A2: $C\_nH\_2n + 2$ (p. 189).

Q3: Are alkanes saturated or unsaturated? Why?
A3: Saturated, because they only have carbon-carbon single bonds (p. 188).

Q4: What are the products of the complete combustion of methane?
A4: Carbon dioxide and water (p. 191).

Q5: What condition is needed for methane to react with chlorine?
A5: Ultraviolet (UV) light (p. 192).

Q6: What is this type of reaction called? (Methane + Chlorine)
A6: A substitution reaction (p. 192).

Q7: What is the general formula for alkenes?
A7: C_nH_2n (p. 194).

Q8: Are alkenes saturated or unsaturated? Why?
A8: Unsaturated, because they have at least one carbon-carbon double bond (p. 194).

Q9: What is the functional group of the alkenes?
A9: The $C = C$ double bond (p. 194).

Q10: What is cracking?
A10: Breaking down large alkanes into smaller, more useful alkanes and alkenes using heat and a catalyst (p. 195).

Q11: What is an addition reaction?
A11: A reaction where atoms are added across a double bond to form a single product (p. 196).

Q12: How can you test for an alkene?
A12: Add aqueous bromine. An alkene will decolourise it from brown/orange to colourless (p. 197).

Q13: What is a monomer?
A13: A small molecule that can be joined together to make a polymer (p. 198).

Q14: What is a polymer?
A14: A large molecule made from many repeating monomer units (p. 198).

Q15: What is addition polymerisation?
A15: The process where alkene monomers join together by breaking their double bonds to form a long polymer chain, with no other product formed (p. 198).

Q16: Name two environmental problems caused by plastic waste.
A16: 1. Accumulation in landfill/oceans because it is non-biodegradable. 2. Production of toxic gases when burned (p. 201).

Q17: What are structural isomers?
A17: Compounds with the same molecular formula but a different arrangement of atoms (structural formula) (p. 191).

Q18: What alcohol is made from the hydration of ethene?
A18: Ethanol (p. 196).

Q19: What alkane is made from the hydrogenation of ethene?
A19: Ethane (p. 196).

Q20: Draw the displayed formula of ethene.
A20: $H_2C=CH_2$ (with all bonds shown) (p. 195).

14) 60-second recap

This chapter covers hydrocarbons, which are compounds of only carbon and hydrogen. The **alkanes** are a **saturated** homologous series with general formula C_nH_{2n+2}. They have single bonds, are unreactive, and are used as fuels (combustion). The **alkenes** are **unsaturated** (C_nH_{2n}) because they have a reactive C=C double bond. This allows them to undergo **addition reactions**. We test for alkenes with bromine water, which they decolourise. We make alkenes by **cracking** large alkanes. The most important reaction of alkenes is **addition polymerisation**, where many **monomers** (like ethene) join to form a **polymer** (like poly(ethene)), which is a plastic. These plastics are non-biodegradable, causing major environmental problems like landfill and ocean pollution.

15) References to pages

- **Alkanes:** 188, 189, 190, 191
- **Alkenes:** 194, 195
- **Addition Polymerisation:** 198
- **Addition Reactions:** 196, 197
- **Combustion:** 191
- **Cracking:** 195, 196

- **Definitions (Key Terms):** 188, 190, 191, 192, 194, 198
- **Displayed Formula:** 188, 189, 195
- **Environmental Issues (Plastics):** 201
- **Formulae (General):** 189, 194
- **Homologous Series:** 188, 190
- **Isomers (Structural):** 190, 191
- **Polymers & Monomers:** 198
- **Practical (Test for Unsaturation):** 197, 198
- **Substitution Reactions:** 192

16) Excluded "Going further" sections (not summarized)

Section title	Pages
Pentane and Hexane diagrams	189
Structural isomerism (extended explanation)	190
Information on Chloromethane, anaesthetics, CFCs, and the ozone layer	192, 193
Isomers of C_5H_{10}	195
Other addition polymers (PVC, PTFE details)	199, 200

Total excluded: 5