

11.5 Alkenes

Name: _____ Class: _____ Date: _____

Total: 28 marks

KEY WORDS bromine 溴 • saturated 饱和的 • unsaturated 不饱和的 • nickel 镍
• catalyst 催化剂

Objective

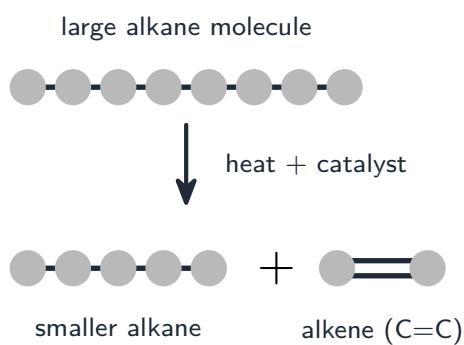
Build the skills to answer exam questions on **alkenes** 烯烃 — unsaturated hydrocarbons, **cracking** 裂化, **addition reactions** 加成反应, and the **bromine water test** 溴水检验.

You must be able to:

- describe alkenes as unsaturated ($C=C$) and reactive
- describe cracking and its products
- describe addition reactions and the test for unsaturation

1 Worked examples

■ Cracking & the bromine water test



Cracking breaks large alkanes into smaller alkanes + alkenes (heat + catalyst)

shake with orange bromine water



Test for unsaturation: an alkene turns orange bromine water colourless; an alkane does not

- H_2 (Ni) $\rightarrow$ alkane; + steam (acid catalyst) $\rightarrow$ alcohol.

■ Cracking, addition, and the test that tells them apart

Cracking 裂化 breaks a long-chain alkane into a shorter alkane plus an **alkene** 烯烃, using heat (about 600–700 °C) and a catalyst. It is done because the long fractions from crude oil are in surplus while the short ones — petrol, and the alkenes needed to make polymers — are in demand. Every cracking equation must balance:



Count the carbons and hydrogens on each side: $10 = 8 + 2$ and $22 = 18 + 4$. An unbalanced equation loses the mark even when the products are right.

Why alkenes react and alkanes do not. An alkane is **saturated** 饱和的 — all single bonds — so it can only substitute. An alkene is **unsaturated** 不饱和的: its $\text{C} = \text{C}$ double bond can open, and a molecule **adds across** it without anything being lost.

Reagent	Conditions	Product
bromine, Br_2	room temperature	1,2-dibromoethane — orange bromine water is decolourised
hydrogen, H_2	nickel catalyst, ~150 °C	the alkane, ethane
steam, H_2O	phosphoric acid catalyst, high pressure	the alcohol, ethanol

The test for unsaturation is the bromine-water one: shake the sample with orange aqueous bromine. An **alkene decolourises it**; an alkane leaves it orange. State the colour BOTH before and after — “it goes colourless” without the starting colour is only half the mark.

Worked example. Explain why $C_{12}H_{26}$ is cracked, and write one possible equation. It is cracked because a 12-carbon molecule is a poor fuel and is in surplus, while shorter molecules and alkenes are in demand. One possibility: $C_{12}H_{26} \rightarrow C_{10}H_{22} + C_2H_4$, which balances at 12 carbons and 26 hydrogens.

2 Practice

2.1 State the functional group in an alkene. [1]

2.2 State what cracking does. [1]

2.3 Write a balanced equation for cracking $C_{14}H_{30}$ to give octane, C_8H_{18} , and one alkene. [2]

2.4 State the reagent and the catalyst used to convert ethene into ethanol. [2]

2.5 Explain, in terms of bonding, why ethene decolourises bromine water but ethane does not. [2]

3 Exam-style questions

3.1 When ethene is shaken with bromine water, the bromine water: [1]

A	B
C	D

A stays orange

B turns colourless

C turns blue

D turns purple

3.2 Cracking breaks decane ($\text{C}_{10}\text{H}_{22}$) into octane (C_8H_{18}) and one other product.

(a) Name the type of compound formed as the other product. [1]

(b) Give the molecular formula of the other product. [1]

3.3 Describe how you could use bromine water to tell an alkene from an alkane. [2]

3.4 A refinery cracks decane, $\text{C}_{10}\text{H}_{22}$.

(a) State two conditions used for cracking. [2]

(b) Explain why a refinery cracks long-chain alkanes. [2]

(c) Decane is cracked to give one molecule of octane and one other product. Write the balanced equation and name the second product. [3]

(d) Describe a test that would distinguish the second product from octane, giving the result for each. [3]

(e) The alkene product is reacted with steam. Name the product, state the catalyst, and give the type of reaction. [3]

(f) Explain why the alkene can take part in addition reactions but octane cannot. [2]
