

Alkenes: double bonds and addition reactions

Chemistry grades 11-12 (A Level · IB · Class 11-12) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test lasts 45 minutes and is worth 20 points. It covers the structure of alkenes, electrophilic addition and Markovnikov's rule, yield calculations and addition polymers. Show every step of the calculations and write balanced equations.

Level: Chemistry grades 11-12 (A Level · IB · Class 11-12) · **Curriculum:** A Level 3.3.4

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Bonding in propene (2 marks)

Propene is $\text{CH}_3\text{CH}=\text{CH}_2$.

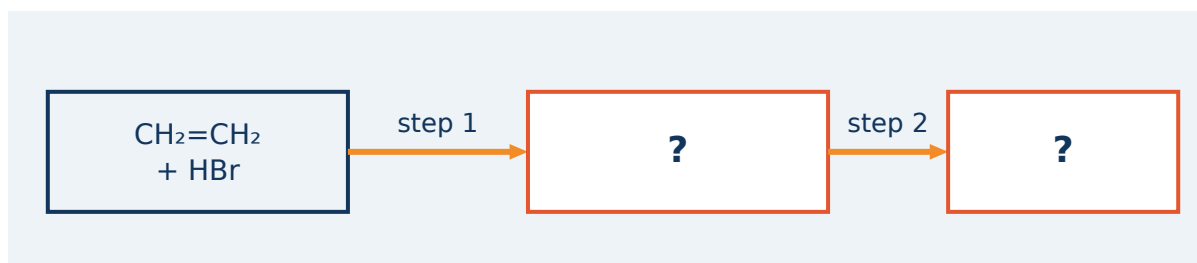
- State the number of σ bonds and π bonds in one molecule. (1 mark)
- State the $\text{H}-\text{C}=\text{C}$ bond angle at the double bond. (1 mark)

Question 2 Test for a double bond (2 marks)

- Describe the test that shows a liquid is an alkene and state the positive result. (1 mark)
- Write the equation for ethene with bromine. (1 mark)

Question 3 Mechanism of addition (3 marks)

Ethene reacts with hydrogen bromide.



Mechanism for part (a) of the question: the intermediate and the product are missing.

- Name the type of mechanism. (1 mark)
- Give the formulae of the intermediate and the product in the empty boxes. (2 marks)

Question 4 Markovnikov product (3 marks)

But-1-ene reacts with HBr.

- Name the major product. (1 mark)
- Explain, using carbocations, why it is the major product. (2 marks)

Question 5 Industrial hydration (2 marks)

Ethanol is made by passing ethene and steam over a catalyst.

- Name the catalyst and give the temperature used. (1 mark)
- Explain why a pressure far above 65 atm is not used. (1 mark)

Question 6 Yield of 2-bromobutane (3 marks)

5.60 g of but-1-ene ($M = 56.0 \text{ g/mol}$) gives 10.2 g of 2-bromobutane ($M = 136.9 \text{ g/mol}$).

- Calculate the theoretical yield. (2 marks)
- Calculate the percentage yield. (1 mark)

Question 7 Polymer from but-1-ene (2 marks)

But-1-ene, $\text{CH}_2=\text{CHCH}_2\text{CH}_3$, forms an addition polymer.

- Draw (write) the repeat unit. (1 mark)
- Explain why the polymer is unreactive. (1 mark)

Question 8 Why bromine adds (3 marks)

Bromine is a non-polar molecule yet it adds to ethene at room temperature.

- Explain how the molecule becomes able to react. (2 marks)
- Name the product. (1 mark)