

CHAPTER 13 HALOGENOALKANES

1 Haloalkanes are used in the synthesis of other organic compounds.

(a) Hot concentrated ethanolic potassium hydroxide reacts with 2-bromo-3-methylbutane to form two alkenes that are structural isomers of each other. The major product is 2-methylbut-2-ene.

(i) Name and outline a mechanism for the conversion of 2-bromo-3-methylbutane into 2-methylbut-2-ene according to the equation.



Name of mechanism

Mechanism

(4 marks)

(ii) Draw the **displayed formula** for the other isomer that is formed.

(1 mark)

(iii) State the type of structural isomerism shown by these two alkenes.

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 (1 mark)

- (b) A small amount of another organic compound, **X**, can be detected in the reaction mixture formed when hot concentrated ethanolic potassium hydroxide reacts with 2-bromo-3-methylbutane.

Compound **X** has the molecular formula $C_5H_{12}O$ and is a secondary alcohol.

- (i) Draw the **displayed formula** for **X**.

(1 mark)

- (ii) Suggest **one** change to the reaction conditions that would increase the yield of **X**.

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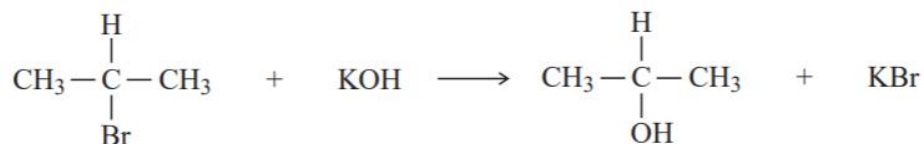
(1 mark)

- (iii) State the type of mechanism for the conversion of 2-bromo-3-methylbutane into **X**.

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(1 mark)

- 2 (a) Consider the following reaction.



- (i) Name and outline a mechanism for this reaction.

Name of mechanism

Mechanism

(3 marks)

(ii) Name the haloalkane in this reaction.

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(1 mark)

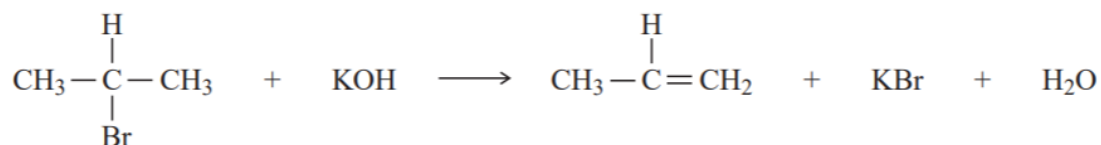
(iii) Identify the characteristic of the haloalkane molecule that enables it to undergo this type of reaction.

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(1 mark)

(iv) A student predicted that the yield of this reaction would be 90%. In an experiment 10.0 g of the halogenoalkane was used and 4.60 g of the organic product was obtained. Is the student correct? Justify your answer with a calculation using these data.

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(1 mark)

(b) An alternative reaction can occur between this haloalkane and potassium hydroxide as shown by the following equation.



Name and outline a mechanism for this reaction.

Name of mechanism

Mechanism

(4 marks)

- (c) Give **one** condition needed to favour the reaction shown in part (b) rather than that shown in part (a).

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(1 mark)

- 3 (a) Write a balanced symbol equation for the reaction of $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$ with aqueous hydroxide ions.

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(2 marks)

- (b) Name the starting material and the product.

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(2 marks)

- (c) Give the formula of the leaving group in this reaction.

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(1 mark)

- (d) Classify the reaction as substitution, elimination or addition.

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(1 mark)

- (e) The hydroxide ion acts as a nucleophile in this reaction. State two features of the hydroxide ion that allow it to act as a nucleophile.

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(2 marks)

- (f) Draw the mechanism of the reaction using 'curly arrows' to show the movement of electron pairs.

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(2 marks)

(g) How would you expect the rate of a similar reaction with $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$ to compare with that of $\text{CH}_3\text{CH}_2\text{CH}_2\text{Br}$? Explain your answer.

(2 marks)

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(h) Water molecules can act as nucleophiles in a similar reaction. How do they compare with hydroxide ions as nucleophiles? Explain your answer.

(2 marks)

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(i) What extra step has to occur in the reaction of a neutral nucleophile such as water compared with the reaction with a negatively charged ion such as the hydroxide ion?

(1 mark)

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