

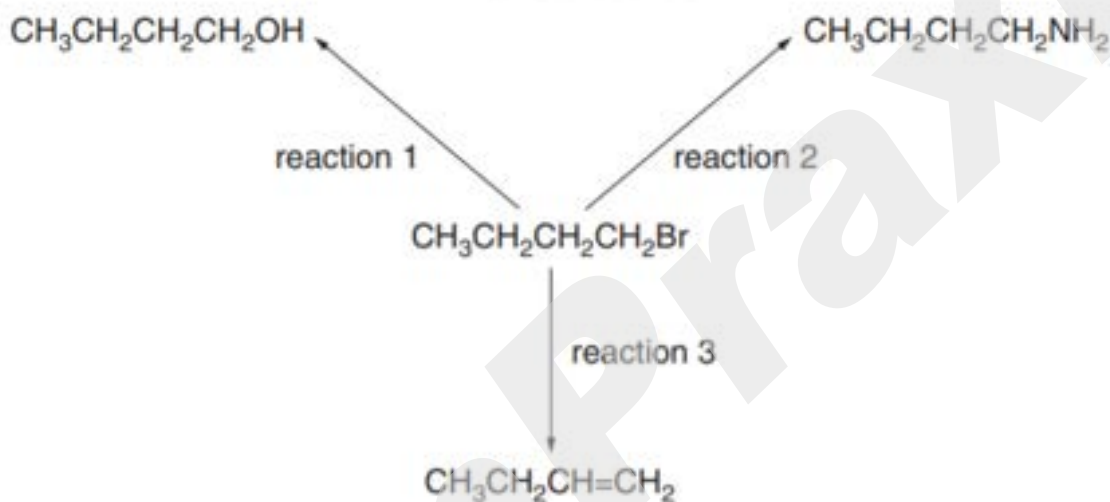
Halogenoalkane

(Past Year Topical Questions 2010-2015)

Oct/Nov 2010 (21)

- 4 Halogenoalkanes have many chemical uses, particularly as intermediates in organic reactions.

Three reactions of 1-bromobutane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$, are shown below.



- (a) For **each** reaction, state the reagent and solvent used.

reaction 1 reagent

solvent

reaction 2 reagent

solvent

reaction 3 reagent

solvent

[6]

- (b) When 1-iodobutane, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{I}$, is reacted under the same conditions as those used in reaction 1, butan-1-ol is formed.

What difference, if any, would there be in the rate of this reaction compared to the reaction of 1-bromobutane?

Use appropriate data from the *Data Booklet* to explain your answer.

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.....

.....

..... [3]

Dichlorodifluoromethane, CCl_2F_2 , is an example of a chlorofluorocarbon (CFC) that was formerly used as an aerosol propellant. In September 2007, at the Montreal summit, approximately 200 countries agreed to phase out the use of CFCs by 2020.

- (c) State two properties of CFCs that made them suitable as aerosol propellants.

1.

2.

[2]

Oct/Nov 2010 (23)

- 4 Although few halogenoalkanes exist naturally, such compounds are important as intermediates in organic reactions and as solvents.

The bromoalkane **B** has the following composition by mass: C, 29.3%; H, 5.7%; Br, 65.0%. The relative molecular mass of **B** is 123.

- (a) Calculate the molecular formula of **B**.

[3]

Halogenoalkanes such as bromoethane, C_2H_5Br , have two different reactions with sodium hydroxide, NaOH, depending on the conditions used.

- (b) (i) When hot aqueous NaOH is used, the C_2H_5Br is hydrolysed to ethanol, C_2H_5OH .

Describe the mechanism of this reaction. In your answer, show any relevant charges, dipoles, lone pairs of electrons and movement of electron pairs by curly arrows.

- (ii) What will be formed when C_2H_5Br is reacted with NaOH under different conditions?

.....

- (iii) What are the conditions used?

.....

- (iv) What type of reaction is this?

..... [7]

When 1,4-dichlorobutane, $ClCH_2CH_2CH_2CH_2Cl$, is reacted with NaOH, two different reactions can occur, depending on the conditions used.

- (c) (i) Draw the **displayed** formula of the product formed when 1,4-dichlorobutane is reacted with hot aqueous NaOH as in (b)(i).

- (ii) Draw the **skeletal** formula of the product formed when 1,4-dichlorobutane is reacted with NaOH in the way you have described in (b)(ii) and (b)(iii).

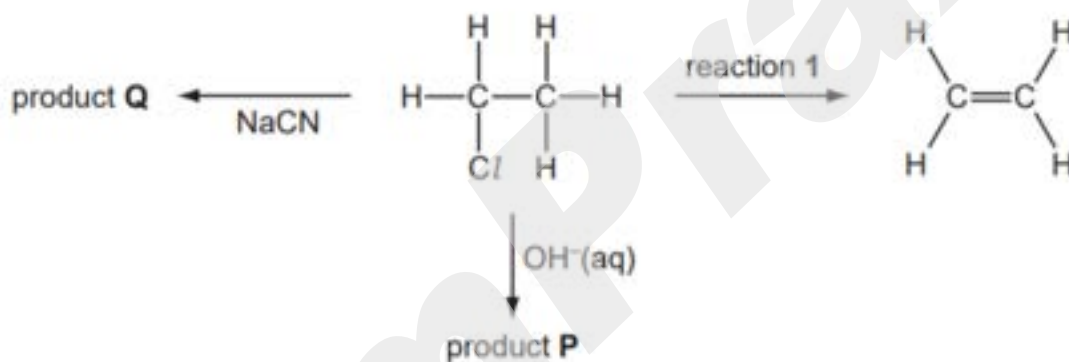
[2]

May/June 2014 (21)/Q4

- (d) Chloroethene can be polymerised to form a polymer commonly known as PVC.
Draw a diagram of the structure of PVC including **three** repeat units.

[2]

- (e) Chloroethane undergoes a series of reactions as shown in the diagram below.



- (i) Give the reagent and conditions necessary for reaction 1.

.....
 [2]

(ii) Give the **skeletal** formula of product **P**.

(iii) Give the **displayed** formula and the name of product **Q**.

[1]

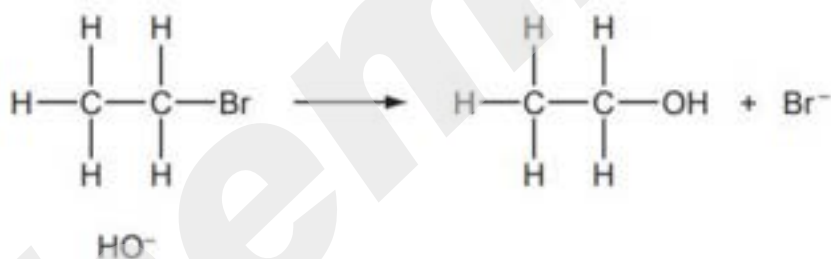
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May/June 2014 (23)/Q4

(e) (i) Give the full name of the mechanism for the reaction between aqueous sodium hydroxide and bromoethane.

..... [2]

(ii) Complete the diagram below to represent this mechanism. Include all necessary curly arrows, partial charges and lone pairs.



[2]

(f) In the past, CFCs such as CF_3Cl were widely used as refrigerants.

(i) State a property of CFCs which makes them suitable for use as refrigerants.

..... [1]

(ii) State the damaging effect of CFCs in the upper atmosphere.

.....

Explain your answer.

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.....

.....

[2]

May/June 2015 (22)/Q3

(b) Chloroethane can be converted back into ethane by a two-stage process via an intermediate compound, X.



(i) Give the name of X.

..... [1]

(ii) Suggest the reagent and conditions needed for reaction 1.

..... [2]

(iii) Suggest the reagent and conditions needed for reaction 2.

..... [1]

May/June 2015 (23)/Q4

- (b) (i) Complete the reaction scheme to show the mechanism of the reaction of **H** with bromine to form **J**.

Include all necessary curly arrows, lone pairs and charges.



[3]

- (ii) Explain the origin of the dipole on the bromine molecule.

.....
 [1]

J is formed as an equimolar mixture of isomers.

- (iii) State the type of isomerism shown by **J**.

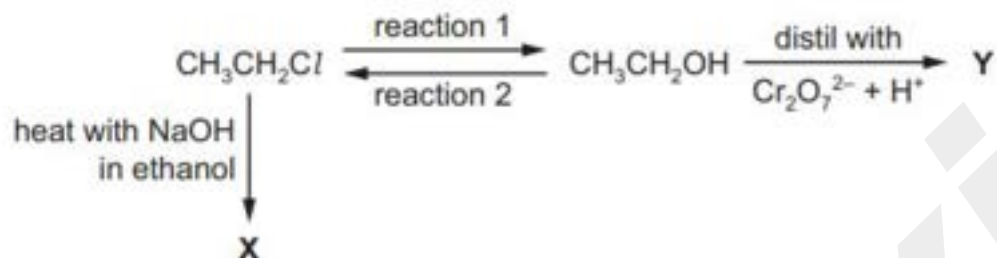
..... [1]

- (iv) Draw the structures of the two isomers of **J**.

[2]

Oct/Nov 2015 (21)

4 Some reactions involving ethanol are shown.



(a) (i) Give an equation for reaction 2 including the reagent needed for the conversion.

..... [2]

(ii) State the reagent and conditions required for reaction 1.

..... [2]

(b) (i) Identify the organic product X.

..... [1]

(ii) Nitric acid is added to the products of reaction of $\text{CH}_3\text{CH}_2\text{Cl}$ with NaOH in ethanol. Silver nitrate solution is then added to this mixture.

State what you would observe.

..... [1]

- (iii) Write an ionic equation, including state symbols, for the reaction responsible for the observation in (ii).

..... [1]

- (c) (i) Identify the organic product Y which is distilled out of the reaction mixture.

..... [1]

- (ii) Explain, in terms of the properties of and intermolecular forces in $\text{CH}_3\text{CH}_2\text{OH}$ and Y, why the chosen conditions for the reaction ensure that Y is the product.

.....
.....
..... [3]

Oct/Nov 2015 (22)

- 4 Halogenoalkanes are useful intermediates in the synthesis of a wide variety of compounds.

- (a) 2-bromobutane reacts in two different ways with sodium hydroxide depending on the conditions.

When warmed with aqueous sodium hydroxide, 2-bromobutane produces an alcohol that exists as a pair of optical isomers.

- (i) Give the name of the mechanism of the reaction between 2-bromobutane and aqueous sodium hydroxide.

..... [1]

- (ii) Explain why the alcohol produced exists as a pair of optical isomers.

.....
..... [1]

- (iii) Draw the three-dimensional structure of the two optical isomers of the alcohol produced in (ii).

.....

[2]

Heating 2-bromobutane with ethanolic sodium hydroxide produces a mixture of three alkenes, two of which are a pair of geometrical isomers.

- (iv) Give the name of the mechanism of the reaction between 2-bromobutane and ethanolic sodium hydroxide.

..... [1]

- (v) Draw and name the structures of the pair of geometrical isomers formed by reaction of 2-bromobutane with ethanolic sodium hydroxide.

name

name

[2]

- (vi) Name the third alkene produced by reaction of 2-bromobutane with ethanolic sodium hydroxide and explain why it does **not** show geometrical isomerism.

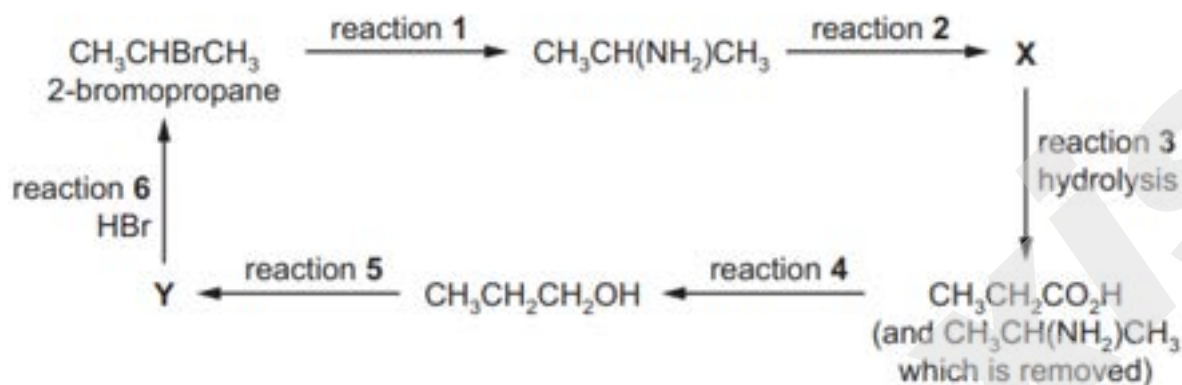
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[2]

(b) Some reactions involving 2-bromopropane are shown.



(i) State the reagent needed for reaction 1.

..... [1]

(ii) State the reagent needed for reaction 2.

..... [1]

(iii) Give the structural formula of X.

[1]

(iv) Name the type of reaction involved in reaction 4 and suggest a suitable reagent.

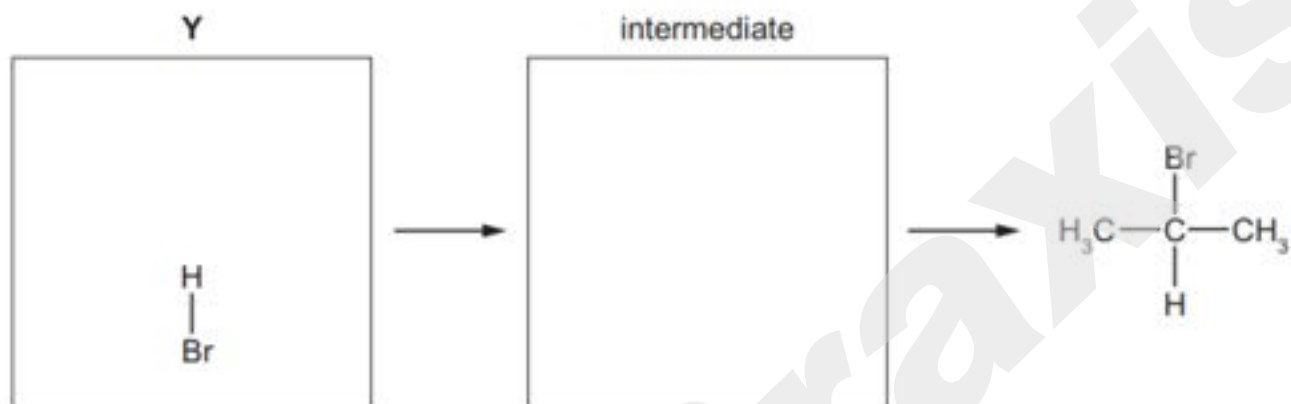
..... [2]

(v) State the name of a solid catalyst for reaction 5.

..... [1]

- (vi) Complete the mechanism for the production of 2-bromopropane from **Y** in reaction **6** shown below.

Include the structure of **Y** and any necessary lone pairs, curly arrows, charges and partial charges.



[4]

- (vii) Give the name of the mechanism in (vi).

..... [1]

- (viii) 1-bromopropane is a minor product of reaction **6**.

Explain why 2-bromopropane is the major product of reaction **6**.

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..... [2]