9. Haloalkanes are alkane molecules that contain at least one group 7 atom.

(a) The table shows information on the boiling points of some haloalkanes.

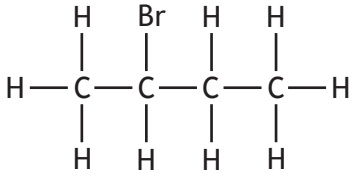
Haloalkane	Boiling point (°C)		
	X = Cl	**X = Br**	**X = I**
CH_3-X	−24.2	3.6	42.4
CH_3CH_2-X	12.3	38.4	72.3
$CH_3CH_2CH_2$-X	46.6	71.0	102.0

(i) Using the information in the table, describe **two** different trends in the boiling points. **2**

(ii) Name the strongest type of intermolecular forces broken when bromoethane, CH_3CH_2Br, boils. **1**

9. (continued)

(b) Haloalkanes can be classified as primary, secondary or tertiary depending on the position of the group 7 atom.



2-bromobutane

(i) State why 2-bromobutane can be classified as a secondary haloalkane. **1**

(ii) Draw a structural formula for an isomer of 2-bromobutane that is a tertiary haloalkane. **1**

[Turn over

9. (continued)

(c) Alkanes can react with group 7 molecules in free radical reactions to form haloalkanes.

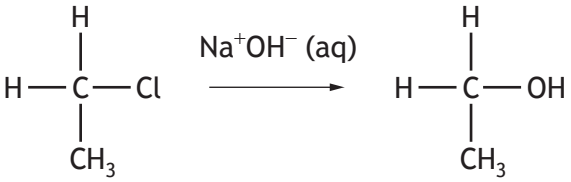
Reaction step	Name of step
$Br_2 \rightarrow 2Br\bullet$	Initiation
$Br\bullet + CH_4 \rightarrow HBr + \bullet CH_3$ $\bullet CH_3 + Br_2 \rightarrow CH_3Br + Br\bullet$	Propagation
	Termination

(i) State what is required for initiation to take place. **1**

(ii) Complete the table to show a possible termination step. **1**

9. (continued)

(d) Haloalkanes can react to form alcohols as shown.



Depending on the structure of the haloalkane used, the alcohol produced can be oxidised to form an aldehyde or ketone.

Compound **P** was converted to compound **R** in two steps.

$$\underset{\textbf{P}}{C_4H_9Br} \rightarrow \underset{\textbf{Q}}{C_4H_9OH} \rightarrow \underset{\textbf{R}}{C_4H_8O}$$

Compound **R** does not react with Tollens' reagent or Fehling's solution.

Draw a structural formula for compound **P**. **1**

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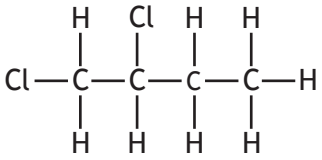
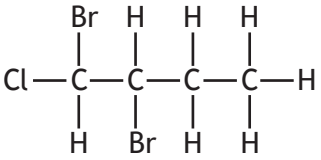
9. (continued)

(e) The structures of two haloalkanes are shown.



1,2-dichlorobutane



1,2-dibromo-1-chlorobutane

The names of haloalkanes are derived from their structures using the following rules.

1. The name is based on the longest chain of carbon atoms.
2. The presence of group 7 atoms is shown by shortening the name of the group 7 atom.

Group 7 atom	Shortened name
fluorine	fluoro-
chlorine	chloro-
bromine	bromo-

3. The chain is numbered to assign numbers to the group 7 atoms. The numbers should be assigned so the lowest possible numbers are used.
4. If two or more of the same group 7 atoms are present, use the prefixes di, tri or tetra.
5. The shortened name of the group 7 atoms attached to the chain are listed alphabetically (ignoring the prefixes di, tri and tetra for alphabetical purposes).

Using these rules, name this molecule. **1**