Concentrated H₂SO₄ is used as an acid catalyst in the elimination of water from alcohols.

There are several alcohols that are structural isomers with the formula C₅H₁₁OH. When the alcohols are heated with H₂SO₄ they form alkenes.

C₅H₁₁OH → C₅H₁₀ + H₂O

(i) Pentan-1-ol is a structural isomer of C₅H₁₁OH that is a primary alcohol.

Draw the structure of another structural isomer of C₅H₁₁OH that is a primary alcohol.

(ii) Pentan-2-ol is a structural isomer of C₅H₁₁OH that is a secondary alcohol. Pentan-2-ol is heated with H₂SO₄.

Three alkenes are formed, L, M and N.

- L and M are stereoisomers.
- N is a structural isomer of the stereoisomers L and M.

Draw the structures for alkenes L, M and N.
(i) Write an equation, using displayed formulae, for the reaction to form PTFE from its monomer.

\[ \text{(PVC) produces hydrogen chloride} \]

OR produces acidic gases

OR (PVC) produces phosgene

OR produces toxic gases

OR (PVC) produces dioxins

Chlorocyclopentane can be hydrolysed by heating with aqueous sodium hydroxide.

\[ \text{products} \]

name of mechanism .......... Nucleophilic substitution ✓

[5]

type of bond fission .......... Heterolytic (fission) spelt correctly ✓
The 'curly arrows' model is used in reaction mechanisms to show the movement of electron pairs during chemical reactions.

Choose a reaction mechanism that you have studied involving the curly arrow model.

Name and describe your chosen reaction mechanism.

In your answer, include:
- an example of the reaction with the chosen mechanism,
- the type of bond fission that occurs,
- relevant dipoles.

EITHER
- Nucleophilic substitution ✓
- Example of nucleophilic substitution ✓
- Heterolytic fission ✓
- C—I curly arrow ✓
- Correct dipole on C—I bond ✓
- OH⁻ curly arrow from one lone pair on O of OH⁻ ion
- OR from minus sign on OH⁻ ion ✓

OR
- Electrophilic addition ✓
- Example of electrophilic addition ✓
- Heterolytic fission ✓
- Curly arrow from C=C bond to Br—Br bond and Dipole and curly arrow associated with Br₂ ✓
- Correct carbocation ion ✓
- Curly arrow from one lone pair on Br⁻ ion
- OR from minus sign on Br⁻ ion ✓
(f) Butan-2-ol is heated with $\text{H}_2\text{SO}_4$ catalyst.

- A mixture of three alkenes forms, B, C and D.
- The alkenes B and C are stereoisomers.

(i) Draw the structures of the two stereoisomers B and C.

(ii) What type of stereoisomerism is shown by B and C?

\[ \underline{\text{E/Z}} \]

[iii] Draw the structure of the other alkene, D, that is formed in this reaction.

\[ \text{CH}_3\text{CH}_2\text{CH} = \text{CH}_2 \text{ OR but-1-ene} \]

Catalysts are increasingly being used in chemical processes.

* A catalyst speeds up a reaction without being consumed by the overall reaction.
* A catalyst provides an alternative reaction route with a lower activation energy.

(i) Chlorine radicals, C$\text{Cl}^\cdot$, catalyse some reactions.

Choose a reaction that you have studied that is catalysed by chlorine radicals.

Write down an equation for the overall reaction and show how chlorine radicals are not consumed by the overall reaction.

\[
\begin{align*}
\text{Cl + O}_3 & \rightarrow \text{ClO + O}_2 \checkmark \\
\text{ClO + O} & \rightarrow \text{Cl + O}_2 \checkmark \\
\text{overall: O}_3 + \text{O} & \rightarrow 2\text{O}_2 \checkmark
\end{align*}
\]

\[
\begin{align*}
\text{OR} \\
\text{Cl + CH}_4 & \rightarrow \text{CH}_3 + \text{HCl} \checkmark \\
\text{CH}_3 + \text{Cl}_2 & \rightarrow \text{CH}_3\text{Cl} + \text{Cl} \checkmark \\
\text{overall: CH}_4 + \text{Cl}_2 & \rightarrow \text{CH}_3\text{Cl} + \text{HCl} \checkmark
\end{align*}
\]