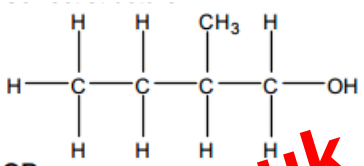
Concentrated H_2SO_4 is used as an acid catalyst in the elimination of water from alcohols.

There are several alcohols that are structural isomers with the formula $C_5H_{11}OH$. When th
alcohols are heated with H_2SO_4 they form alkenes.

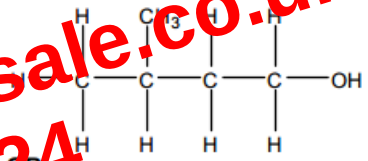
$$C_5H_{11}OH \rightarrow C_5H_{10} + H_2O$$

(i) Pentan-1-ol is a structural isomer of $C_5H_{11}OH$ that is a primary alcohol.

Draw the structure of another structural isomer of $C_5H_{11}OH$ that is a primary alcohol.



OR



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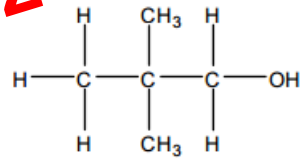


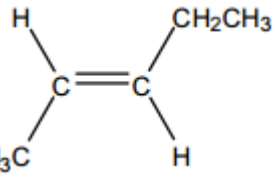
(ii) Pentan-2-ol is a structural isomer of $C_5H_{11}OH$ that is a secondary alcohol.
Pentan-2-ol is heated with H_2SO_4.

Three alkenes are formed, **L**, **M** and **N**.

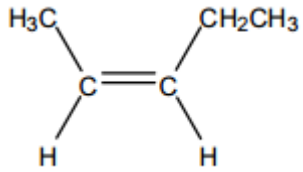
- **L** and **M** are stereoisomers.
- **N** is a structural isomer of the stereoisomers **L** and **M**.

Draw the structures for alkenes **L**, **M** and **N**.

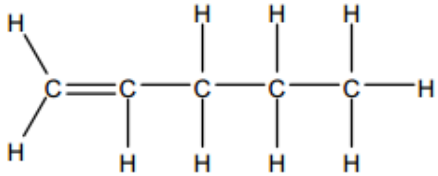
alkene **L**



alkene **M**



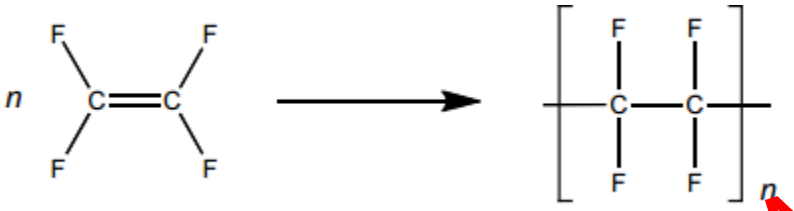
alkene **N**



[3]

Poly(tetrafluoroethene), PTFE, and poly(chloroethene), PVC, are halogenated plastics.

(i) Write an equation, using displayed formulae, for the reaction to form PTFE from its monomer.



[2]

(ii) The combustion of waste polymers can be used for energy production.

What problem is caused by disposing of PTFE and PVC in this way?

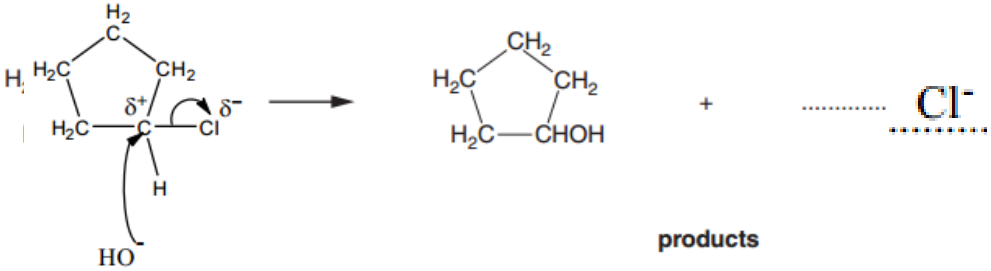
(PVC) produces hydrogen chloride
OR produces acidic gases
OR (PVC) produces phosgene
OR produces toxic gases
OR (PVC) produces dioxins ✓

Chlorocyclopentane can be hydrolysed by heating with aqueous sodium hydroxide.

Use the curly arrow model to complete the mechanism for this hydrolysis reaction.

Include in your answer, relevant dipoles, the name of the mechanism and the type of bond fission.

In your answer you should use the correct technical terms, spelled correctly.



products

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

type of bond fission ..... Heterolytic (fission) spelt correctly ✓ ..... **[5]**

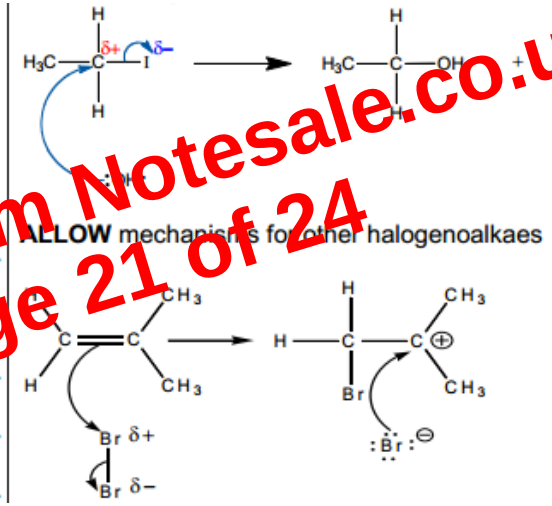
The 'curly arrows' model is used in reaction mechanisms to show the movement of electron pairs during chemical reactions.

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.



ALLOW mechanisms for other halogenoalkaes

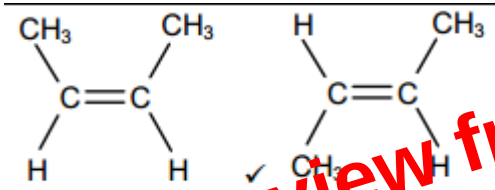
EITHER
Nucleophilic substitution ✓
Example of nucleophilic substitution ✓
Heterolytic fission ✓
C–I curly arrow ✓
Correct dipole on C— I bond ✓
OH^- curly arrow from one lone pair on O of OH^- ion
OR from minus sign on OH^- ion ✓

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 Br_2 ✓
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 H_2SO_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**.



✓ ✓

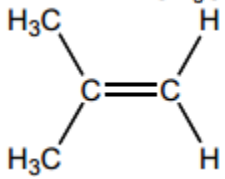
[2]

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

E/Z ✓ ..... **[1]**

(iii) Draw the structure of the other alkene, **D**, that is formed in this reaction.

$CH_3CH_2CH{=}CH_2$ **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, $Cl^{\bullet}$, 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.

$Cl + O_3 \rightarrow ClO + O_2$ ✓
$ClO + O \rightarrow Cl + O_2$ ✓
overall: $O_3 + O \rightarrow 2O_2$ ✓

OR

$Cl + CH_4 \rightarrow CH_3 + HCl$ ✓
$CH_3 + Cl_2 \rightarrow CH_3Cl + Cl$ ✓
overall: $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ ✓

]