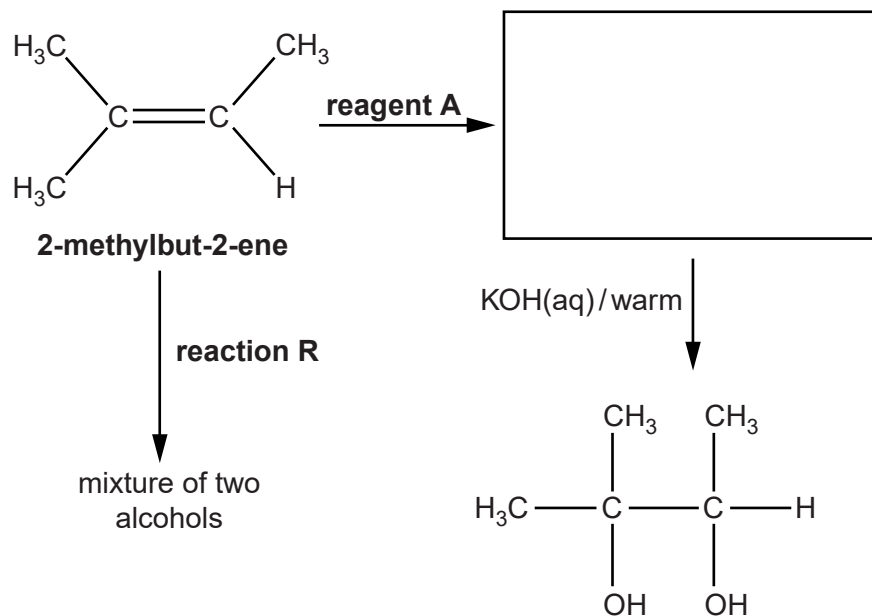


1 The flowchart shows how 2-methylbut-2-ene can be converted into a number of organic products.

(a) Complete the flowchart by drawing an organic structure in the box below.



[1]

(b) Identify reagent A.

..... [1]

(c) In the flowchart, **reaction R** forms a mixture of two alcohols that are structural isomers of $C_5H_{12}O$.

(i) State the reagents and conditions needed for **reaction R**.

..... [1]

(ii) What is meant by the term *structural isomers*?

..... [1]

(iii) Draw the two structural isomers of $C_5H_{12}O$ formed in **reaction R**.

[2]

(iv) Suggest why 2-methylbut-2-ene is less soluble in water than either of the structural isomers formed.

.....
.....
..... [2]

(d) Describe the oxidation reactions of propan-1-ol when using a suitable oxidising agent.

Indicate how the use of different reaction conditions can control which organic product forms.

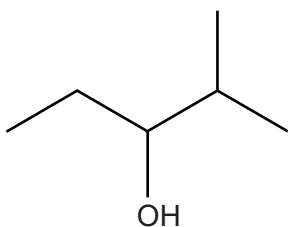
Include reagents, observations and equations in your answer.

In your equations, use structural formulae and use [O] to represent the oxidising agent.

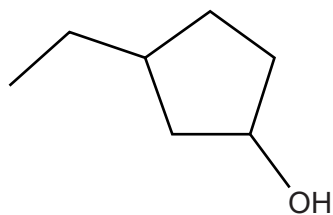
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
..... [6]

[Total: 14]

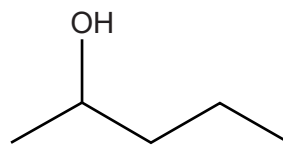
2 The skeletal formulae of six alcohols, **C**, **D**, **E**, **F**, **G** and **H**, are shown below.



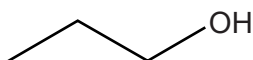
C



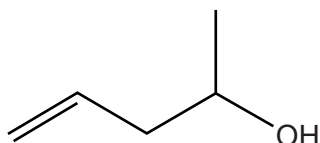
D



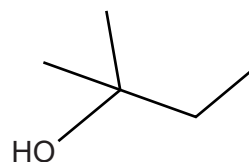
E



F



G



H

(a) (i) Which **two** alcohols are structural isomers of one another?

.....

[1]

(ii) Which alcohol is a tertiary alcohol?

.....

[1]

(iii) Which alcohol can be oxidised to a carboxylic acid using acidified $K_2Cr_2O_7$?

.....

[1]

(b) (i) What is the molecular formula of alcohol **G**?

..... [1]

(ii) What is the name of alcohol **C**?

..... [1]

(c) The alcohols are members of a homologous series.

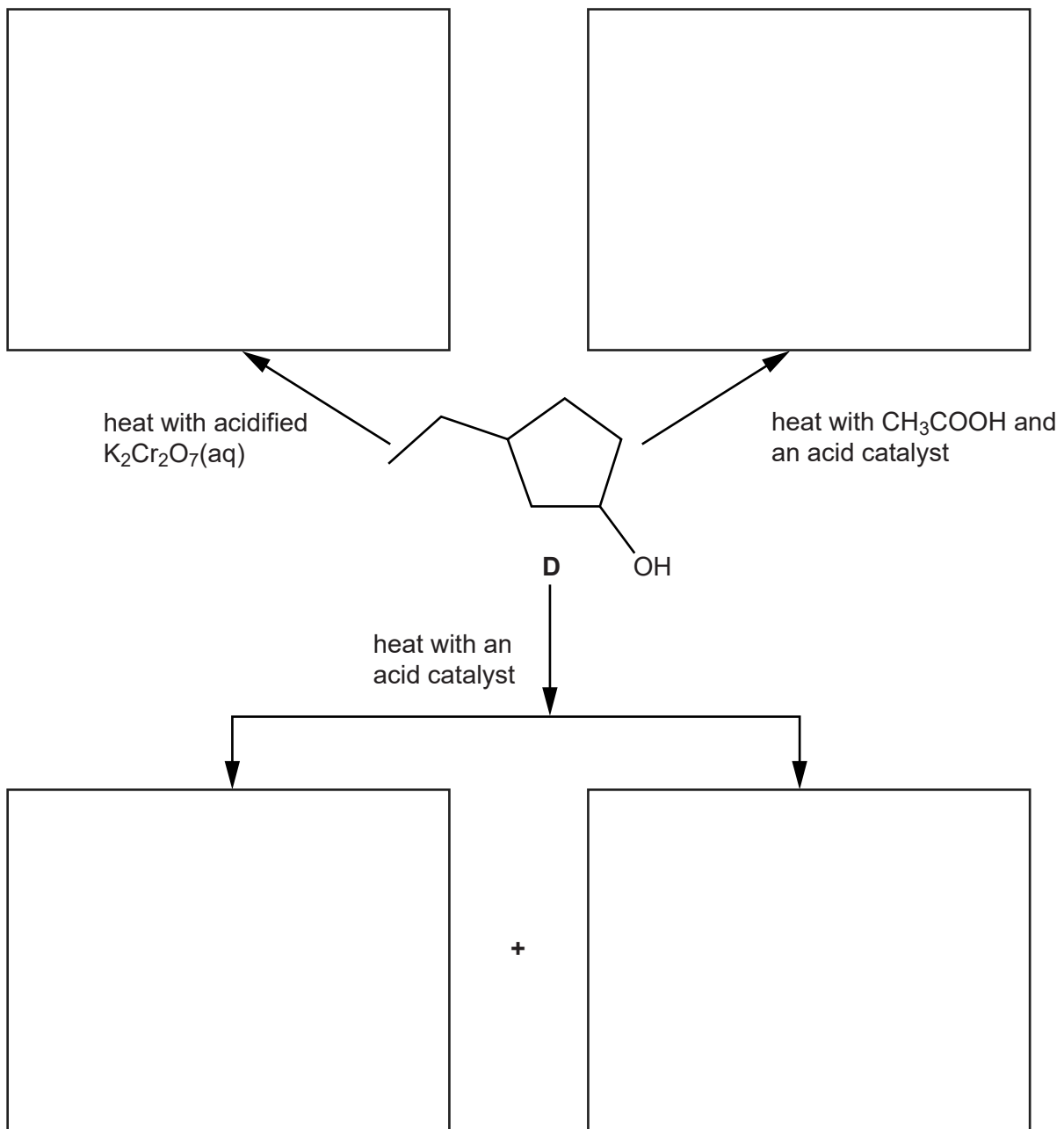
Explain the term *homologous series*.

.....

[2]

(d) Alcohol **D** is reacted with three different reagents.

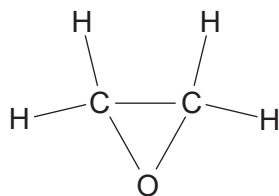
Complete the flowchart below to show the organic product(s) formed in each of the reactions of alcohol **D**.



[4]

[Total: 11]

- 3 Epoxyethane, C_2H_4O , is a synthetic intermediate that is used to make ethane-1,2-diol and some polymers. The structure of epoxyethane is shown below.



- (a) The controlled catalysed reaction of ethene with oxygen forms epoxyethane as the only product.

(i) Write the equation for this reaction.

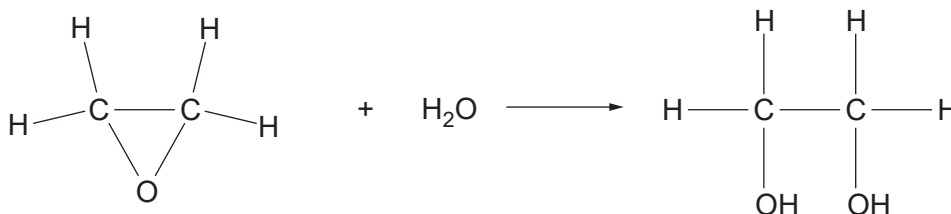
[1]

- (ii) When burnt in excess oxygen, ethene completely combusts.

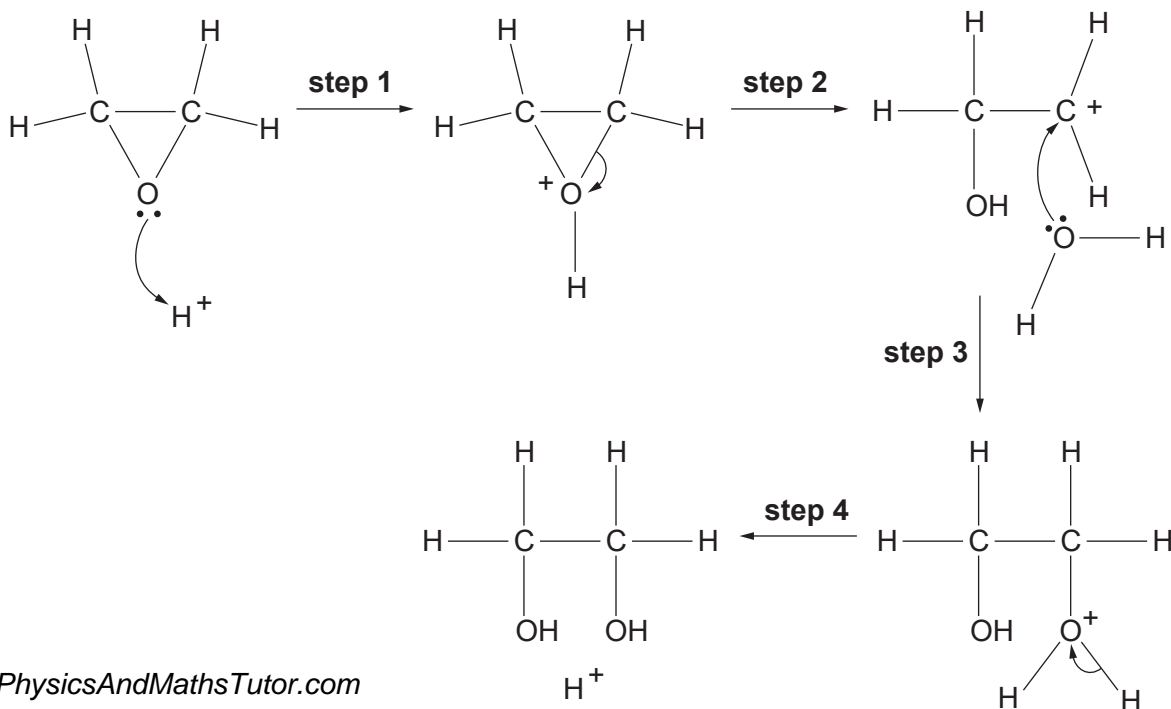
Write the equation for the complete combustion of ethene.

..... [1]

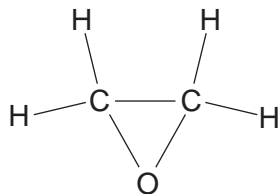
- (b) Epoxyethane reacts with water in the presence of an acid catalyst to form ethane-1,2-diol.



The mechanism for this reaction is shown below.



(i) Draw dipoles on the carbon and oxygen atoms on the displayed formula of epoxyethane.



[1]

(ii) The mechanism uses the 'curly arrow' model.

What does a 'curly arrow' represent?

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

(iii) What type of bond fission occurs in **step 2**?

Explain your answer.

.....
.....
..... [2]

(iv) How can you tell that water is behaving as a nucleophile in **step 3**?

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

(v) How does the mechanism show that H^+ ions act as a catalyst in this reaction?

Refer to the steps in the mechanism in your answer.

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

(vi) Epoxyethane reacts with methanol, CH_3OH , to form a compound with the molecular formula $C_3H_8O_2$.

Suggest the structure of this compound.

[1]

(c) Ethane-1,2-diol is much less volatile than ethanol.

Suggest why.

.....

.....

.....

.....

..... [2]

(d) Ethane-1,2-diol reacts with an excess of ethanoic acid, CH_3COOH , in the presence of an acid catalyst. A compound is formed with the molecular formula $\text{C}_6\text{H}_{10}\text{O}_4$.

Draw the structure of this compound.

[2]

(e) Ethane-1,2-diol reacts with warm acidified potassium dichromate(VI). A number of different organic products are formed.

Draw the displayed formulae of **two** of these organic products.

[2]

[Total: 15]

4 The alcohols are an example of an homologous series.

The table shows the boiling points for the first four members of straight-chain alcohols.

alcohol	structural formula	boiling point / °C
methanol	CH ₃ OH	65
ethanol	CH ₃ CH ₂ OH	78
propan-1-ol	CH ₃ CH ₂ CH ₂ OH	97
butan-1-ol	CH ₃ CH ₂ CH ₂ CH ₂ OH	118

(a) (i) What is the general formula of a member of the alcohol homologous series?

..... [1]

(ii) Deduce the molecular formula of the alcohol that has 13 carbon atoms per molecule.

..... [1]

(b) Alcohols contain the hydroxyl functional group.

What is meant by the term *functional group*?

.....
.....
.....
..... [2]

(c) (i) At room temperature and pressure, the first four members of the alcohol homologous series are liquids whereas the first four members of the alkanes homologous series are gases.

Explain this difference.

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

- (ii) Methylpropan-1-ol and butan-1-ol are structural isomers. Methylpropan-1-ol has a lower boiling point than butan-1-ol.

Suggest why.

.....
.....
.....
.....
..... [2]

- (d) Alcohols, such as methanol, can be used as fuels.

- (i) Write equations for the complete and incomplete combustion of methanol.

complete:

incomplete: [2]

- (ii) Suggest what conditions might lead to incomplete combustion of methanol.

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

- (iii) In addition to its use as a fuel, methanol can be used as a solvent and as a petrol additive to improve combustion.

State **another** large-scale use of methanol.

..... [1]

- (e) Butan-1-ol can be oxidised by heating under reflux with excess acidified potassium dichromate(VI).

Write an equation for the reaction that takes place.

Use [O] to represent the oxidising agent.

..... [2]

(f) Butan-1-ol is one of the structural isomers of $C_4H_{10}O$.

(i) Write the name and draw the structure of the structural isomer of $C_4H_{10}O$ that is a tertiary alcohol.

name:

structure:

[2]

(ii) Draw the structure of the structural isomer of $C_4H_{10}O$ that can be oxidised to form butanone.

[1]

[Total: 18]