Q1. Which statement about *E*-1,2-dichloroethene is correct?

A It has the same boiling point as *Z*-1,2-dichloroethene. ⬭

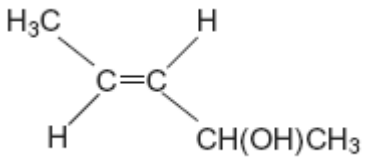
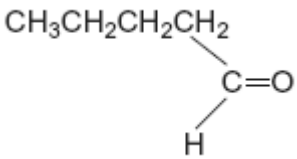
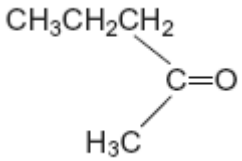
B It forms a polymer with the same repeating unit as *Z*-1,2-dichloroethene. ⬭

C It has the same IR spectrum as *Z*-1,2-dichloroethene in the range 400–1500 cm^{-1}. ⬭

D It has a molecular ion peak different from that of *Z*-1,2-dichloroethene in its mass spectrum. ⬭

(Total 1 mark)

Q2. The table below shows the structures of three isomers with the molecular formula $C_5H_{10}O$

Isomer **1** 	(*E*)-pent-3-en-2-ol
Isomer **2** 	pentanal
Isomer **3** 	

(a) Complete the table by naming Isomer **3**.

(1)

(b) State the type of structural isomerism shown by these three isomers.

.....

(1)

(c) The compound (*Z*)-pent-3-en-2-ol is a stereoisomer of (*E*)-pent-3-en-2-ol.

(i) Draw the structure of (*Z*)-pent-3-en-2-ol.

(1)

(ii) Identify the feature of the double bond in (*E*)-pent-3-en-2-ol and that in (*Z*)-pent-3-en-2-ol that causes these two compounds to be stereoisomers.

.....

(1)

(d) A chemical test can be used to distinguish between separate samples of Isomer **2** and Isomer **3**.
Identify a suitable reagent for the test.
State what you would observe with Isomer **2** and with Isomer **3**.

Test reagent .....

Observation with Isomer **2**.....

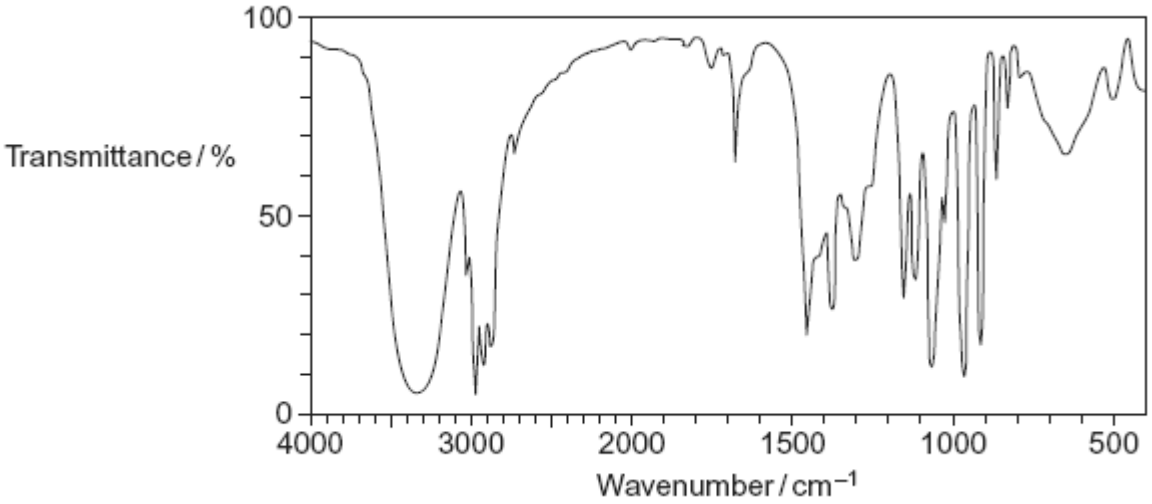
.....

Observation with Isomer **3**.....

.....

(3)

(e) The following is the infrared spectrum of one of the isomers **1**, **2** or **3**.



(i) Deduce which of the isomers (**1**, **2** or **3**) would give this infrared spectrum. You may find it helpful to refer to **Table 1** on the Data Sheet.

.....

(1)

(ii) Identify two features of the infrared spectrum that support your deduction. In each case, identify the functional group responsible.

Feature 1 and functional group .....

.....

.....

.....

Feature 2 and functional group .....

.....

.....

.....

(2)
(Total 10 marks)

Q3. (a) Give the **formula** of a Group 2 metal hydroxide used in agriculture.

.....

(1)

(b) Identify a sodium halide that does **not** undergo a redox reaction when added as a solid to concentrated sulfuric acid.

.....

(1)

(c) Chlorine gas reacts with cold dilute sodium hydroxide solution to form sodium chloride and another chlorine-containing compound, **X**.

Give the **formula** of **X**.

.....

(1)

(d) Give the **formula** of the substance responsible for the orange colour when chlorine gas is bubbled through an aqueous solution of sodium bromide.

.....

(1)

(e) Solid sodium iodide undergoes a redox reaction with concentrated sulfuric acid.

Give the **formula** for each of the following in this reaction.

Formula of the solid reduction product .....

Formula of the oxidation product .....

(2)

(f) Draw the structure of each of the following organic compounds.

(i) The hydrocarbon that is a chain isomer of methylpropene, but does **not** exhibit E–Z stereoisomerism.

(1)

(ii) The alcohol that is a position isomer of butan-2-ol.

(1)

(iii) The hydrocarbon that has a peak, due to its molecular ion, at *m/z* = 44 in its mass spectrum.

(1)

(iv) The bromoalkane that reacts with sodium cyanide to produce propanenitrile.

(1)
(Total 10 marks)

Q4. Which statement about ethene is correct?

A It has no geometric isomers because there is free rotation around the C=C bond. ⬭

B It reacts with HBr in a nucleophilic addition reaction. ⬭

C It burns in excess oxygen to produce carbon dioxide and water. ⬭

D The C=C bond is twice as strong as the C–C bond in ethane. ⬭

(Total 1 mark)

Q5. It is possible to convert but-1-ene into its structural isomer but-2-ene.

(a) State the type of structural isomerism shown by but-1-ene and but-2-ene.

.....

(1)

(b) The first stage in this conversion involves the reaction of hydrogen bromide with but-1-ene.

$$CH_3CH_2CH=CH_2 + HBr \longrightarrow CH_3CH_2CHBrCH_3$$

Outline a mechanism for this reaction.

(4)

(c) The second stage is to convert 2-bromobutane into but-2-ene.

$$CH_3CH_2CHBrCH_3 + KOH \longrightarrow CH_3CH=CHCH_3 + KBr + H_2O$$

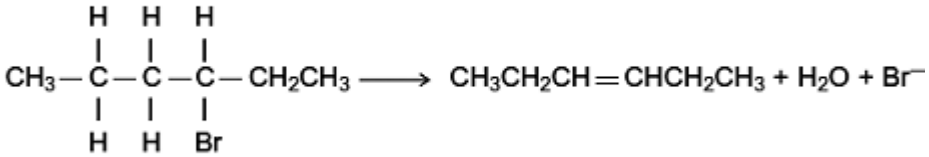
Outline a mechanism for this reaction.

(3)
(Total 8 marks)

Q6. Alkenes are useful intermediates in the synthesis of organic compounds.

(a) (i) Complete the elimination mechanism by drawing appropriate curly arrows.

HO^{-}:



3-bromohexane hex-3-ene

(3)

(ii) Draw structures for the E and Z stereoisomers of hex-3-ene.

E isomer of hex-3-ene Z isomer of hex-3-ene

(2)

(iii) State the meaning of the term *stereoisomers*.

.....

.....

.....

.....

.....

(Extra space) .....

.....

(2)

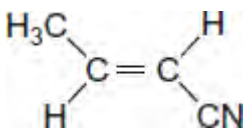
(b) The equation for the first reaction in the conversion of hex-3-ene into hexan-3-ol is shown below.

$$CH_3CH_2CH{=}CHCH_2CH_3 + H_2SO_4 \longrightarrow CH_3CH_2CH_2CH(OSO_2OH)CH_2CH_3$$

Outline a mechanism for this reaction.

(4)
(Total 11 marks)

Q7. The alkene *(E)*-but-2-enenitrile is used to make acrylic plastics.
The structure of *(E)*-but-2-enenitrile is



(a) (i) Draw the structure of *(Z)*-but-2-enenitrile.

(1)

(ii) Identify the feature of the double bond in the E and Z isomers that causes them to be stereoisomers.

.....

.....

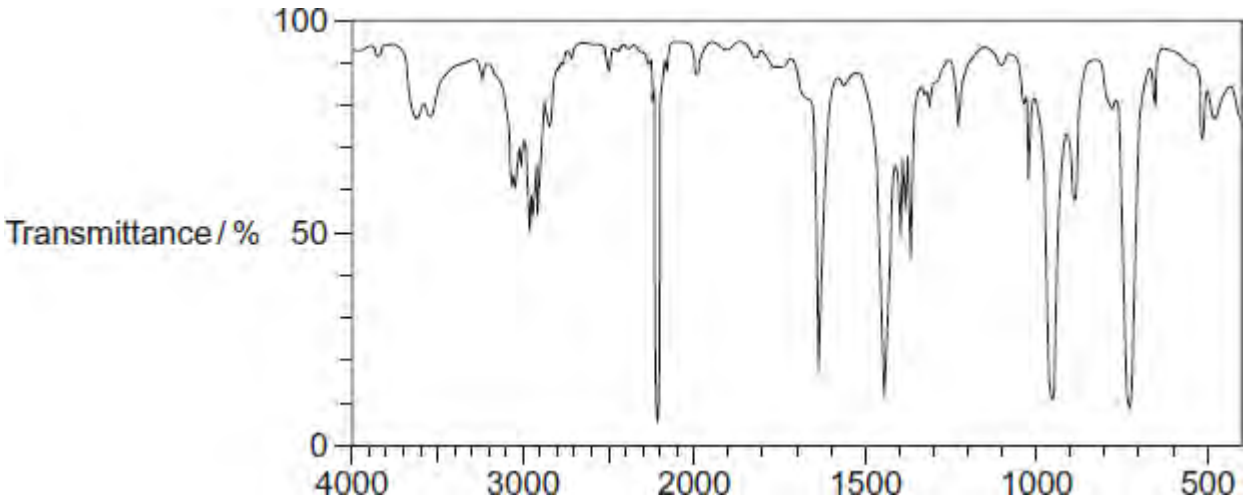
.....

(1)

(b) Draw the repeating unit of the polyalkene formed by addition polymerisation of *(E)*-but-2-enenitrile.

(1)

(c) Consider the infrared spectrum of *(E)*-but-2-enenitrile.



Identify **two** features of the infrared spectrum that support the fact that this is the infrared spectrum for but-2-enenitrile.
You may find it helpful to refer to **Table 1** on the Data Sheet.

Feature 1 .....

.....

.....

Feature 2 .....

.....

.....

(2)
(Total 5 marks)