AS LEVEL CHEMISTRY

TOPIC 9 – ANALYSIS OF ORGANIC COMPOUNDS

TEST

Answer all questions

Max 50 marks

Name ……
Mark …….../50 ……..% Grade ……

1. Ethanol can be oxidised slowly to ethanal. State how a sample of ethanol could be tested to confirm the presence of ethanal. State what you would observe.

Test .....

Observation .....

(Total 2 marks)

2. In each of the following questions, you should draw the structure of the compound in the space provided.

(a) Draw the structure of the alkene that would form 1,2-dibromo-3-methylbutane when reacted with bromine.

(1)

(b) Draw the structure of the alcohol with molecular formula $C_4H_{10}O$ that is resistant to oxidation by acidified potassium dichromate(VI).

(1)

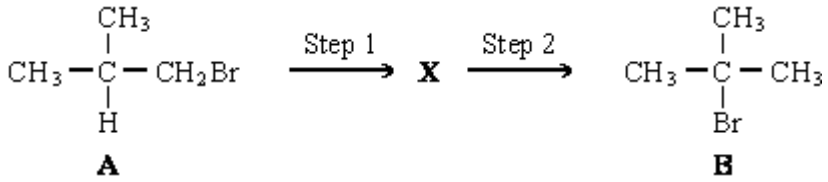
(c) Draw the structure of the alkene that has a peak, due to its molecular ion, at *m/z* = 42 in its mass spectrum.

(1)

(d) Draw the structure of the organic product with M_r = 73, made from the reaction between 2-bromobutane and ammonia.

(1)
(Total 4 marks)

3. The conversion of compound **A** into compound **B** can be achieved in two steps as shown below.



A **B**

The intermediate compound, **X,** has an absorption at 1650 cm^{-1} in its infra-red spectrum.

(a) Identify compound **X**. Explain your answer.

……

……

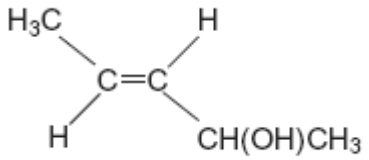
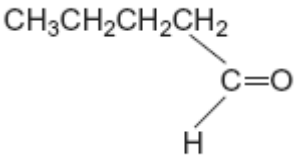
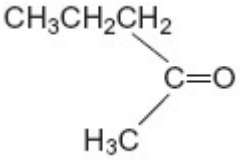
……

(2)

(b) For each step in this conversion, give the reagents and essential conditions required and outline a mechanism.

(11)
(Total 13 marks)

4. 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**.....

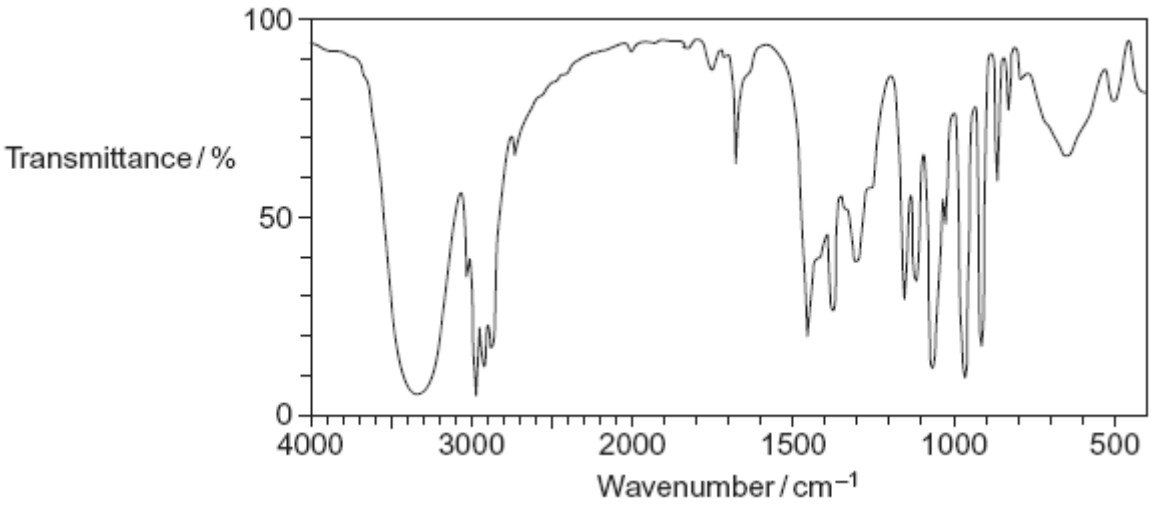
.....

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 .....

.....

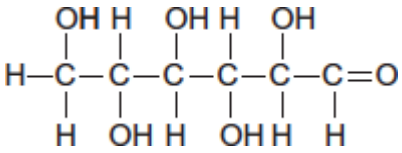
.....

(2)

(Total 10 marks)

5. Glucose is an organic molecule. Glucose can exist in different forms in aqueous solution.

(a) In aqueous solution, some glucose molecules have the following structure.

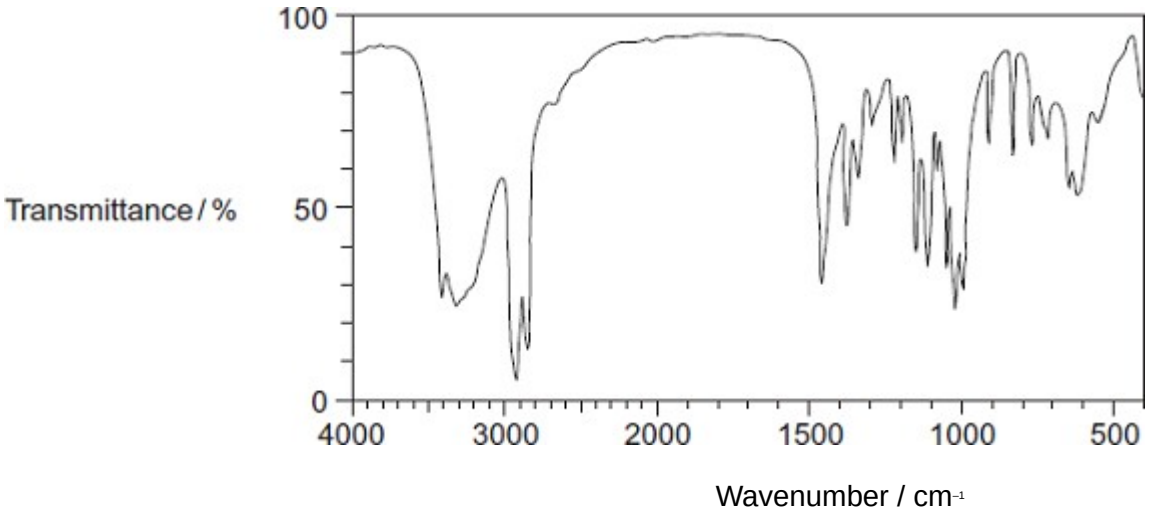


(i) Deduce the empirical formula of glucose.

.....

(1)

(ii) Consider the infrared spectrum of solid glucose.



State why it is possible to suggest that in the solid state very few molecules have the structure shown.
You may find it helpful to refer to **Table 1** on the Data Sheet.

.....

.....

(1)

(b) In the absence of oxygen, an aqueous solution of glucose can be fermented to produce ethanol for use in alcoholic drinks.

Write an equation for this fermentation reaction.
Give **two** other essential conditions for the production of ethanol in this fermentation.

Equation

.....

Condition 1 .....

Condition 2 .....

(3)

(c) Any ethanol present in the breath of a drinker can be detected by using a breathalyser.
The ethanol is converted into ethanoic acid. The breathalyser has negative and positive electrodes. A current is measured and displayed in terms of alcohol content.

The earliest breathalysers used laboratory chemicals to oxidise the ethanol to ethanoic acid. Detection was by a colour change.

Identify a reagent or combination of reagents that you would use in the laboratory to oxidise ethanol to ethanoic acid.

State the colour **change** that you would expect to see.

Reagent or combination of reagents .....

Colour change .....

(2)

(d) The fermentation of glucose from crops is the main method for the production of ethanol. The product is called bioethanol. The European Union has declared that bioethanol is carbon-neutral.

(i) Other than carbon-neutrality, state the **main** advantage of the use of glucose from crops as the raw material for the production of ethanol.

.....

.....

(1)

(ii) Give *one* disadvantage of the use of crops for the production of ethanol.

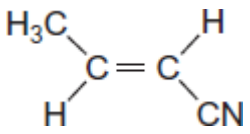
.....

.....

(1)

(Total 9 marks)

6. 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.

.....

.....

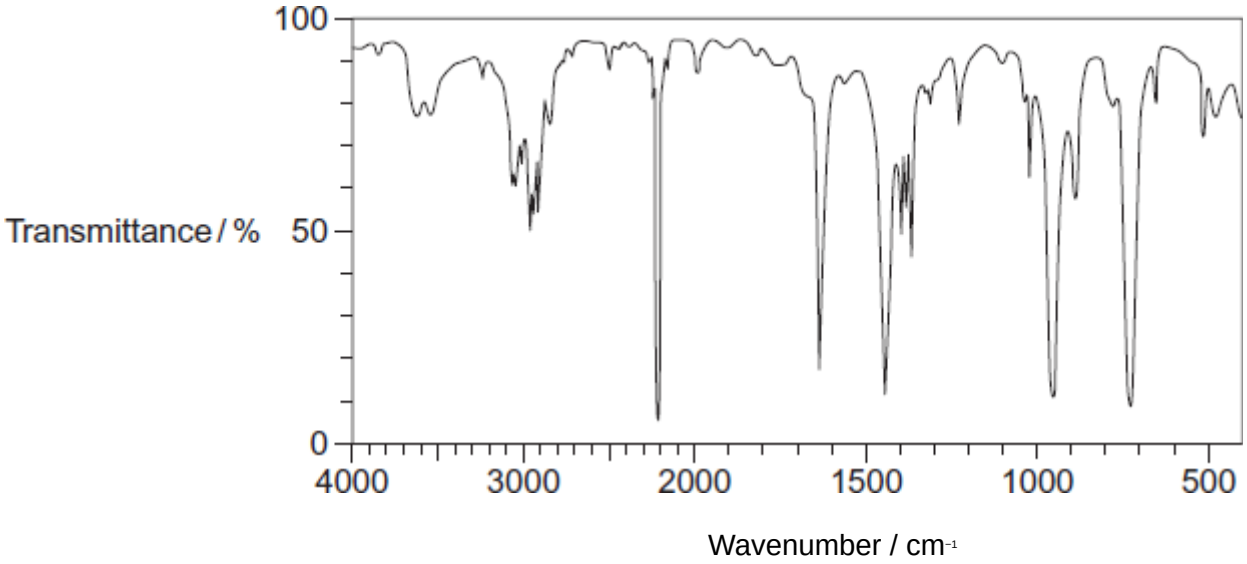
.....

(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 .....

.....

.....

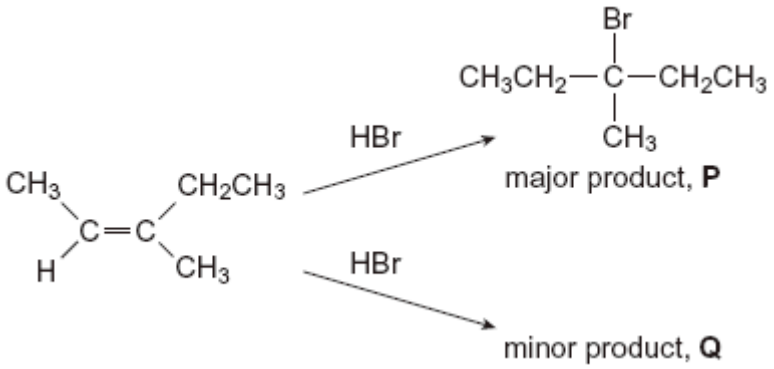
Feature 2 .....

.....

.....

(2)
(Total 5 marks)

7. The alkene (Z)-3-methylpent-2-ene reacts with hydrogen bromide as shown below.



(a) (i) Name the mechanism for these reactions.

.....

(1)

(ii) Draw the displayed formula for the minor product **Q** and state the type of structural isomerism shown by **P** and **Q**.

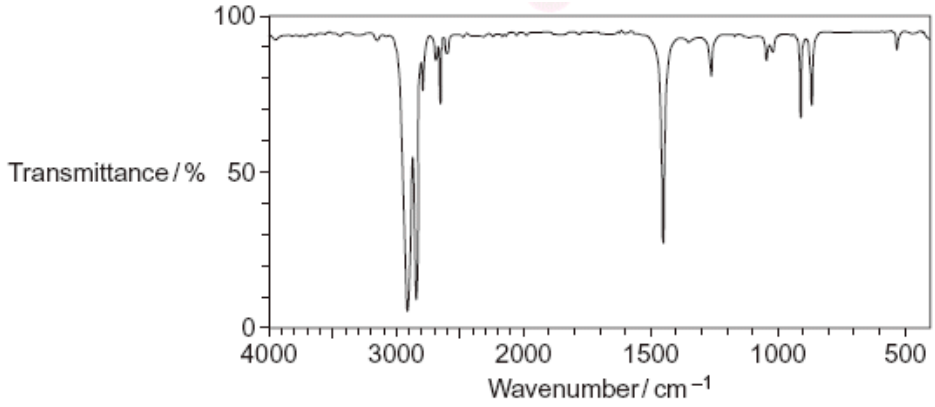
Displayed formula for **Q**

Type of structural isomerism .....

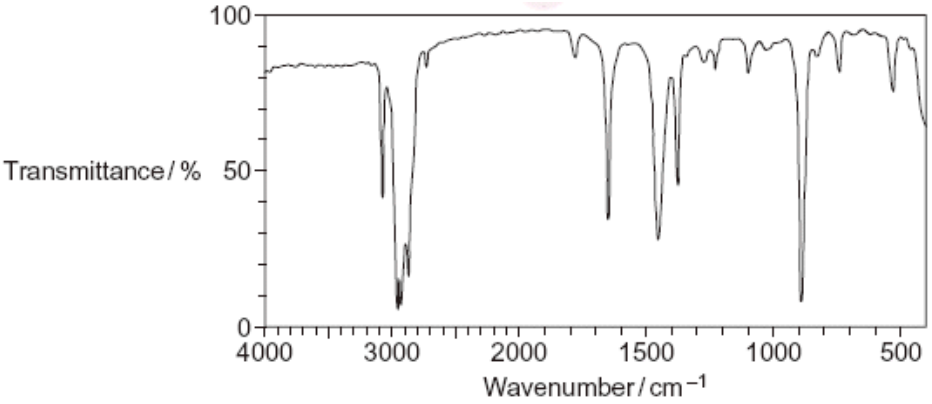
(2)

(b) The infrared spectra of two compounds **R** and **S** are shown below. **R** and **S** have the molecular formula C_6H_{12} and are structural isomers of 3-methylpent-2-ene. **R** is an unsaturated hydrocarbon and **S** is a saturated hydrocarbon.

Spectrum 1



Spectrum 2



(i) Identify the infrared Spectrum **1** or **2** that represents compound **R**.
Use information from the infrared spectra to give **one** reason for your answer.
You may find it helpful to refer to **Table 1** on the Data Sheet.

R is represented by Spectrum .....

Reason .....

.....

(2)

(ii) State the type of structural isomerism shown by **R** and **S**.

.....

(1)

(iii) Name **one** possible compound which could be **S**.

.....

(1)

(Total 7 marks)