READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX compulsory questions in TWO sections.

2. Section A consists of THREE structured questions, one from each Module. Section B consists of THREE extended response questions, one from each Module.

3. For Section A, write your answers in the spaces provided in this booklet. For Section B, write your answers in the answer booklet provided.

4. All working must be shown.

5. The use of non-programmable calculators is permitted.

6. A data booklet is provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.
SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

MODULE 1
THE CHEMISTRY OF CARBON COMPOUNDS

1. (a) Draw and state the name of FOUR isomeric alcohols with formula C_4H_{10}O.

   (i) ___________________________ (ii) ___________________________

   Name ___________________________ Name ___________________________

   ___________________________

   (iii) ___________________________ (iv) ___________________________

   Name ___________________________ Name ___________________________

   [8 marks]

   (b) Identify the type of isomerism illustrated in (a) above.

   ___________________________

   [ 1 mark ]

GO ON TO THE NEXT PAGE
(c) State ONE other type of isomerism that can be displayed by alcohols.

[ 1 mark ]

(d) EACH isomer in 1. (a) on page 2 was treated with acidified potassium permanganate. Describe the expected observation in EACH case.

<table>
<thead>
<tr>
<th>Alcohol</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td></td>
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<tr>
<td>(iii)</td>
<td></td>
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<tr>
<td>(iv)</td>
<td></td>
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</tbody>
</table>

[ 4 marks ]

(e) $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+\text{ (aq)}$ would also react with the alcohols in a way similar to $\text{KMnO}_4/\text{H}^+\text{ (aq)}$.

State the colour change with $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+\text{ (aq)}$ which would indicate a positive result.

[ 1 mark ]

Total 15 marks
2. (a) State ONE use of chromatography in criminal investigations.

[ 1 mark ]

(b) Outline FOUR essential experimental steps in the separation of the components of a dye using thin-layer chromatography (TLC).

[ 4 marks ]

(c) Define the terms ‘stationary phase’ and ‘mobile phase’ in relation to thin-layer chromatography (TLC).

Stationary phase

[ 2 marks ]

Mobile phase
(d) Name TWO materials commonly used as the stationary phase in TLC.

(e) Figure 1 shows the separation of the components of a dye on a TLC plate.

![Diagram of TLC separation](image)

Figure 1. The separation of the components of a dye using TLC

(i) Calculate the $R_f$ values of components A and B.

$R_f$ values of component A

$R_f$ values of component B

[2 marks]

[1 mark]

[1 mark]
(ii) Suggest TWO reasons for the difference in the $R_y$ values of A and B.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

[ 2 marks]

(iii) State TWO factors, other than the distance travelled by the solvent, which influence the $R_y$ value of a solute.

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________

[ 2 marks]

Total 15 marks
3. (a) Describe how the concepts of reuse, recycle and reduce can be applied to paper as a solid waste.

Paper

Reuse

[ 1 mark ]

Recycle

[ 1 mark ]

Reduce

[ 1 mark ]

(b) Suggest TWO ways in which the presence of nuclear waste can affect the terrestrial environment.

[ 2 marks ]

(c) In landfills, chemical and microbial reactions can lead to the formation of gaseous pollutants. State the names OR chemical formulae of TWO landfill gases.

[ 2 marks ]
(d) (i) Describe, with the aid of equations, the steps involved in the fermentation of sucrose.


[5 marks]

(ii) When beer is exposed to air for some time, it produces a sharp smell and is described as becoming “sour”.

Identify TWO possible compounds responsible for the sharp smell and state the type of reaction responsible.

Compound 1: ____________________________

Compound 2: ____________________________

Type of Reaction ____________________________

[3 marks]

Total 15 marks
SECTION B

Answer ALL questions in this section.

Write your answers in the answer booklet provided.

MODULE 1

THE CHEMISTRY OF CARBON COMPOUNDS

4. Compound A is an alkene. Study its structural formula given below and answer the questions which follow.

\[
\begin{array}{c}
\text{CH}_3 \\
\text{H}_2\text{C} - \text{C} = \text{C} - \text{H} \\
\text{H}
\end{array}
\]

\( \text{Compound A} \)

(a) Give the structural formula for the reaction of Compound A with

(i) aqueous bromine

(ii) liquid bromine

(iii) cold \( \text{KMnO}_4/\text{H}^+ \)

(iv) hot \( \text{KMnO}_4/\text{H}^+ \).  

[6 marks]

(b) State whether Compound A exhibits geometric (cis/trans) isomerism.  

[1 mark]

(c) Give TWO reasons for your answer in (b).  

[2 marks]

(d) Outline the mechanism for the reaction between Compound A and \( \text{HBr} \), using curved arrows to show the movement of electrons.  

[5 marks]

(e) State the type of reaction mechanism outlined in (d) above.  

[1 mark]

Total 15 marks
5. (a) Two pieces of apparatus used in the filtration process are shown in Figure 2 and Figure 3 respectively.

![Figure 2](image1)

![Figure 3](image2)

State the names and functions of these pieces of apparatus. [5 marks]

(b) When a solute is shaken in a mixture of two immiscible solvents and allowed to stand, a dynamic equilibrium is established in which the solute is partitioned or distributed between the two solvents.

(i) Write an equation to explain the term ‘partition coefficient’ or ‘distribution coefficient’ using the example of an ester dissolved in a mixture of water and toluene. [1 mark]

(ii) State TWO factors which affect the value of the partition coefficient. [2 marks]

(iii) Explain the principles of solvent extraction with respect to the recovery of an organic compound from an aqueous solution. [4 marks]

(iv) A solution of 10.0 g of an ester, Y, in 100 cm³ of water was shaken with 200 cm³ of ether. After separation, the aqueous solution was found to contain 1.6 g of Y.

Calculate the partition coefficient of Y between ether and water. [3 marks]

Total 15 marks
6. (a) List FOUR factors which would influence the location of an industrial plant. [4 marks]

(b) State TWO safety concerns associated with the locating of an ammonia plant and for EACH concern suggest a measure that can be taken to reduce its effect. [4 marks]

(c) The reduction in harmful gaseous emission from vehicles has been achieved by fitting vehicles with catalytic converters. These allow for the conversion of carbon monoxide and nitrogen monoxide to carbon dioxide and nitrogen, respectively.

Write TWO equations for these conversions. [4 marks]

(d) The burning of fossil fuels in industrialised countries emits sulphur dioxide as one of the combustion products.

(i) ONE reason why sulphur dioxide is considered to be a pollutant is that it produces acid rain.

Write an equation to support this reason. [2 marks]

(ii) Give ONE reason (other than the production of acid rain) why sulphur dioxide is considered to be a pollutant. [1 mark]

Total 15 marks

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.