Materials
For this paper you must have:
• a ruler
• a scientific calculator
• the periodic table (enclosed).

Instructions
• Use black ink or black ball-point pen.
• Fill in the boxes at the top of this page.
• Answer all questions in the spaces provided.
• Do all rough work in this book. Cross through any work you do not want to be marked.
• In all calculations, show clearly how you work out your answer.

Information
• The maximum mark for this paper is 70.
• The marks for questions are shown in brackets.
• You are expected to use a calculator where appropriate.
• You are reminded of the need for good English and clear presentation in your answers.
Tablets to cure indigestion contain a mixture that has been designed as a useful product.

Complete the sentence.

Choose the answer from the box.

[1 mark]

| catalyst | formulation | hydrocarbon | solvent |

Tablets to cure indigestion are an example of a ________________________.

Table 1 shows the substances in one tablet.

<table>
<thead>
<tr>
<th>Substance</th>
<th>Mass in mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium hydrogencarbonate</td>
<td>64</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>522</td>
</tr>
<tr>
<td>Magnesium carbonate</td>
<td>68</td>
</tr>
</tbody>
</table>

The total mass of these substances in the tablet is 654 mg.

What is the approximate fraction of magnesium carbonate in the total mass of these substances?

[1 mark]

Tick one box.

\[ \frac{1}{10} \quad \frac{1}{100} \quad \frac{1}{1000} \quad \frac{1}{10000} \]
01.3 The tablets also contain sugar.
Suggest why. [1 mark]

01.4 Sodium hydrogencarbonate cures indigestion by reacting with acid in the stomach.
What type of reaction is this? [1 mark]
Tick one box.

- Combustion
- Displacement
- Neutralisation

Question 1 continues on the next page
A student adds an indigestion tablet to dilute hydrochloric acid.

The gas produced is bubbled through limewater.
The gas turns the limewater milky.

Name the gas produced. [1 mark]

Water is also produced.

Which two statements are reasons why water is a liquid at room temperature? [2 marks]

Tick two boxes.

- Water has a boiling point of 100 °C
- Water has a giant covalent structure
- Water has a melting point lower than room temperature
- Water has delocalised electrons
- Water is made of ions
Calcium chloride is also produced.

- The formula for a calcium ion is $\text{Ca}^{2+}$
- The formula for a chloride ion is $\text{Cl}^{-}$

What is the formula of calcium chloride? [1 mark]

Tick one box.

CaCl   $\phantom{\text{CaCl}_2}$  CaCl$_2$  Ca$_2$Cl$\phantom{2}$  Ca$_2$Cl$_2$

The tablets are stored in glass bottles.

Figure 1 shows part of a flowchart for recycling glass.

Complete Figure 1.

Choose the answers from the box. [2 marks]

<table>
<thead>
<tr>
<th>crushed</th>
<th>electrolysed</th>
<th>frozen</th>
<th>melted</th>
<th>oxidised</th>
</tr>
</thead>
</table>

Figure 1

Waste glass bottle

\[\text{ }\]

\[\text{ }\]

\[\text{ }\]

Moulded

\[\text{ }\]

New glass bottle
There are no questions printed on this page
Table 2 shows the gases in the Earth’s atmosphere today.

<table>
<thead>
<tr>
<th>Gas</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₂</td>
<td>78.0</td>
</tr>
<tr>
<td>O₂</td>
<td>21.0</td>
</tr>
<tr>
<td>Ar</td>
<td>0.9</td>
</tr>
<tr>
<td>Other gases</td>
<td>𝑿</td>
</tr>
</tbody>
</table>

What is the percentage of 𝑿?

Tick one box.

- 0.01%
- 0.1%
- 1%
- 10%

Question 2 continues on the next page
0.2.2 Complete Figure 2.
Plot the data from Table 2 on Figure 2.

Figure 2

0 20 80 100
Percentage (%)

N₂ O₂ Ar

0.3 What is the name of the gas with symbol Ar?
Tick one box.

Aluminium
Argon
Arsenic
Astatine

[1 mark]
Some theories suggest that the Earth’s early atmosphere was the same as the atmosphere of Mars today.

Describe the change in the percentage of oxygen from the Earth’s early atmosphere to the Earth’s atmosphere today.

Use values from Table 2 on page 6 and Figure 3.

[2 marks]
Figure 4 shows the percentage of greenhouse gases from human activities.

Figure 4

- Electricity 30%
- Agriculture 25%
- Industry 30%
- Transport 15%

Compare the contribution of each activity to the total amount of greenhouse gases.

Use data from Figure 4.

[4 marks]
02.6 Suggest one way greenhouse gas emissions could be reduced. [1 mark]

02.7 Give one reason why it is difficult for some countries to reduce emissions of greenhouse gases. [1 mark]
There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED
A student investigated the effect of concentration on the rate of the reaction between sodium thiosulfate and dilute hydrochloric acid.

**Figure 5** shows the apparatus the student used.

![Sodium thiosulfate and dilute hydrochloric acid](image)

0.3 The symbol equation for the reaction is:

\[
\text{Na}_2\text{S}_2\text{O}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{SO}_2 + \text{H}_2\text{O} + \text{S}
\]

Complete the word equation for the reaction.

**[1 mark]**

sodium thiosulphate + hydrochloric acid → + sulfur dioxide + water + sulfur

**Question 3 continues on the next page**
Table 3 shows the results.

<table>
<thead>
<tr>
<th>Concentration of sodium thiosulfate in mol/dm³</th>
<th>Time for student to no longer see the cross in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>41</td>
</tr>
<tr>
<td>0.20</td>
<td>21</td>
</tr>
<tr>
<td>0.30</td>
<td>20</td>
</tr>
<tr>
<td>0.40</td>
<td>10</td>
</tr>
<tr>
<td>0.50</td>
<td>8</td>
</tr>
</tbody>
</table>

Plot the data from Table 3 on Figure 6.

Draw a line of best fit. [3 marks]
The student determined the time for a concentration of 0.15 mol/dm³.

What is the concentration when the reaction is 20 seconds faster?

You should show your working on Figure 6.

$$\text{Concentration} = \frac{0.15 \text{ mol/dm}³}{?}$$

[2 marks]

Estimate the time taken for the reaction when the concentration of sodium thiosulfate is 0.60 mol/dm³.

$$\text{Time taken} = \frac{? \text{ s}}{0.60 \text{ mol/dm}³}$$

[1 mark]
Crude oil and natural gas are natural resources in many countries.

Table 4 shows percentages of hydrocarbons in natural gas from three different countries.

Table 4

<table>
<thead>
<tr>
<th>Hydrocarbon</th>
<th>Percentage (%) of hydrocarbon in natural gas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Country X</td>
</tr>
<tr>
<td>Methane</td>
<td>78.03</td>
</tr>
<tr>
<td>Ethane</td>
<td>9.70</td>
</tr>
<tr>
<td>Propane</td>
<td>4.82</td>
</tr>
<tr>
<td>Butane</td>
<td>1.33</td>
</tr>
<tr>
<td>Pentane</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Calculate the mean percentage of propane from countries X, Y and Z. Give your answer to 2 decimal places. [2 marks]

Mean percentage of propane = %

Suggest why natural gas from different countries has different percentages of hydrocarbons. [1 mark]
Complete the sentence.

Choose the answer from the box.

[1 mark]

| an atom | an electron | an ion | a molecule |

The formula CH₄ represents ________________ of methane.

Complete the sentence.

[1 mark]

The hydrocarbons in Table 4 belong to the homologous series of ________________.

Question 4 continues on the next page
Figure 7 shows how properties vary with the increasing size of molecule in this homologous series.

**Figure 7**

<table>
<thead>
<tr>
<th>Property</th>
<th>Property</th>
<th>Property</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing size of molecule</td>
<td>Increasing size of molecule</td>
<td>Increasing size of molecule</td>
<td>Increasing size of molecule</td>
</tr>
</tbody>
</table>

Which graph shows how boiling points vary?

Tick one box.

A   B   C   D

Which graph shows how viscosity varies?

Tick one box.

A   B   C   D

Crude oil is fractionally distilled.

Fractions with larger molecules are cracked.

Describe two differences between fractional distillation and cracking.

1. 

2. 
**04.8** Ethene is a product of crude oil.

Complete the sentence.

Ethene polymerises to produce __________________________.  

**04.9** The production of plastic bags uses limited resources.

**Figure 8** shows two ways (A and B) of saving limited resources.

**Figure 8**

Make → Use → Dispose

Name A and B.

Choose the answers from the box.

<table>
<thead>
<tr>
<th>recycle</th>
<th>reduce</th>
<th>release</th>
<th>reuse</th>
<th>reverse</th>
</tr>
</thead>
</table>

A __________________________

B __________________________
A student investigated the effect of different catalysts on the decomposition of hydrogen peroxide.

**Figure 9** shows the apparatus the student used.

**Table 5** shows the student’s observations.

<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese dioxide</td>
<td>A lot of gas and hydrogen peroxide bubbles up into gas syringe</td>
</tr>
<tr>
<td>Potato</td>
<td>Steady bubbles of gas</td>
</tr>
<tr>
<td>Copper oxide</td>
<td>Few bubbles of gas</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>Very few bubbles of gas</td>
</tr>
</tbody>
</table>

Which is the most useful catalyst?

Explain your answer.

[2 marks]
Figure 10 shows the gas syringe during the investigation.

![Figure 10](image)

What is the volume of gas?

Tick one box.

- 52 cm\(^3\)  
- 55 cm\(^3\)  
- 70 cm\(^3\)  
- 75 cm\(^3\)  

[1 mark]

Question 5 continues on the next page
For one of the catalysts the student measures the volume of gas given off every 20 seconds for 2 minutes.

The volume of gas was zero at the start of the experiment.

The measured volumes of gas are:

\[ 23 \text{ cm}^3 \quad 42 \text{ cm}^3 \quad 59 \text{ cm}^3 \quad 72 \text{ cm}^3 \quad 80 \text{ cm}^3 \quad 88 \text{ cm}^3 \]

Complete Table 6 to show these results. [4 marks]

**Table 6**

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
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</tr>
</tbody>
</table>

Suggest why the readings might be lower than expected. [1 mark]

------------------------------------------------------------------

------------------------------------------------------------------
The student did the experiment with four different catalysts.

Give two variables the student should keep constant. [2 marks]

1
2

Turn over for the next question
**Figure 11** shows a chromatogram for a food colouring.

**Figure 11**

- Solvent front
- Spot C
- Food colouring

How does the chromatogram show that the food colouring is a mixture? [1 mark]

________________________________________________________________________

________________________________________________________________________
A student makes measurements for spot C.

Table 7 shows the results.

Table 7

<table>
<thead>
<tr>
<th>Distance in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance moved by spot C</td>
</tr>
<tr>
<td>Distance moved by solvent</td>
</tr>
</tbody>
</table>

Calculate the R_f value for spot C.

Give your answer to 2 significant figures.

Use the results in Table 7.

R_f value = ____________________

[3 marks]

Question 6 continues on the next page
Plan a chromatography experiment to investigate the colours in an ink.

[6 marks]
07.1 Methane is burned in a plentiful supply of oxygen. Which is the correct balanced chemical equation?

Tick one box. [1 mark]

CH$_4$ + O$_2$ $\rightarrow$ CO$_2$ + H$_2$O

CH$_4$ + 2O$_2$ $\rightarrow$ CO$_2$ + H$_2$O

CH$_4$ + 2O$_2$ $\rightarrow$ CO$_2$ + 2H$_2$O

CH$_4$ + 3O$_2$ $\rightarrow$ 2CO$_2$ + 2H$_2$O

07.2 Burning fuels causes atmospheric pollution. Write one effect for each pollutant in Table 8. [3 marks]

Table 8

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide</td>
<td></td>
</tr>
<tr>
<td>Sulfur dioxide</td>
<td></td>
</tr>
<tr>
<td>Particulates</td>
<td></td>
</tr>
</tbody>
</table>

Question 7 continues on the next page
Methane, petrol and coal are fuels.

**Table 9** shows information about these fuels.

<table>
<thead>
<tr>
<th>Fuel</th>
<th>State</th>
<th>Energy content in kJ per g</th>
<th>Mass in mg of CO₂ produced for one kJ of energy released</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methane</td>
<td>Gas</td>
<td>52</td>
<td>53</td>
</tr>
<tr>
<td>Petrol</td>
<td>Liquid</td>
<td>43</td>
<td>71</td>
</tr>
<tr>
<td>Coal</td>
<td>Solid</td>
<td>24</td>
<td>93</td>
</tr>
</tbody>
</table>

Evaluate the use of the fuels.

Use in the information in **Table 9** and your knowledge. [6 marks]

END OF QUESTIONS